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Town Planning

IMPROVING THE SAFETY OF LOCAL STREETS

T. M. Pharoah, MSc

R.M. 1/83

Research Monograph

Polytechnic of the South Bank, Faculty of the Built Environment, Wandsworth Road, London SW8 2JZ

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ABSTRACT

The paper argues that insufficient attention is paid to the design of local streets. Ample guidance is available on the design of new residential roads, though not all local authorities adopt a modern approach. In existing residential streets there are many neglected opportunities to bring about major improvements in road safety and environmental quality. The paper shows how these opportunities can be exploited through physical design rather than legal restrictions. Specific possibilities are described and illustrated. The paper is intended for all those concerned (professionally or otherwise) with the design, quality, maintenance and safety of local roads.

THE AUTHOR

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CONTENTS

1. INTRODUCTION

Urban life requires the existence side by side of all types of activities, most of which create few environmental problems. The main source of conflict and certainly the most pervasive is transport, the vital activity which links all the others.

No one seriously disputes that the motor car has brought enormous benefits to a substantial proportion of the population. But equally, no one can deny that the proliferation of motor vehicles has created an environment which is often dangerous, noisy, unsightly or otherwise unpleasant. (What is disputed is the effect of this nuisance on people's decisions about where to live and work.)

The debate about what should be done to reap the benefits of motorisation and to control its harmful effects is often strongly polarised between the extreme pro-car and anti-car viewpoints. This is a pity because it tends to obscure the opportunities that exist for widespread, simple and relatively uncontroversial improvements. Some of these opportunities, namely those on local residential streets, are discussed in this paper.

The problems to be confronted are essentially those of competing or conflicting interests (between pedestrians and drivers, between buses and other traffic, between parked and moving vehicles, between the noisy rush of vehicles and the peace of the environment).

These disadvantages of motorisation do not affect all people equally, nor are they spread evenly across urban areas. At one end of the scale we have urban motorways whose sole function is to carry motor vehicles. At the other end of the scale we have the streets from which vehicles have been totally excluded for the sake of safety and comfort for pedestrians and a peaceful living and working environment. Such streets are usually shopping streets.

In between these two extremes are the great majority of urban roads and streets. They vary enormously in their appearance and function, but their significant characteristic is that they are usually "all purpose" streets: they carry both vehicle and pedestrian traffic, and they are lined with frontage development. The level of priority afforded to, say, pedestrians as opposed to vehicles is sometimes a product of deliberate planning, especially on the main roads and in the more recent housing schemes, but more often the unintended result of street designs inherited from the days before the problems of motorised traffic.

Amongst the driving population, there will always be those who drive as badly as they are allowed to. For this reason, street design and traffic management are of vital importance, and the present shortage of measures to control traffic creates widespread and often serious problems.

It is on the main roads that conflicts are most intense and most difficult to resolve. Design solutions are often controversial because it has proved impossible to reconcile the interests of drivers with those of pedestrians, cyclists and occupiers of

frontage property within reasonable financial limits.

Not surprisingly, it is these difficulties which absorb the majority of traffic planning effort. Meanwhile, however, problems abound on the thousands of miles of purely residential (or local) roads where the majority of people live. Here the problems are less frequent, less dramatic and more thinly distributed than on the main traffic arteries. But vehicles in these streets nevertheless impinge on our lives in vital ways.

The presence of vehicles in close proximity to people's homes has become so dominant that streets now are rarely places where children meet and play, where young mothers or the elderly stop and chat, or where other "homely" activities occur. To the extent that streets are used in this way, it is often accompanied by danger and disturbance.

This paper puts the case that more attention should be given to the design and redesign of local streets in order to resolve these conflicts and to exploit the many opportunities for creating a better residential environment. The paper offers both general guidelines and specific suggestions for achieving these objectives.

2. THE IMPORTANCE OF LOCAL STREETS*

At least 8 out of 10 people live in roads or streets which are mainly residential, and which carry relatively small volumes of traffic (not more than about 3,000 vehicles per day, and a peak flow not exceeding about 500 vehicles an hour). These streets comprise the great majority of urban road networks. In London, for example, the non-Principal roads account for 87% of the total network, and unclassified roads (using the now historic categories of A, B and C roads) account for 75% of the total mileage. The design and consequent quality of these "local" streets therefore affects almost the entire population.

As suggested in the Introduction, the majority of design effort (in terms of both road layout and traffic management schemes) is expended trying to solve the problems of roads carrying large volumes of vehicle and pedestrian traffic. The designer's (or engineer's) aim is usually to strike a satisfactory balance between conflicting objectives including road safety, smooth traffic flow, easier bus operating conditions, parking, servicing of frontage properties, and improving the environment. Whatever the degree of priority attached to the safety objective, it remains a fact that the busiest roads present the highest accident rates per mile of road.

Whilst it would be foolish to suggest that the problems on main roads should receive less attention than at present, it is important to question why the problems of traffic in local streets are so often ignored.

Certainly there is evidence of people's concern about the impact of vehicles in their home environment.

In a survey carried out in 1972,** 31% of respondents, when asked how they would like to see their street improved, spontaneously mentioned some kind of traffic improvement (in the context of improvements ranging from tree planting to street cleaning). The survey revealed a preference for streets with "very little traffic", and a concern that whatever traffic there is "should not unduly disturb the peacefulness of the location. Nor should it become a danger to people or of detriment to buildings and environmental quality." Of traffic disturbances in the street, most concern was expressed about traffic danger, followed closely by traffic noise. Not surprisingly, the extent of concern correlated with the volume of traffic in the street.

Similar results were obtained from a national survey of road traffic and the environment carried ut in Britain in 1972. This found that pedestrian danger (the most prominent nuisance) bothered 69% of the adult population (see table below). The same survey found that 53% of people were worried about the safety of others, especially children and elderly people.

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* See Appendix A for notes on the definition of local streets.

** Hoinville, G. & Prescott-Clarke, P. "Traffic Disturbance and Amenity Values" SCPR 1972. A survey of 1200 adults randomly sampled from six British towns and cities.

TRAFFIC DISTURBANCES IN BRITAIN*

Type of disturbance	% of adults Bothered at all	Seriously Bothered
Pedestrian Danger	69	27
Noise at Home	49	9
Noise Outside	54	16
Fumes at Home	7	3
Fumes Outside	47	23
Dust and Dirt	36	15
Vibration	27	8
Parking	21	12

A Department of Education report published in 1973** recorded the widely felt anxiety about the safety of pupils walking to school, especially the younger children. A San Francisco study concluded that traffic flow governs city street life: "The effects of traffic on street life are subtle, complex and, in many instances, destructive. Traffic provides a poor environment for any kind of life, especially family life."***

One cannot deny the practical values of the presence of motor vehicles in local streets. The convenience of cars and delivery vehicles being able to reach people's front doors is a highly valued advantage of motorisation. On the whole, car drivers like to park close to and within sight of their homes. This convenience at the home end of journeys depends, of course, on the ability of local as well as main roads to distribute traffic throughout urban areas. Indeed, many short vehicle journeys are made entirely on local streets. But conflicts inevitably arise because those same people who value the convenience of a car outside their doors suffer in turn from others driving past to reach their front doors.

The quality of local streets therefore hinges on the balance that is struck between the various roles of providing access to property, distributing traffic and providing amenity space outside the home (the light, space and air between buildings, and opportunities for outdoor activities).

* Sando, F.D. and Batty, V. "Road Traffic and the Environment", Social Trends No. 5, 1974. The survey covered a representative sample of over 5000 adults.

** Dept. of Education and Science "School Transport" HMSO 1973

*** Appleyard, D. & Lintell, M. "Streets: Dead or Alive?" in New Society 3rd July 1975

3. WHAT ARE THE PROBLEMS OF LOCAL STREETS?

Big problems are not the only problems

Traffic jams, major accidents, fume-laden air, long waits to cross the road, conversation-drowning noise from lorries, and other unpleasantness associated with heavy traffic are not often experienced in local streets. This is welcome, of course, but as a result the problems that do occur in local streets tend to get overlooked. Because these problems are infrequent or undramatic or sporadic in their occurance, it is often considered to be uneconomic to take measures to ameliorate them. For example, the provision of zebra or pelican crossings depends upon certain criteria of pedestrian-vehicular conflict being met. If the conflict if not sufficiently great, no special provision will be made. This does not mean that there is no conflict; merely that it will not be solved by conventional means.

The main problem in local streets is the discord between vehicles and residential activities. Accidents are the most distressing aspect, but they amount to a fraction of the total problem. For every accident there may be a hundred near-misses, and for every near-miss, how much fear and anxiety?

One cannot assume that people's anxieties about traffic relate mostly to busy roads. It may, for example, be acceptable to have to concentrate when crossing the occasional busy road. It may be much less acceptable to have to be on one's guard at every turn, and this is increasingly necessary on the entire network of local streets.

Such problems are difficult to quantify, and this may help to explain the neglect of local streets. Local authorities tend only to act (if at all) where accidents have occured, thus leaving a large part of the problem untouched.

Three main factors determine traffic conflict in local streets:

1. Traffic volume and composition
2. Traffic speed
3. User behaviour (especially drivers, but pedestrians also)

Consider the following facts. First, most urban streets have a 30mph (or 50kmph) speed limit so that legally a driver is entitled to proceed at that speed, provided that the way ahead appears to be clear. The speed limit is not usually varied and so takes no account of the wide differences in street functions and designs. The speed limit on local streets cannot easily be enforced by the Police (and this largely accounts for the standard limit).

Second, it appears that, mile for vehicle mile, local streets are just as dangerous for pedestrians as main roads. In other words, a driver is as likely to injure a pedestrian while driving on local streets as he is while driving on main roads.

Third, the majority of child pedestrian casualties occur on local streets. It is estimated in London, for example, that the casualty rate (per vehicle mile) to children under 10 is three

times higher on non-Principal roads than on Principal roads.* Moreover, whilst the non-Principal roads (87% of the total network) carry around 40% of the traffic, about two thirds of child casualties occur on them. A study of child accidents in Hampshire** showed that 65% of injuries to children under 10 occured within a quarter of a mile of the child's home, and that at least 25% of these were in the street where they lived. 41% occured within 100 yards of the child's home. Swedish research*** has found that 70% of all accidents to children under 6 take place in streets carrying less that 3000 vehicles per 24 hours.

Placing emphasis on these points gives a clue to the arguments to which we shall return in the next section, namely that in local streets the demands of motor vehicles are out of balance with what may be termed residential amenities, and also that legal restrictions are not sufficient to redress this imbalance. But before elaborating on this theme, some further points are appropriate.

"Girls and boys come out to play" (19thC rhyme)

The legal right of drivers to travel along local streets at up to 30 mph, and to park at the kerbside, effectively confines strolling and meeting to the footway**** and conversation can be distracted by the noise and intrusive presence of motor vehicles. More importantly perhaps, the only place where children can play in relative safety is on the footway. Even where dwellings have their own gardens, it is difficult and unecessarily restrictive to impose on children the formality and isolation associated with playing in their own homes.

Street life has traditionally provided children from the age of 4 or 5 onwards with their first important social contacts outside home. Mixing with the peer groups in the local streets has been emphasised, but meeting with other adults is no less important.

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* Analysis by the author of GLC 1981 road accident data based on the conservative assumption that non-Principal roads carry 42% of vehicle mileage. (It has sometimes been claimed that the non-Principal roads carry only 20% of total traffic. If this were true, the casualty rate to pedestrians per vehicle mile would be 2.4 times higher than on Trunk and Principal roads. For children under 10 the rate would be 7.7 times higher.)

** Grayson, G. B. "The Hampshire Child Pedestrian Accident Study" TRRL report LR 668. 1975

*** Report by Commission of the Swedish Statens Vaginstitut; research project led by Ove Lindgren and Jenny Winter, Goteborg, 1967)

**** The word "footway" in this paper refers to that part of the highway reserved for pedestrians, otherwise known as the "pavement"(UK), "sidewalk"(US), or "trottoir"(Fr). It is to be distinguished from "footpath", which usually means a track for pedestrians physically separated from roads or carriageways.

Moreover, in urban areas it is often only the footways and streets which can provide children with the physical space necessary for many of their games, for running and for learning to ride bicycles. This is all particularly important for younger children who are not able to go to parks and commons alone, and whose busy mothers or minders do not have the time to take them.

But in streets of conventional design freedom for children is bought at a heavy price in terms of injuries, death and parents' worry about these dangers. "Don't go in the road", "Mind the traffic", "Stay this side of the cross roads", "Hold my hand", are familiar exhortations which concerned parents continually deliver to their children. But children are easily distracted from common sense, and some are naturally less cautious than others*. All too often the penalty for a child's momentary lapse of concentration is serious injury or death.

Some may try to argue that unless children can be kept under careful and continuous supervision, they should be confined to their homes. This is surely unrealistic and even unhealthy? The great strains on both parents and children of confinement (for example in tower blocks) has been well documented.

Some argue that inadequate parental supervision is a major factor in child road accidents. ("Inadequate supervision contributed to over a third of the accidents involving children of pre-school age."**) The question is not so much whether parents are failing in their responsibilities, but whether, given the strains of child minding, and the inherently dangerous character of modern traffic, greater vigilance is possible. Can better results be achieved by controlling the source of the danger, namely drivers?

"Does enchantment pour out of every door? No, it's just on the street where you live" (From "My Fair Lady")

The demise of "street life" is often said to reflect changes in social structure, and in particular the reduced importance of the home environment in people's social life. We know from comparison of early photographs and contemporary experience that street life has diminished but there is little concrete research on changes in home life. Since these changes appear to have taken place along with the rise of motorisation, we should admit the possibility that the quantity of street contact over the past 50 years did not fall, but was pushed by the increasing dominance of motor vehicles.

The elderly and those in retirement depend upon the home environment for social contact to a much greater degree than those in employment. The need for safe streets is also greater because they may be slow and have poor hearing or sight. Lacking in agility, and often in confidence, the elderly can easily feel

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* For example on London's roads, the number of injuries to boys under 10 is almost double that for girls in the same age group.

** Grayson, G. B. "The Hampshire Child Pedestrian Accident Study" TRRL Report 668, 1975

threatened and confused when crossing the road. Drivers may claim to know this, but they do not always show consideration when behind the wheel.

The hazards or even the presence of vehicles in local streets may, by spoiling the pleasure of walking, encourage people to make journeys by car rather than on foot. The Department of Education report quoted ealier acknowledged the deterioration in walking conditions with the growth of traffic, and stated that "As a result of the increase in motor traffic and in the speed and size of vehicles on the road, it is no longer generally considered reasonable to expect a child of eight to walk two miles, or an elder child three miles, to school." Since the catchment areas of schools have not got smaller, the implication was clearly an expected increase in motorised travel for the journey to school. There is evidence of such an increase: We know that the number of escort trips has increased (for example, by 40% between 1965 and 1972) and that in 1980 they comprised 15% of all housewives' journeys, and 21% of all journeys made by housewives aged between 21 and 29. A majority of escort journeys are made to and from school. The point is that the number of "escort" journeys may be higher than would be necessary in a safe environment.*

In these ways travel patterns may be distorted in an undesirable way (ie. by encouraging traffic).

The problems of local streets, then, may be summarised as the conflict between residential and associated activities including people walking and playing, and the presence of parked and moving vehicles. The conflict is too often one-sided because whilst motor vehicles are hard and fast, people are soft and slow.

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* Escort journeys are those where the purpose is solely to accompany others (eg. children and the elderly). References are:
The National Travel Surveys for 1965 and 1972 quoted in Plowden, S. "Taming Traffic" Andre Deutsch 1980 p36; and Pickup, L. "Housewives' Mobility and Travel Patterns" TRRL Report LR 971, 1981.

4. THE LEGACY OF POOR DESIGN

The great majority of urban streets have been designed and constructed on principles established in the mid-1800's. These principles were simple. Roads were divided by a change of level (which also provided a gutter for surface water drainage) into a carriageway wide enough at least for two carriages to pass, and a footway on one or both sides.

The dimensions and geometry have developed over the years, and official standards for urban road layout and design were published in 1946 and 1966*. The need for design standards arose as the volume of moving and parked vehicles increased, but their application has been sporadic, and too often concerned purely with the interests of drivers.

Four wheels good; two legs bad.

By and large, road planning has benefited vehicles at the expense of pedestrians, but there are two fairly obvious reasons for this. The first is that it is not essential for pedestrians to have carefully planned and engineered spaces in which to move. The adaptability of the pedestrian enables him to manage even in the most hostile environments created primarily for wheeled traffic. This is far from saying, of course, that pedestrians do not benefit from good design.

The second reason is that road safety and the efficiency of movement has been threatened not by pedestrians but by vehicles, so that municipal engineers have tended to concentrate on the requirements of the latter. Vehicular traffic has increased; walking, probably, has not.

However strongly one feels about the consequences of vehicle-oriented road design, it is indisputable that the basic principles of over 100 years ago are still applied today. It is also true that whilst the scale and dimensions of roads have varied according to their intended or actual traffic function, the behaviour of road users has been controlled largely by traffic regulations rather than by street design.

Where traffic problems have become acute, both design and traffic regulations have been developed to cope. But where problems are apparently less intense or less severe, as on most local streets, very little has been done to improve upon the basic design set down more than a century ago.

Thus we see the absence of a design philosophy that differentiates between the obvious and intense problems on main roads, and the less obvious but more widespread problems on local roads.

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* 1. Ministry of War Transport "Design and Layout of Roads in Built-Up Areas" HMSO 1946

2. Ministry of Transport "Roads in Urban Areas" HMSO 1966

This section ends with a quote from Chermayeff and Alexander which expresses, from a North American viewpoint, some of the problems we have been discussing.

> "Where will Johnny Walk..?
>
> The spectacular speed crashes on the highways in which civilised men kill themselves by the car-load fill the headlines and are horribly and vividly portrayed in illustrated weeklies, but little is made of the poignant death of a child playing by the cars parked in the street where the unprotected, innocent, untrained and careless are to be found.
>
> The Deadly Street
>
> The street on which the houses grow is deadly. The public sidewalk made good sense before it was cut to pieces every few yards to make way for the private driveway. Now it is a shambles of curbs and changing levels - an obstacle race for mothers with their baby buggies. The street itself is no longer a promenade for friends and neighbors among whom pleasant exchanges can take place, but a service artery carrying dangerous trucks and other high-smelling vehicles filled with strangers. It is no longer a place for a community of children at play, or strolling lovers. Nor is it fit for a dog. The unresolved conflict between pedestrians and vehicles has made it obsolete."*

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* Chermayeff, S. and Alexander, C. "Community and Privacy: Toward a New Architecture of Humanism" Pelican, 1963, pp88-89

5. A NEW APPROACH

Broadly speaking, the layout of local streets is an inheritance from an age when vehicles were few in number, and relatively compatible with walking, playing and other street activities. These streets have altered little in their basic design, but they have to accommodate motor vehicles which, if not properly controlled, inevitably dominate people on foot.

Apart from the basic traffic law of driving on the left (in the UK), the only widespread measure to control the handling of vehicles in local streets is the 30mph speed limit. Of course legal restrictions of this kind provide no effective control if they are not enforceable, as in the case of local streets. But that is not the problem. To achieve safety and tranquillity outside the home, vehicle speeds well below 30mph are required.

Design, not regulation

If the objective is to reduce conflict in local streets, measures are required to make drivers proceed slowly and cautiously. The two main methods of achieving this are traffic regulations and street design.

Traffic regulations can provide a solution, but they have a number of serious disadvantages:-

1. Not all traffic regulations can be enforced (in particular the 30mph speed limit).
2. The existence of regulations, and the need for them, is not always appreciated by drivers. Thus one-way streets or no-entry restrictions are often seen as irritating and unnecessary curtailments of freedom.
3. Traffic management schemes designed to reduce conflicts, or to reduce traffic volumes, often make local access less convenient and so are resisted by residents themselves.
4. Traffic regulations usually require signs and road markings which tend to intrude into the local environment and serve to reinforce the right of drivers to use the local streets.

A much more satisfactory approach is to reduce the need for legal restrictions through skilfull road design. An ideal design will be one that conveys directly to drivers the residential function of the street, and the consequent need for them to behave as "guests". Just as the design of motorways unambiguously gives exclusive freedom to the drivers of motor vehicles, so the design of local streets should give the clear message that the residential function is the most important.

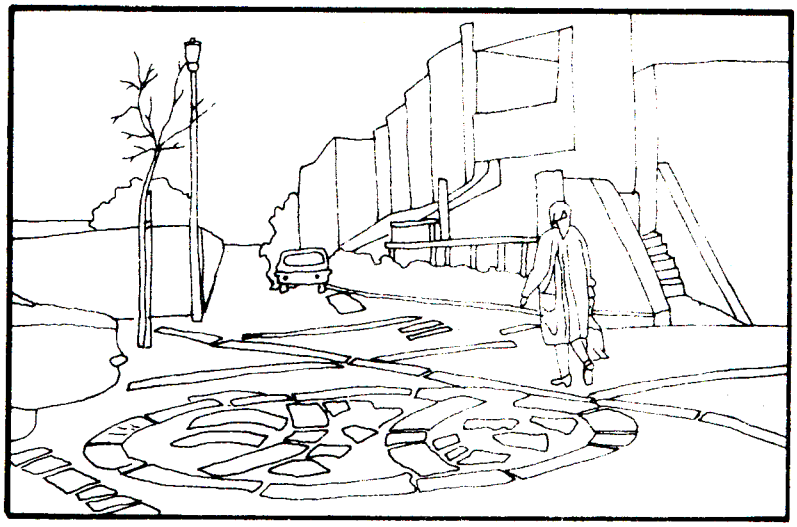
If one has to resort to road signs to instruct or exhort drivers to slow down or watch out for children, then this indicates a failure in design.

The very design of streets by itself can convey to drivers the behaviour that is expected of them. Figures 1 to 3 illustrate a few examples of streets where this has been done.

The disciplines of architecture, interior design and landscape design, yield many instances of techniques employed to influence

people's behaviour and attitudes. For example, colour is used to engender particular moods; internal office layouts may be designed to promote or discourage conversation; landscaping may be used to create an atmosphere of formality or informality; walls, hedges and changes of surface materials may be used to denote boundaries between spaces that are private and those that are public or semi-public.

FIG. 1 USE OF PATTERNS IN SURFACE WHERE STREET IS SHARED BY PEDESTRIANS AND VEHICLES (Byker development, Newcastle-upon-Tyne)



There is no reason why this approach should not be adopted within traffic management and street design, except possibly the contingent one that training in these fields has traditionally been almost wholly concerned with engineering and the application of standards, rather than creative design.

A design approach to traffic control requires the combination of the skills of traffic and highway engineers, with the insights of urban designers, architects, and even specialists in perception or environmental psychology. It probably also requires more money. Its feasibility, however, does not depend on the narrow accounting limits of local authorities, but on the long term benefits and cash savings that can be achieved.

The need for an approach of the kind outlined above was recognised sometime ago in the official design guide published in 1946*:

> "Opinions differ on the extent to which road conditions are contributory to accidents, but there is no doubt of the importance of so designing our roads as to minimise risk due to carelessness or faulty judgment whilst dispensing, as far as possible, with restrictive measures. The proper planning and design of roads can make a substantial contribution to road safety. A layout of such form as will promote the harmonious flow of traffic, and automatically lead road users to follow the right path, is an essential feature of a well designed road."

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* "Design & Layout of Roads in Built-Up Areas", paragraph 23

This paper is consistent with that philosophy, but places a different interpretation on the terms "harmonious flow of traffic" and "the right path", at least as far as local streets are concerned. As regards the former, "harmony" can only be achieved if traffic volumes and speeds are limited to the extent necessary for other aspects of street life to be safe and convenient. As regards the latter, the "right path" should not imply that pedestrians should be confined to a limited section of the road (see reference to the "Woonerf" example below).

FIG. 2 ARCHWAY CLEARLY DENOTING ENTRANCE TO A SEMI-PRIVATE AREA (Mews, Kensington)

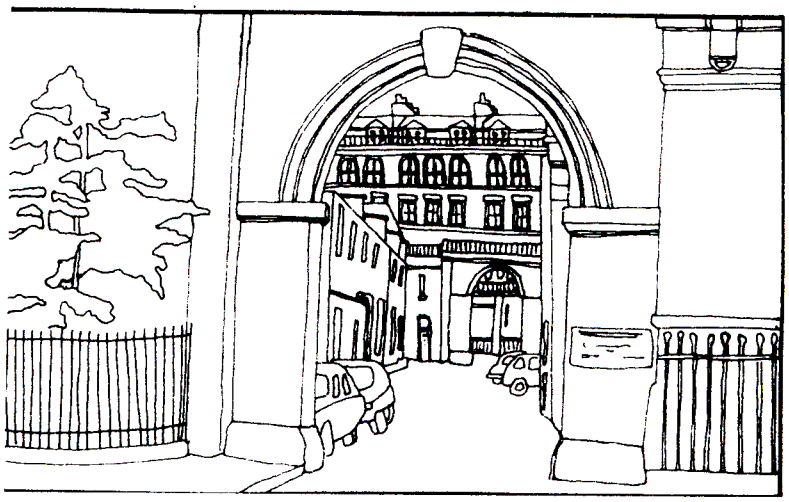
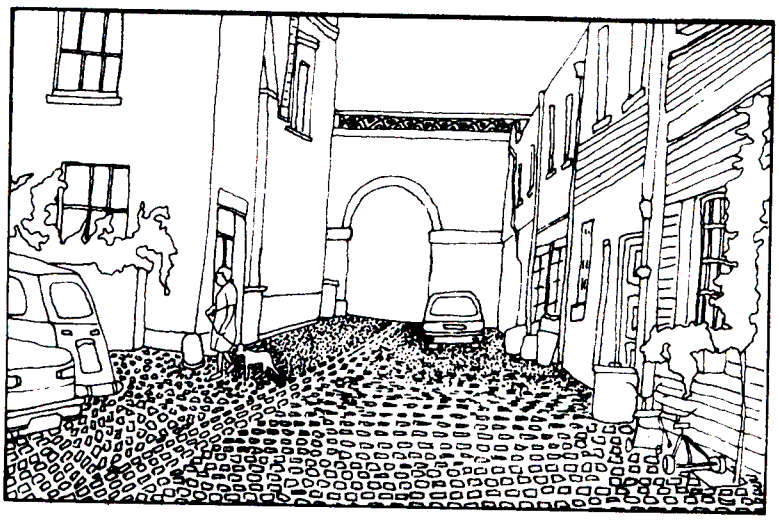


FIG. 3 ABSENCE OF FOOTWAYS AND USE OF "SETTS" HELPS TO EMPHASISE SPACE AS BEING PART OF THE HOME ENVIRONMENT RATHER THAN PART OF THE ROAD NETWORK (Mews, Kensington)



6. DESIGN PRINCIPLES

We have so far argued for a modern approach to the design, redesign and management of local streets, and this embodies the following objectives:

1. Safety, for all road users, but particularly those for whom the street may be regarded as an important part of their home ground (and who are specially vulnerable):
   - children
   - the elderly and disabled
   - other pedestrians
   - pedal cyclists
   - animals (pets)
2. Tranquillity. This environmental objective embraces:
   - quietness
   - visual quality
   - freedom from **worry** about danger
   - freedom from vehicle fumes and dirt
   - the opportunity to play, linger and dawdle without intimidation by vehicles
3. Convenience of Access to buildings in the street for pedestrian and vehicle traffic (including residents, visitors, roundsmen, emergency services and so on)
4. Parking for the vehicles of residents and their visitors (cars, vans and cycles)

These objectives could be achieved by the adoption of four guiding design principles:

1. **KEEP VEHICLE SPEEDS DOWN TO A LEVEL THAT IS COMPATIBLE WITH THOSE ON FOOT**
2. **CONTROL DRIVER BEHAVIOUR SO THAT THOSE ON FOOT HAVE PRIORITY, FREEDOM AND SAFETY**
3. **MINIMISE CONFLICTS BETWEEN ROAD USERS BY DESIGN RATHER THAN REGULATION**
4. **ENCOURAGE STREET LIFE**

These principles should guide the design process, and determine priorities when the demands of vehicles conflict with the more important demands made of local streets.

It is important to stress that improvements to local streets can be achieved without significantly affecting the capacity or efficiency of the road network as a whole, and so (in contrast to measures to improve main roads) may be uncontroversial.

"WOONERVEN"

Bold attempts to tackle the problems of residential streets have been made in the Netherlands. Over the past 10 years more than 1000 streets have been redesigned for shared use by pedestrians and vehicles. The word for such a street is "Woonerf" (pronounced Vonerf), or "Woonerven" for the plural.

The basic idea of a Woonerf is that the residential street should be part of the home environment rather than part of the traffic network, safe for children and other pedestrians, pleasant to be in, but without banning access by vehicles. This objective is

reflected in the word Woonerf, which roughly translated means "residential yard".

Woonerven probably represent the best expression to date of the principles advocated in this paper and so a description of the ideas behind them is justified. (The related traffic laws are set out at **Appendix B.** An example of a street converted to a "Woonerf" is reproduced at **Appendix C.**)

A Woonerf is a clearly identified area within which the residential function predominates over provision for vehicles, and this fact is expressed through the physical design and lay-out of the streets and other public areas. The design is attractive to pedestrians, with paving, trees, planting, lighting, children's play equipment and other features set out to create a welcoming atmosphere.

Parking is allowed only at places designated by a letter "P" set in the street surface; parking elsewhere is prohibited. Play areas for children are provided where possible, but children are allowed to play anywhere within a Woonerf.

A key element in the design is the removal of features (such as continuous raised kerbs) which suggest a division of different classes of traffic, or priority for wheeled traffic. There is no separation of footpath and carriageway.

A second key element is the introduction of speed-reducing features which make it very difficult for vehicles to proceed faster than walking pace. The most commonly used techniques are "sleeping policemen" or ramps, sharp bends, narrowed sections and the provision of street furniture which prevents long views of the road ahead (eg. planting boxes, bicycle racks, seating). Frequent variation in the streetscene using these techniques in combination with different materials and colours also conveys to drivers the message that speeds must be kept low. In a Woonerf vehicles are "manouvered" rather than "driven"!

Though there are now many examples of Woonerven in the Netherlands, information on their effectiveness is rather scarce. Surveys in Delft revealed more "social" use of converted streets than in comparable unconverted streets. And a testament to the success of the Woonerf is that comparison studies in Delft were hampered because residents in the control areas were pressing the local authority to convert their streets before the studies were completed. Two large scale demonstration projects (in Rijswijk and Eindhoven) are currently being evaluated and should provide more definitive conclusions on the Woonerf idea.

The Woonerf, however, in spite of its success cannot provide a solution to the problems of all local streets. Firstly, since driver cooperation is essential for them to be safe, the converted area cannot be so large as to engender irritation at driving slowly. Drivers should be able to reach a "normal" road within a few minutes. In the Netherlands, Woonerven usually cover areas not exceeding 500 metres radius.

Secondly, conversion usually results in a reduction of on-street parking space. If there is excess parking demand and drivers

ignore the parking restrictions, this negates one of the main principles of the Woonerf.

Thirdly, a Woonerf can be created only in predominantly residential areas where traffic volumes are low. A peak flow of about 250 vehicles an hour is the maximum that can be accommodated, but of course conversion itself may reduce volumes by discouraging drivers from entering the area.

Fourthly, creating a Woonerf involves considerable expenditure and design effort. In Holland, central government grants are available for this purpose.

Finally, legal changes are required for the implementation of the Woonerf idea. The relevant Dutch laws are outlined at **Appendix B.**

Clearly then, whilst the Woonerf is an exciting development with a lot of potential for improving both existing and new residential areas, it cannot be universally applied. For the improvement of urban road networks as a whole, a range of measures must be used. The objectives of traffic control and environmental quality, and the appropriate mix of techniques to achieve them will vary as widely as the different streets which comprise the network.

Road Hierarchy

For the engineer, or perhaps we should now say "designer", a useful technique is to classify urban roads into some form of hierarchy. This is not by any means a new idea, but the designation of "primary, secondary and tertiary" roads, or "strategic, district and local distributor" roads has very often been a mere reflection of existing traffic volumes.

If, however, the purpose is prescriptive rather than descriptive, the definition of a road hierarchy can be a valuable tool in aiding decisions on

- traffic rules and regulations (laws)
- design objectives and standards
- priorities in resource allocation.

The emphasis in the past has been on canalising traffic onto the highest tier possible in the hierarchy, and excluding through traffic from the lower tiers, or what Buchanan termed "environmental areas". This approach still finds favour - in plans if not in practice - but the use of the hierarchy concept to plan traffic behaviour rather than traffic routes could be a productive development.

It should be remembered that drivers are unconcerned with road hierarchies. They react to signposting and to the design of the road upon which they drive. If it is clear, well surfaced, well lit, and with few interruptions then priority for the driver is evident. If to the contrary the road is laid out with sharp turns, limited forward views, frequent crossings and junctions, changes of surface materials and levels, then the driver will exercise the appropriate care or choose an alternative route.

Deciding the role of each street in the network may not be a simple task, but it is one that cannot easily be avoided if sensible decisions on street design are to be achieved.

As already suggested, the basis of defining a hierarchy of urban roads should be, for each level, the intended purpose and the relative priority to be given to each of the street's various functions. Each tier should be defined in terms of factors including the following:

- traffic volume (vehicles per day and per peak hour)
- speed desired
- priority for pedestrians (whether walking or in the street for social reasons)
- expected environmental quality
- frontage activities
- access requirements.

The next section sets out various design techniques for local streets. Defining a network hierarchy will help in deciding where to apply each technique, and which dimensions to use. For example, kerb radii at junctions are a vital aspect of design for pedestrian safety and convenience. These can be varied according to the relative priorities for pedestrians and vehicles on each type of road.

Example: Variations in maximum kerb radii (metres) at junctions

Tiers in road hierarchy:
A Access street
L Local street
D District distributor
T Town distributor

			1	A
		2	1	L
	3	2	2	D
4	3	2	2	T
T	D	L	A	

It must be emphasised, however, that setting standards of design is a hazardous business, and can never be a substitute for creative and sensitive design. A willingness to experiment and to re-think conventional regulations and standards in order to achieve the best objectives has often been lacking. But without such an approach the quality of urban streets will continue to be eroded by the increasing volume of traffic.

7. SOME PRACTICAL DESIGN POSSIBILITIES

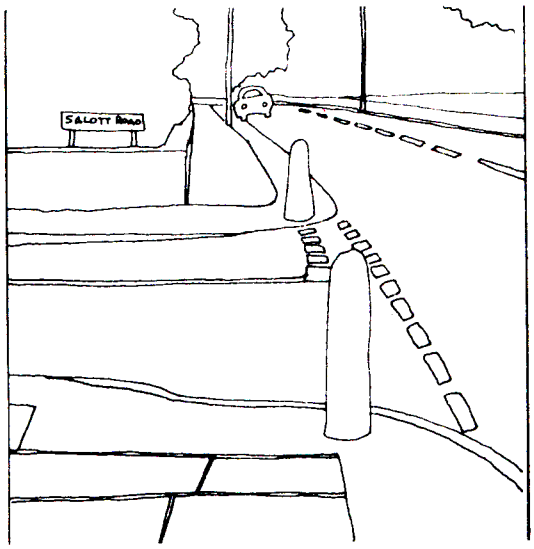
This section describes, and illustrates with examples, design techniques that have been or could be employed to improve local streets. The design ideas put forward are neither comprehensive nor universally applicable: design is a complex creative process and satisfactory solutions will vary with local circumstances and the wishes of local residents, as well as the skill of the designer. (The three dimensional drawings are all based upon photographs; the two dimensional drawings are not based on any specific locations.)

(i) Reducing Vehicle Speeds at Junctions

A large proportion of pedestrian/vehicle conflicts occur at junctions. When traffic volumes are or can be made very low-indeed the measures described in (iv) below may be appropriate. But apart from the busiest junctions, conflict can nearly always be alleviated by reducing the kerb radius (or "tightening the bend") at the junction itself.

The Highway Code exhorts drivers to "give way to pedestrians" when turning. Most drivers appear to be unaware of this advice, or choose to ignore it. But exhortation is no substitute for self-enforcing design.

FIG. 4. EXAMPLE OF JUNCTION WITH SMALL KERB RADII - ABOUT 1 METRE (Battersea)



With a small corner radius (up to about 2 metres as in Fig 5):

- vehicles turning must slow down to a maximum of 10-15 mph, probably engaging second gear
- pedestrians crossing (eg. **X** - **X** in Fig. 5 below) can more easily assert their right to cross: a vehicle can stop from 10 mph within a few feet
- the pedestrian's "desire line" is uninterrupted
- the width of carriageway to be crossed is minimised
- pedestrians do not have to look far behind them in order to check for fast moving vehicles that may cut in front of them.

FIG. 5. PLAN OF JUNCTION WITH SMALL KERB RADII (1.5 metres)

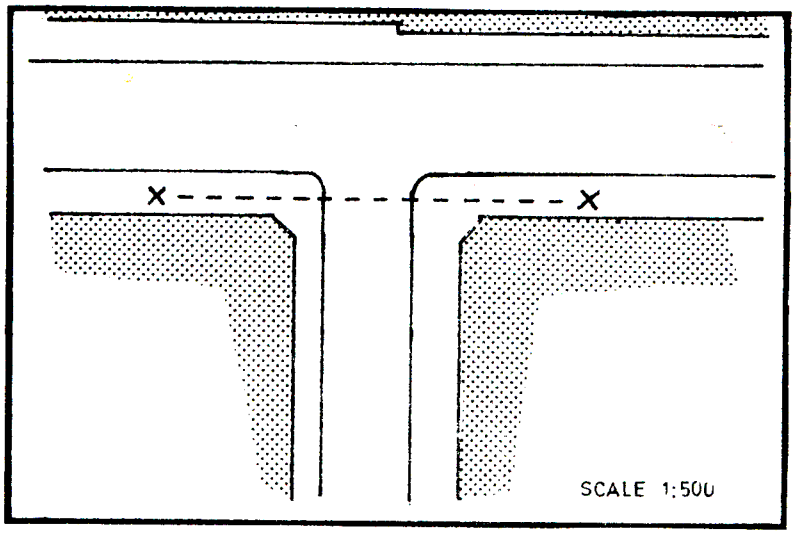
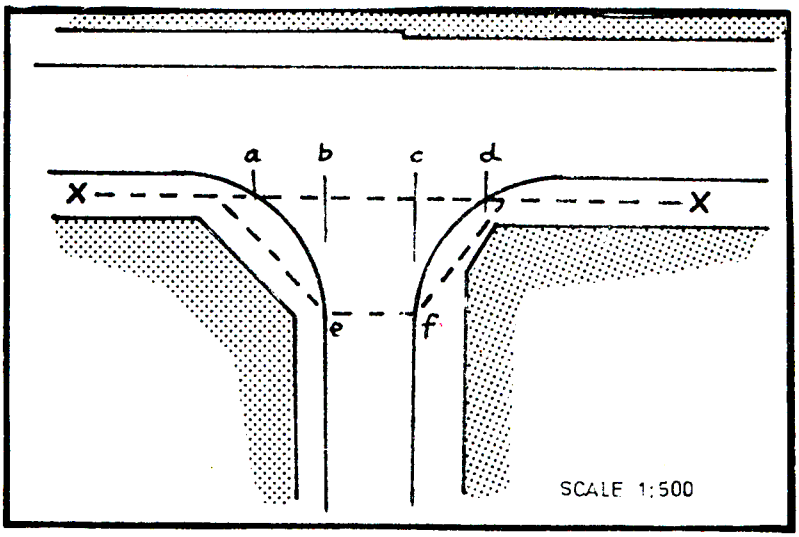


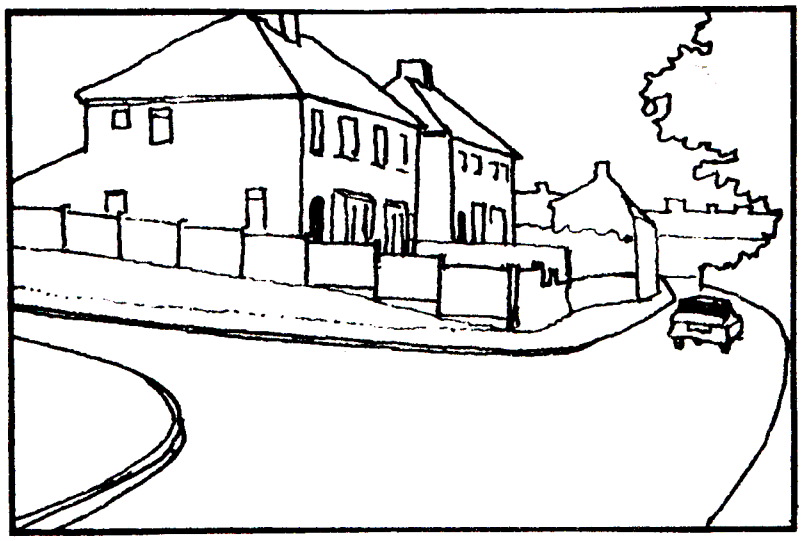
FIG. 6. PLAN OF LOCAL ROAD JUNCTION WITH LARGE KERB RADII (about 7 metres)



With large corner radii, more than 3 metres (7 metres in Fig. 6)

- vehicles can turn off the main road without slowing to less than 25 - 30 mph, probably in third gear
- pedestrians crossing (eg. **X - X** in Fig. 6 above) find it more difficult and more dangerous to persuade drivers travelling at this speed to wait for them to cross
- angle at which pedestrians must look behind them for approaching vehicles is sharper (they must look further behind)
- if pedestrian follows desire line, width of carriageway to cross is increased by **a-b** plus **c-d.**
- if pedestrian chooses minimum crossing width (for safety) then to take advantage of **e-f** additional distance must be walked (less convenient)

FIG. 7 EXAMPLE OF LOCAL ROAD JUNCTION WITH EXCESSIVE KERB RADII - ABOUT 10 METRES (Somerset)



At junctions on the main road network, the issue of traffic flow versus pedestrian safety and convenience is equally affected by kerb radii but may be difficult to resolve. At junctions of local streets, however, a tight radius design which favours the pedestrian should be simple to justify.

FIG. 8 SIGN WARNING DRIVERS OF DANGEROUS JUNCTIONS AHEAD - A SIGNAL OF FAILURE IN STREET DESIGN (Battersea)

(ii) Reducing Vehicle Speeds in Local Streets

The blanket speed limit of 30mph (50kph) is too high for most local streets and is in any case not enforceable. Additional measures to reduce speeds are usually taken only in response to a proven safety hazard, and so they occur infrequently. They may include warning signs, traffic islands or width restrictions. Occasionally the carriageway may be re-aligned or speed control humps ("sleeping policemen") introduced.

These measures are often inadequate as speed-reducing techniques.

- Warning signs can be ignored.(See Fig. 8)
- Traffic islands serve to emphasise the right of vehicles to be in the street, but can reduce excessive speed and overtaking. (See Fig. 9)
- width restrictions have been used mainly to exclude large vehicles , but they also have a speed reducing effect. (See Fig. 10)
- The effectiveness of speed control humps depends on their design, spacing and perceived relevance to the driver. Many drivers will be frustrated if travel at 30 mph on an otherwise clear street is hindered only by speed humps.

FIG. 9 TRAFFIC ISLAND TO HELP SLOW TRAFFIC AT A JUNCTION. NOTE SURFACE WARNINGS INVARIABLY OBSCURED BY PARKED CARS (Battersea)

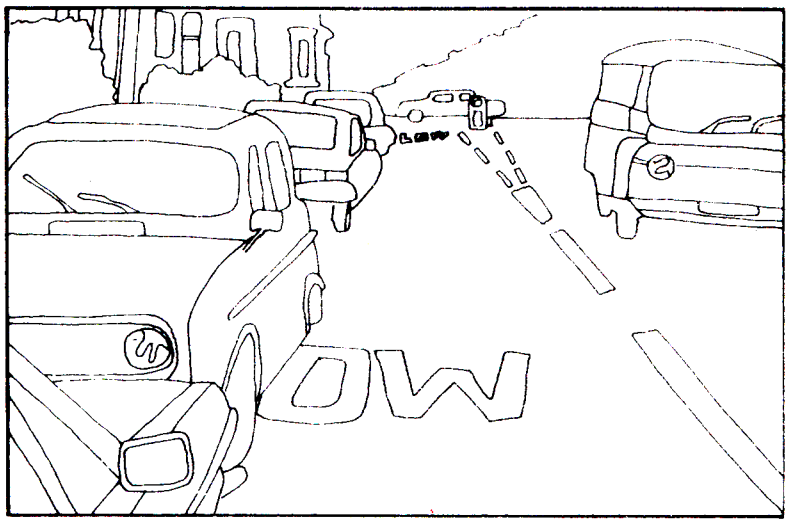
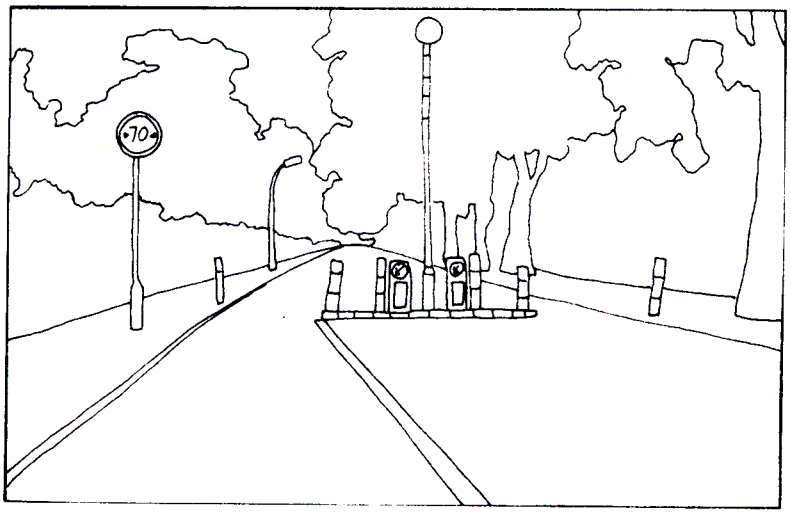


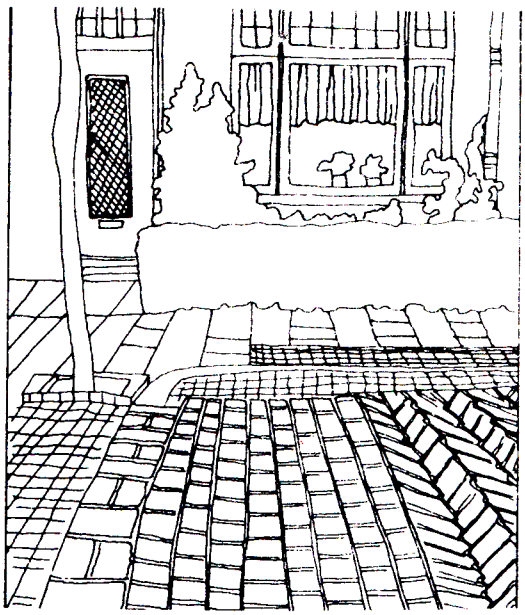
FIG. 10 WIDTH RESTRICTION USING BOLLARDS AND WARNING SIGN (Fulham)



Techniques of speed reduction in local streets have been developed to a high degree in the Dutch "Woonerf" schemes:

- Speed reducing elements at least every 50 metres (though the ANWB recommends 30 metres)
- Changes of horizontal alignment must be fairly severe (at least 45 degrees) whilst diversion from the axis should be at least sufficient to avoid a long view of the vehicle path ahead.
- Humps are not a pre-requisite but when used should be properly designed and visible (usually in association with vertical elements of street furniture). See Fig. 11.
- The impression of any distinction between the "carriageway" and the "footway" must be avoided. In particular, no kerb or other demarcation should continue for more than 25 metres.

FIG. 11 AN ATTRACTIVELY DESIGNED AND CONSTRUCTED SPEED CONTROL HUMP (Delft, Holland)



As already explained, the Woonerf is not a universal solution because it is feasible only where there are alternative routes for through traffic, where peak traffic volumes do not exceed about 300 vehicles per hour, and where parking space is adequate.

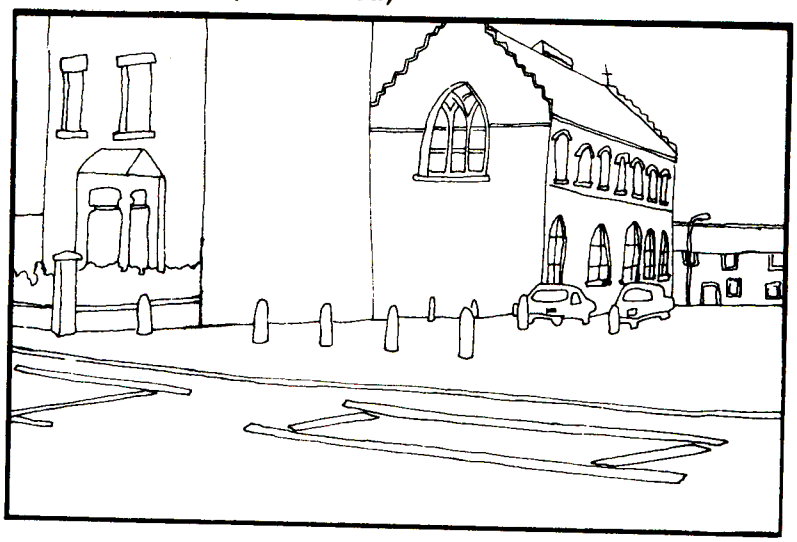
For the local street network in general, therefore, speed reduction must be achieved using one or more of a variety of techniques. In summary these are:

(a) two-way traffic operation
(b) narrow carriageways (with or without passing spaces at, say, 50 metre intervals)
(c) speed control humps
(d) shifts in horizontal alignment
(e) changes of surface texture (setts, bricks, rough aggregate, rumble strips, colour and pattern)
(f) street furnishing (to give appearance of semi-private or semi-public space)
(g) continous (ramped) footways at junctions and pedestrian crossings (See Fig. 27b)

(iii) Closing Road Junctions to Vehicles

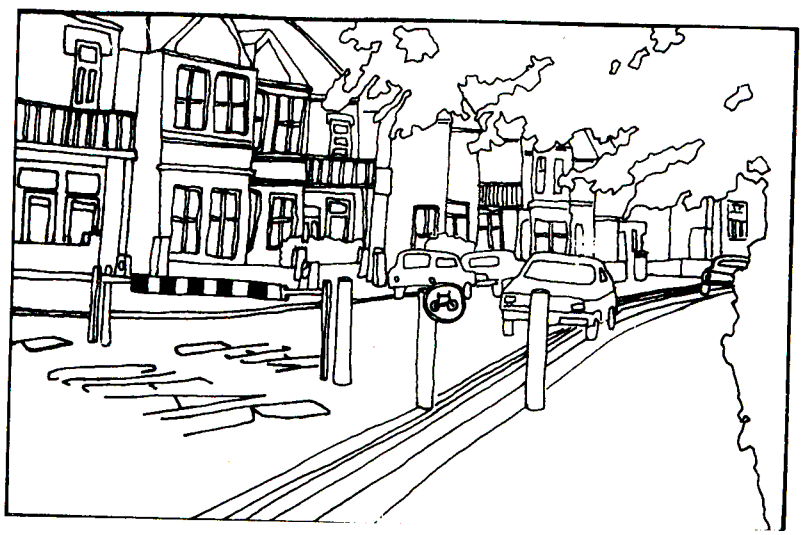
Total closure can only be carried out when there is alternative access for vehicles. It has the following benefits:
- eliminates vehicle/vehicle conflict at the junction
- eliminates vehicle/pedestrian conflict at the junction
- improves pedestrian convenience by allowing the footway to be extended accross the (closed) road

FIG. 12 SIDE STREET CLOSURE WITH FOOTWAY EXTENDED ACCROSS FORMER JUNCTION (Battersea)



Partial closure is more common. Allowing restricted vehicular access obviously compromises the benefits of junction closures, but if traffic volumes are low this can be acceptable. Some examples of partial closure are:
- one-way entry or exit (this enables the mouth of the junction to be narrowed
- access restricted (eg to residents or emergency vehicles). This is usually achieved by the provision of a removable bollard or gate
- exemption of pedal cyclists from the closure by the provision of a separate way through

FIG. 13 PARTIAL STREET CLOSURE WITH ACCESS FOR CYCLISTS AND EMERGENCY SERVICES (Fulham)



(iv) Discouraging Vehicles From Entering Local Streets

Where total or partial closure is not possible or desirable, drivers can be discouraged from entering a local street if it is designed to present the appearance of being "semi-public" or "semi-private". All of the following techniques, used alone or in combination, can dramatically alter the impact of a street:

- a change of level
- a reduction of carriageway width
- interrupting the view along the road
- changing surface materials
- provision of trees or street furniture

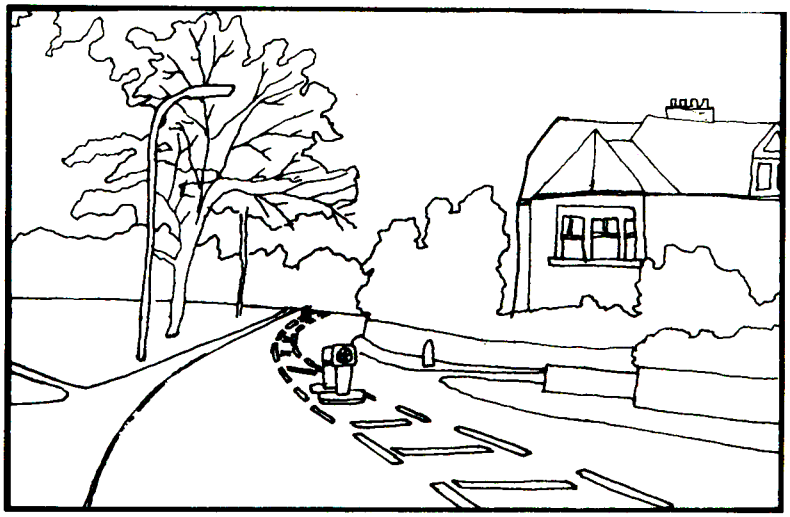
FIG. 14 RAISED FOOTWAY ACCROSS MOUTH OF JUNCTION (Hoorn, Holland)

The extent to which drivers can be discouraged depends not only on the "entrance" design, but also on the overall convenience of the street as a way through. If the use of the street is marginal (eg when there are reasonable alternative routes) then discouragement at the entrance may be sufficient. When the street seems to provide drivers with a really "attractive" alternative to main roads, then more extensive redesign is necessary including, for example, speed-reducing elements throughout its length.

(v) Reducing Overtaking

The more heavily-trafficked local streets (eg those carrying bus routes) cannot easily be redesigned to reduce traffic volumes. It may also be difficult to reduce traffic speeds below 25 - 30mph. In these circumstances it is possible to restrict traffic speeds to the legal maximum, and to discourage "high speed" overtaking by installing traffic islands at intervals along the street. Intervals of about 100 metres serve this purpose whilst allowing slow vehicles (eg milk floats) and buses at bus stops to be overtaken in safety. The provision of traffic islands has the additional benefit of helping pedestrians to cross the road. (See Fig. 15 below)

FIG. 15 TRAFFIC ISLANDS AND CENTRE MARKINGS (Battersea)



Some local streets are so wide that overtaking occurs even where traffic islands have been provided. Here the carriageway should be reduced in width to one lane in each direction (about 6 metres). Provision for parking or servicing can be made in addition to this, but should be distinguished by the use of surface materials which discourage moving traffic.

One-way streets encourage speeding and (if more than one lane in width) overtaking, and should be avoided in the local network.

(vi) Improving Predictability of Vehicle Movements

Where carriageways are wider than is necessary for the passage of vehicles in single file, vehicles may follow more than one "path". The number of possibilities increases with the surplus width of carriageway. There is no justification for any surplus: a road that is too wide can cause as many problems as one that is too narrow. If conflicts are to be avoided and convenience is not to be impaired, pedestrians, as well as other vehicle users, need to be able to predict the path of oncoming vehicles. The problem is found particularly at junctions which are "open mouthed" or which have excessive and "inarticulate" carriageway space.

FIG. 16 "OPEN MOUTHED" JUNCTION (Clapham)

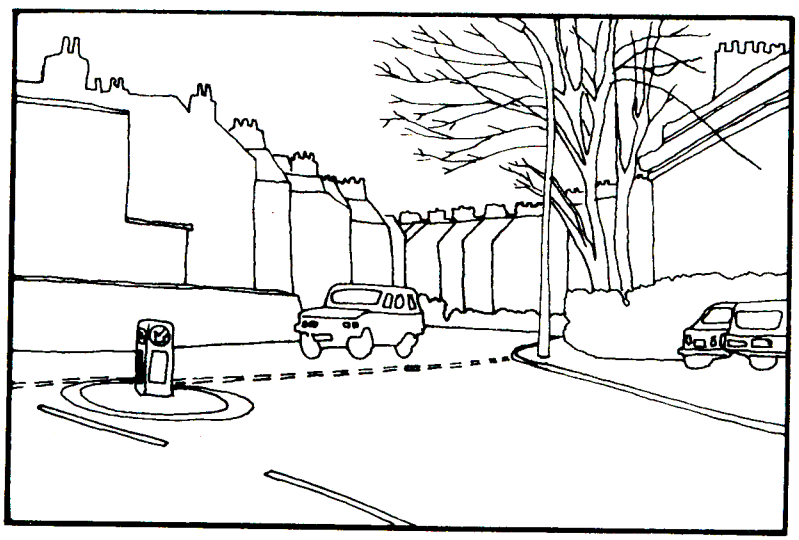
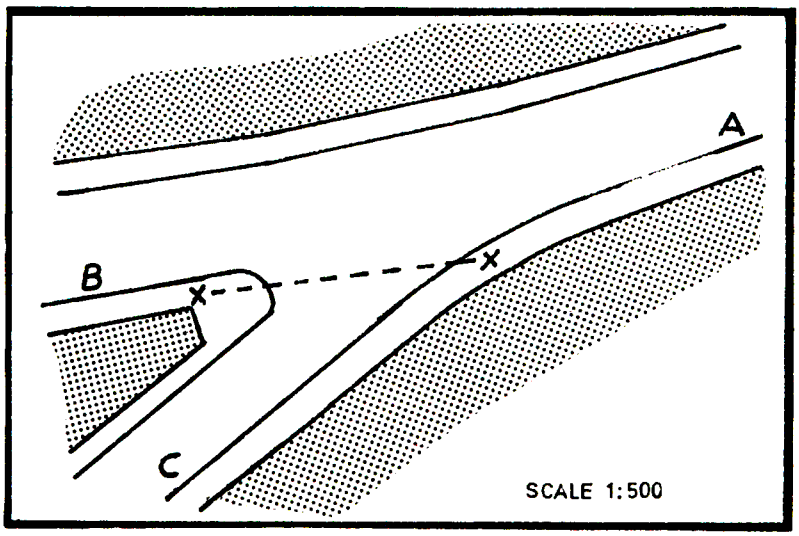


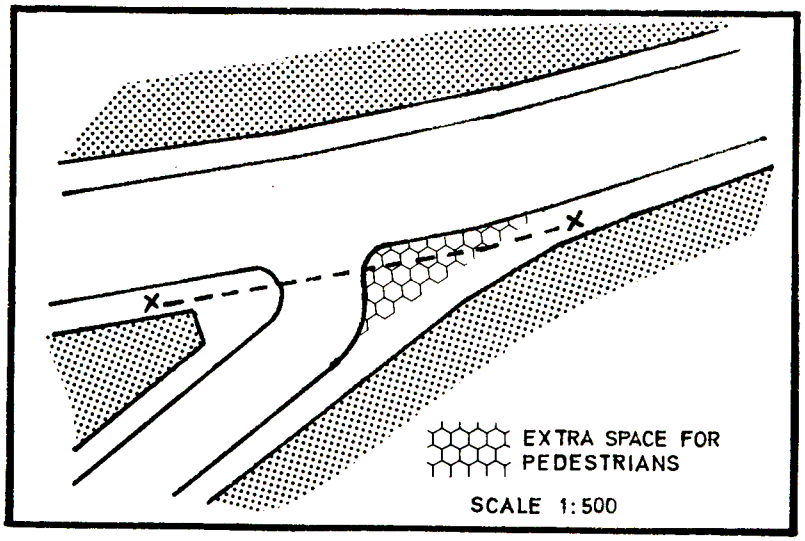
FIG. 17 "INARTICULATE" CARRIAGEWAY SPACE (Battersea)

FIG. 18a PLAN OF OPEN "Y" JUNCTION



In this example, pedestrians crossing **X - X** cannot predict whether vehicles from **A** are proceeding towards **B** or **C.** It is therefore necessary to wait at the kerb until no vehicles are approaching from **A.** The waiting time can be reduced and safety improved by modifying the junction as shown below.

FIG. 18b OPEN "Y" JUNCTION MODIFIED FOR IMPROVED SAFETY



The modification shown in Fig. 18b improves the predictability of vehicle paths and reduces speeds and the resulting conflicts. Pedestrians gain the bonus of additional space (the shaded area).

Widening footways and narrowing or realigning carriageways is the best method of improving predictability of vehicle paths. Lane markings (such as centre white lines and hatched areas can, at little cost, also help to achieve the same purpose, but white paint is obviously not as effective in determining vehicle paths as raised kerbs or other vertical features.

It can be instructive to observe streets after a light fall of snow. Vehicles tend to follow the path made in the snow by previous vehicles, so path predictability is improved. Photographs taken during these conditions can help to identify where surplus carriageway exists.

(vii) Increasing the Space For Pedestrians

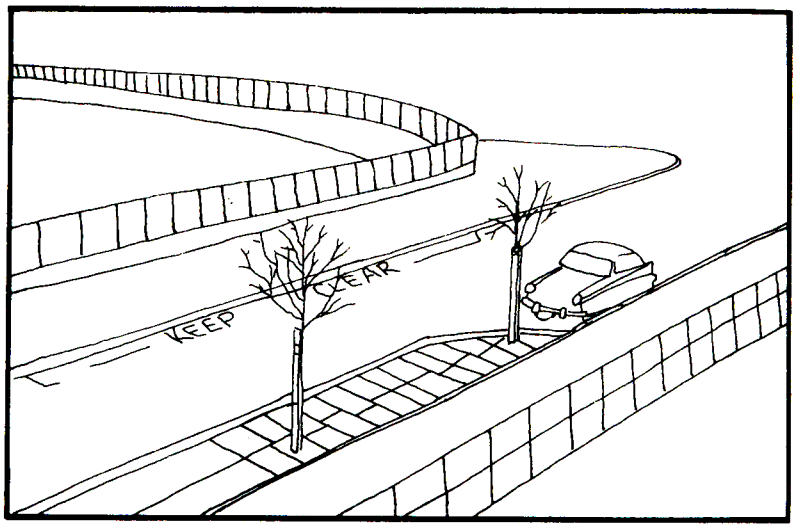
It was Colin Buchanan who said that "the freedom with which a person can walk about and look around is a very useful guide to the civilised quality of an urban area". (The Buchanan report "Traffic In Towns", HMSO 1963, p40.) Reducing carriageway space has the added advantage of providing extra space for pedestrians and for amenities such as planting and seating.

This objective can be pursued by turning over as much ground area as possible to pedestrian movement and associated amenities. At the present time much space is devoted to vehicles which actually hinders their safe and efficient movement.

Increasing footway space can radically improve safety for both pedestrians and vehicles at the following locations.

- Where parking is not required, for example outside school entrances. The zig-zag yellow warning markings on the carriageway should be replaced with extended footways.

FIG.19 FOOTWAY EXTENSION OUTSIDE SCHOOL (Camden) In this example, although parking is discouraged, the extended footway is on the opposite side of the road from the school.

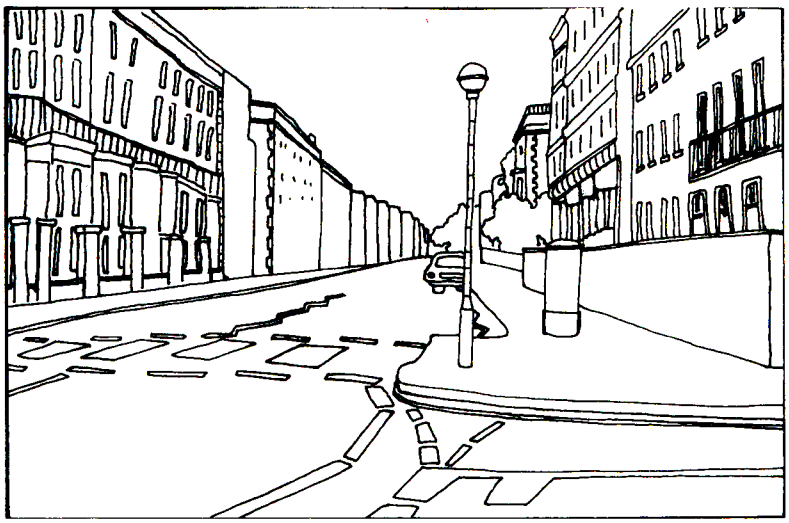


- At pedestrian crossings

There is little point in painting white zig-zag markings to indicate that parking is not allowed, when footway extension will ensure that parking will not occur. In addition, footway extensions narrow the width of carriageway to be crossed and also make pedestrians wishing to cross more clearly visible to drivers. It also tends to remove the uncertainty as to whether a pedestrian standing by the kerbside is intending to cross.

FIG. 20 ZEBRA CROSSING UNNECESSARILY WIDE (Battersea)

FIG. 21 ZEBRA CROSSING WIDTH REDUCED BY FOOTWAY WIDENING (Fulham) Note that the footway has been widened only at the crossing itself. It is better to widen accross the entire section covered by the "zig-zag" markings.



- At junctions

Parking close to junctions has been called in a recent safety poster (depicting a driver straining to see if the road is clear) a "pain in the neck". It is also illegal. It is recognised as a hazard - for both pedestrians and drivers - because of reduced visibility. Narrowing the carriageway at junctions (often referred to by North American highway engineers as "necking"!) is an effective solution which carries the same additional benefits mentioned above in relation to pedestrian crossings.

FIG. 22a ZEBRA CROSSING - BEFORE MODIFICATION

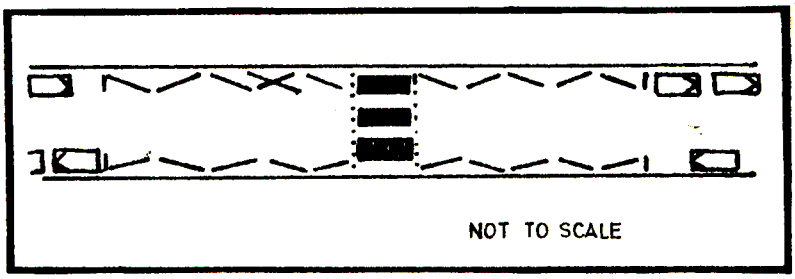


FIG. 22b ZEBRA CROSSING - AFTER MODIFICATION (Note that zig-zag lines are not shown here, but they would in practice still be required.)

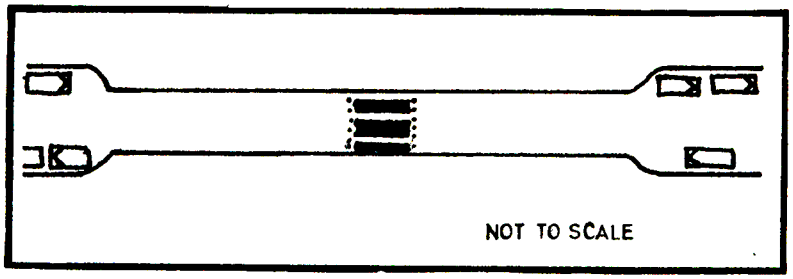


FIG. 23 FOOTWAY WIDENING OR "NECKING" AT JUNCTION (Sheffield)

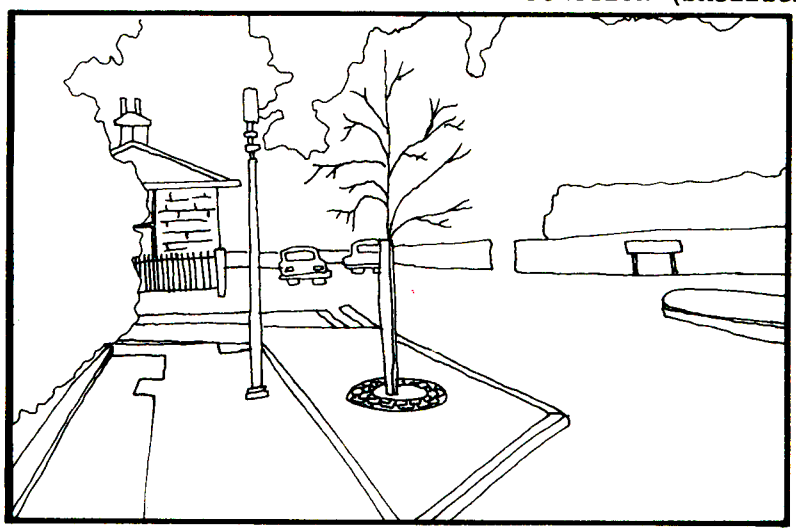
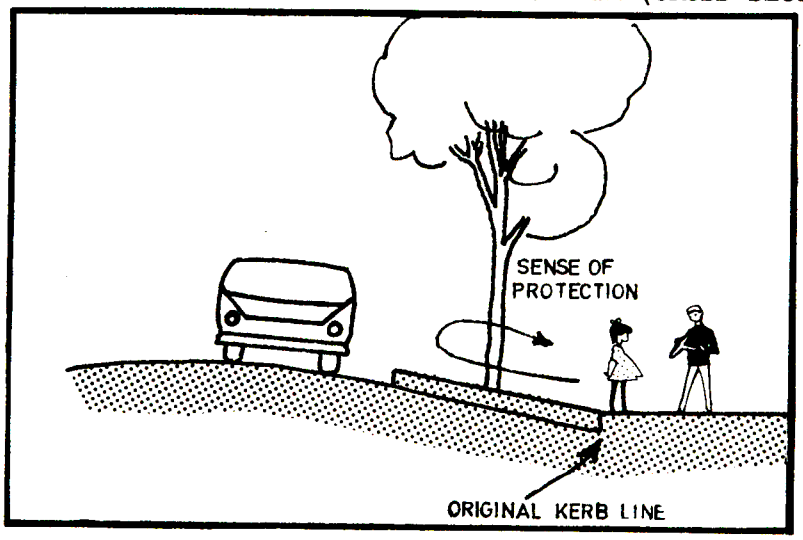


FIG. 24 FOOTWAY EXTENDED AND RISING WITH CAMBER (CROSS SECTION)



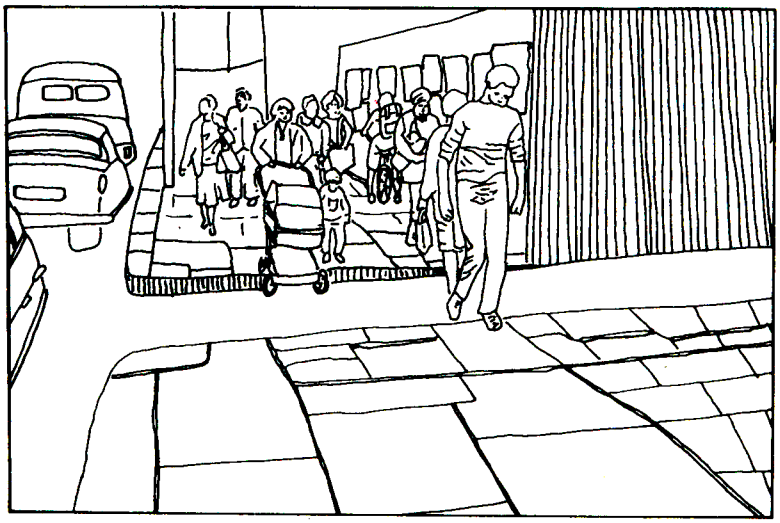
A further advantage of footway widening in existing streets arises when the carriageway has a significant camber as shown in Fig. 24. The extension rises with the camber and thus gives a sense of security to pedestrians and acts, particularly for children, as a psychological barrier to straying onto the carriageway. This can be useful particularly outside school entrances.

(viii) Removing Surface Interruptions for Pedestrians

To improve conditions for pedestrians, particularly the very young, the elderly, the disabled and also for people using wheels on footways (eg prams, buggies, wheelchairs and shopping trolleys) it is important to maintain a continuous smooth surface along which to travel.

- Removing crossovers
  It has often been the practice to build crossovers at carriageway level. This entails two changes of level for the pedestrian, yet in most cases crossovers are used far more by pedestrians than by vehicles. There is an example in Battersea (London) of a crossover that has not been used by vehicles for many years, yet anything up to 1000 pedestrians an hour have to negotiate the two changes of level. See Fig. 25

FIG. 25 CROSSOVER INCONVENIENT FOR PEDESTRIANS, YET RARELY USED BY VEHICLES (Battersea)

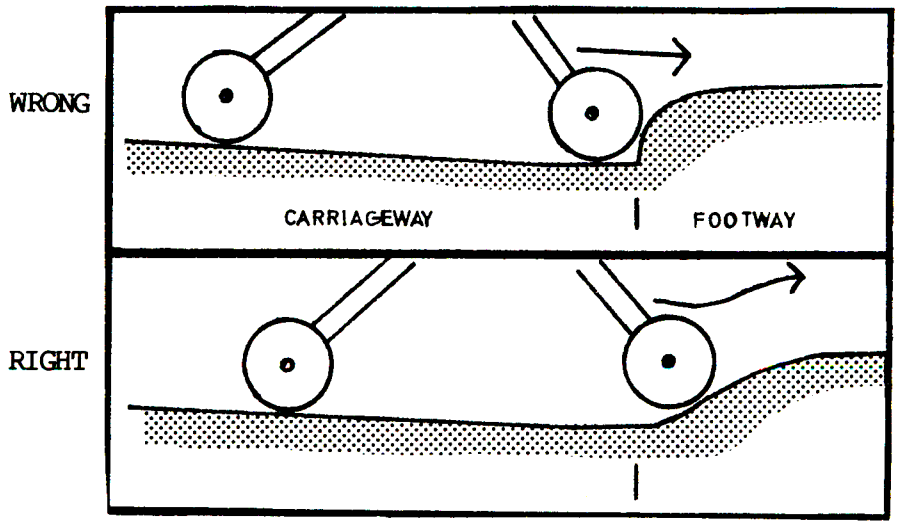


Crossovers should therefore be raised to footway level, and a short ramp provided for the occasional vehicle wishing to cross over the footway. A different surface texture or colour is may be used to warn pedestrians that vehicles have a right of way accross their path. The result is similar to that shown in Fig. 14.

- Providing dropped kerbs
  Lowering footway kerbs to carriageway level is a common technique for smoothing the path for those on foot. But dropped kerbs are often so badly designed or constructed

that they provide little help. The kerb should be lowered to exactly carriageway level; a change of level of even an inch or two can cause difficulties for people with baby buggies or wheelchairs. The ramp should be as gentle as possible, but this will be determined by the footway width. The dropped section of kerb should usually be sufficiently wide to allow two prams to pass (1.5 metres).

FIG. 26 DROPPED KERB DESIGN (CROSS SECTIONS)



- Raising carriageways to footway level
This has been mentioned already in (iv) above. In local streets with very low traffic volumes it is possible to raise the entire junction area of carriageway to footway level. This gives a high level of priority to pedestrians by making it clear to drivers that they must slow down and give way if necessary. This technique involves ramping the carriageway, and is most effective if this is reinforced visually, both in the road surface, and by the location of verticle features such as bollards or planting boxes. Verticle features are required also to prevent vehicles from straying onto the footway.

FIG. 27a CONVENTIONAL LOCAL STREET JUNCTION

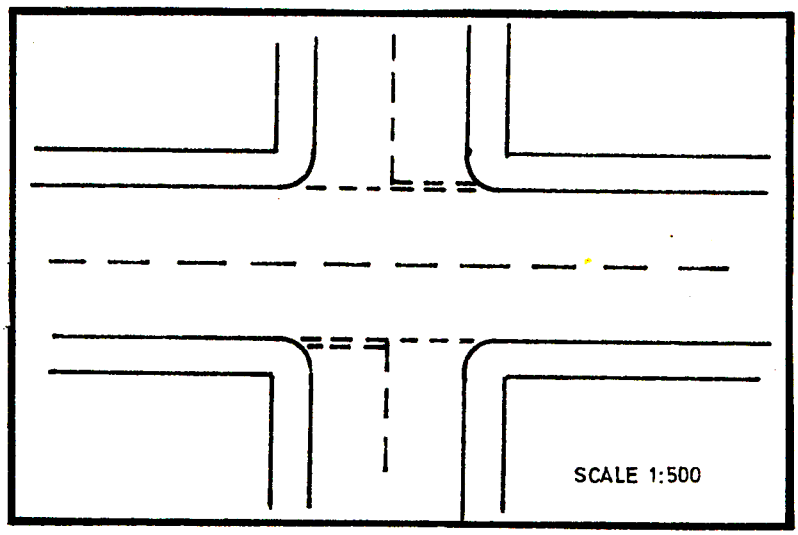


FIG. 27b MODIFIED LOCAL STREET JUNCTION

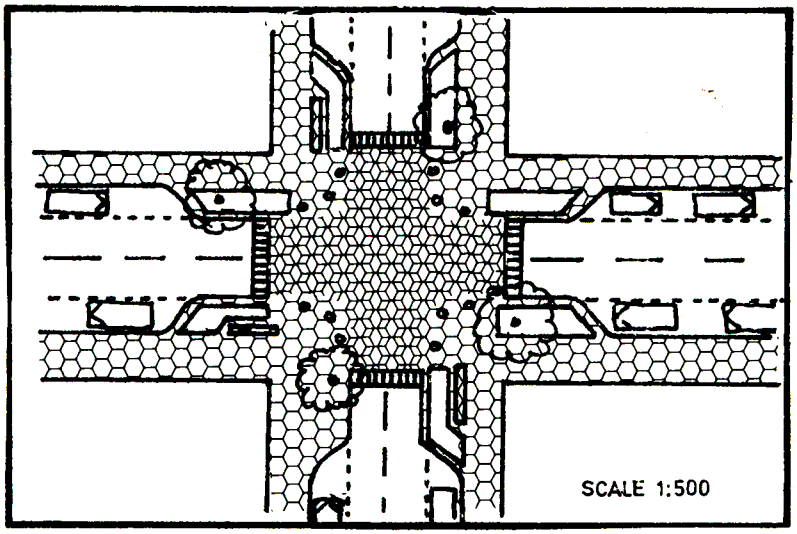


Fig. 27a provides an example of what can be done to slow traffic and give pedestrians greater freedom at local street junctions. Space shared by vehicles and pedestrians is shown paved in a different material. Vertical elements (planting boxes, seats and trees) emphasise the presence of speed-reducing ramps at the approaches to the junction.

8. CONCLUSIONS

The adverse impact of motor vehicles has spread throughout the network of urban streets as motorisation has increased. Whilst the debate has raged about improving the main road system, little attention has been paid to the problems of local streets. Yet it has been shown in this paper that child accident rates in these streets give major cause for concern, and that fear and anxiety about traffic conflict has all but ruled out the use of residential streets for social purposes.

We have examined the design of streets for their ability to control driver behaviour and found it wanting. Indeed it makes little sense to describe the resulting casualties as "accidents"; they are the inevitable product of street layouts where vehicles are physically encouraged, and legally entitled, to travel at speeds of 30 mph within a few feet of people's front doors.

Few local streets have been designed in any conscious way to promote good driver behaviour. Sometimes their layout happens to be satisfactory from an environmental and pedestrian viewpoint, but all too often it is inconvenient and full of hazards. New street layouts are often no better, and sometimes considerably worse, than those of the Victorian era.

Traffic regulations, upon which so much emphasis has been placed, are largely unenforceable and ineffective. A new approach is required which controls driver behaviour and keeps speeds down through physical design. This can be not only self-enforcing but also capable of striking a reasonable balance between vehicles and other street activities - the Dutch "Woonerf" schemes being one praiseworthy example of how this approach has already been applied.

The ideal balance of priority between traffic and other activities will vary throughout the urban road network. The appropriate design measures and level of expenditure will also vary. It is suggested that decisions can be aided by defining a road hierarchy, with the intended role and character determined for each tier in the hierarchy. Unlike the definition of road hierarchies in many existing plans, the purpose should be prescriptive rather than merely descriptive.

There is a wide range of design measures that can be applied in both new and existing local streets. Most of the ideas illustrated in this paper are simple and inexpensive relative to the complexity and cost of many schemes for improving major traffic routes. They should also be relatively uncontroversial provided that people affected are involved in the design process.

Local street design is at a rudimentary stage of development, and much experimentation and research is required to achieve more civilised results. While most current practice is unsatisfactory, there are sufficient examples of good design - in this country as well as abroad - to show that it is a fertile field awaiting skilful and imaginative cultivation. It is hoped that this paper will stimulate awareness of what needs to be done.

APPENDIX A

WHAT ARE "LOCAL STREETS"?

Classification of roads is fraught with problems. There exists in London, for example, the following different classifications which are not mutually exclusive.

(a) Road Class:	Motorway, Class A, Class B, Class C, and Unclassified.
(b) Highway Authority:	Trunk, Principal (otherwise known as Metropolitan), and Non-Principal.
(c) Signed Routes:	Primary Routes (green signs), ring roads, North and South Circular roads, and others.
(d) GLDP Hierarchy:	Primary Roads, Secondary Roads, Local Roads.
(e) Local Plan Hierarchies:	Many Borough and other local plans identify a road hierarchy for their particular area which modifies the GLDP hierarchy.

Most of these classifications are based on existing traffic densities, and there is a considerable degree of overlap between the various categories.

Although no precise definition of local streets is offered, a working definition for the purpose of this paper is that they are streets which by and large carry relatively small volumes of traffic, and which serve the essentially "local" functions of access to premises and distribution of traffic to and from major traffic routes. Excluded from the definition are motorways, Class A roads, Principal roads and other roads carrying in excess of about 5000 vehicles per day.

APPENDIX B

"WOONERF" DESIGN STANDARDS AND TRAFFIC REGULATIONS

The Netherlands Ministry of Transport and Public Works has issued minimum design standards supplemented by traffic regulations applicable within Woonerven. These are set out briefly below.

DESIGN STANDARDS

1. A Woonerf shall be primarily a residential area.

2. Roads or the road network within a Woonerf shall be structured so that only has a function - so far as motor traffic is concerned - for traffic with an origin or destination within that Woonerf (through traffic shall be excluded).

3. No road within a Woonerf shall carry a flow of motor traffic which could affect the character of that road as part of a Woonerf.

4. The impression that the road is divided into a separate carriageway and a footway should be avoided. There should therefore be no continuous difference in cross-sectional elements along the length of the road. Breaks should therefore occur in kerbs which may give the impression of the presence of a footway and should be at intervals of approximately 25 metres; these should be quite clear to the motorist.

5. Vertical elements such as plant tubs and shrubs should not restrict visibility.

6. The entrances and exits of a Woonerf should be designed so that they can be clearly recognised. In the case of entrances and exits which can be used by vehicles, the kerb preferably should be lowered and continued. Each entrance and exit must also be marked by a sign of specified design.

7. Parts of the road intended for parking must be identified at least by corner markings, and with a letter "P".

8. There must be adequate parking facilities for the residents of a Woonerf, within the Woonerf itself, or very close by.

9. On those parts of the road intended for use by motor vehicles, features must be introduced which will restrict the speed of all different types of vehicles. These features should not be more than 50 metres apart (although recent experience suggests that a maximum of 30 metres is more appropriate).

10. Speed reducing features should not be located so as to cause vehicles to pass close to housing which fronts directly onto the road.

11. Speed reducing features should create no danger to traffic.

12. Adequate public lighting must be provided to ensure that all features, especially speed reducing features, are fully visible at night.

13. Areas specially designated as play areas must be clearly identified so that they can readily be distinguished from areas which can be used by vehicles.

TRAFFIC REGULATIONS RELATING TO WOONERVEN (as at 1978)

Pedestrians may use the full width of the road within an area defined as a Woonerf; playing on the roadway is also permitted.

Drivers within a Woonerf may not drive faster than at walking pace. They must make allowance for the possible presence of pedestrians, children at play, unmarked objects and irregularities in the road surface and in the alignment of the roadway.

Within a Woonerf traffic from the right has priority (under normal Dutch law "fast" traffic has priority over "slow" traffic).

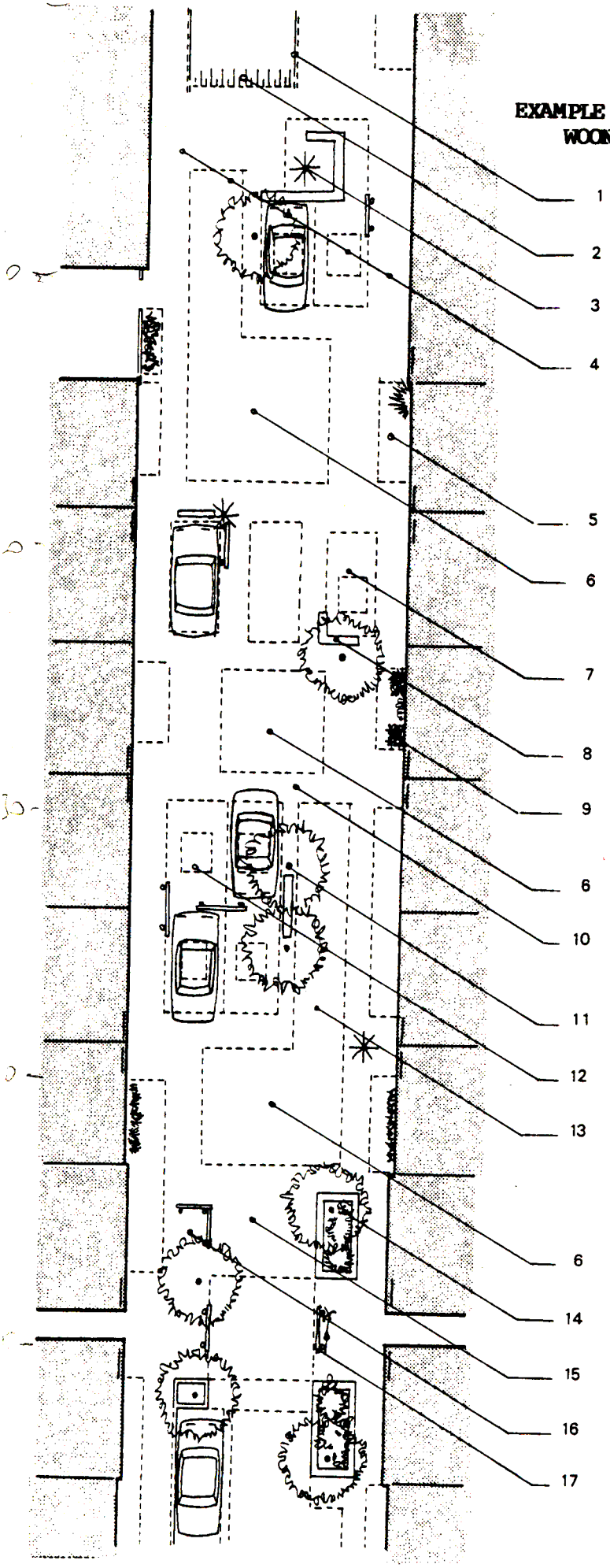
Drivers may not impede pedestrians within a Woonerf.

Pedestrians may not unnecessarily hinder the progress of drivers.

Drivers of vehicles with more than two wheels are not permitted to park within a Woonerf except at designated parking places.

The Woonerf sign may only be displayed if the design of the area satisfies the standards established by the Minister of Transport.

APPENDIX C
EXAMPLE OF STREET CONVERTED TO WOONERF (Source: ANWB)



1. no continuous kerb
2. private access
3. bench around low lighting column
4. use of varied paving materials
5. private footway
6. bend in the roadway
7. empty parking lot: place to sit or play in
8. bench/play object
9. on request: plot with plants in front of facade
10. no continuous roadway marking on the pavement
11. tree
12. clearly marked parking lots
13. bottleneck
14. plant tub
15. space for playing from facade to facade
16. parking prevented by obstacles
17. fence for parking bicycles etc.