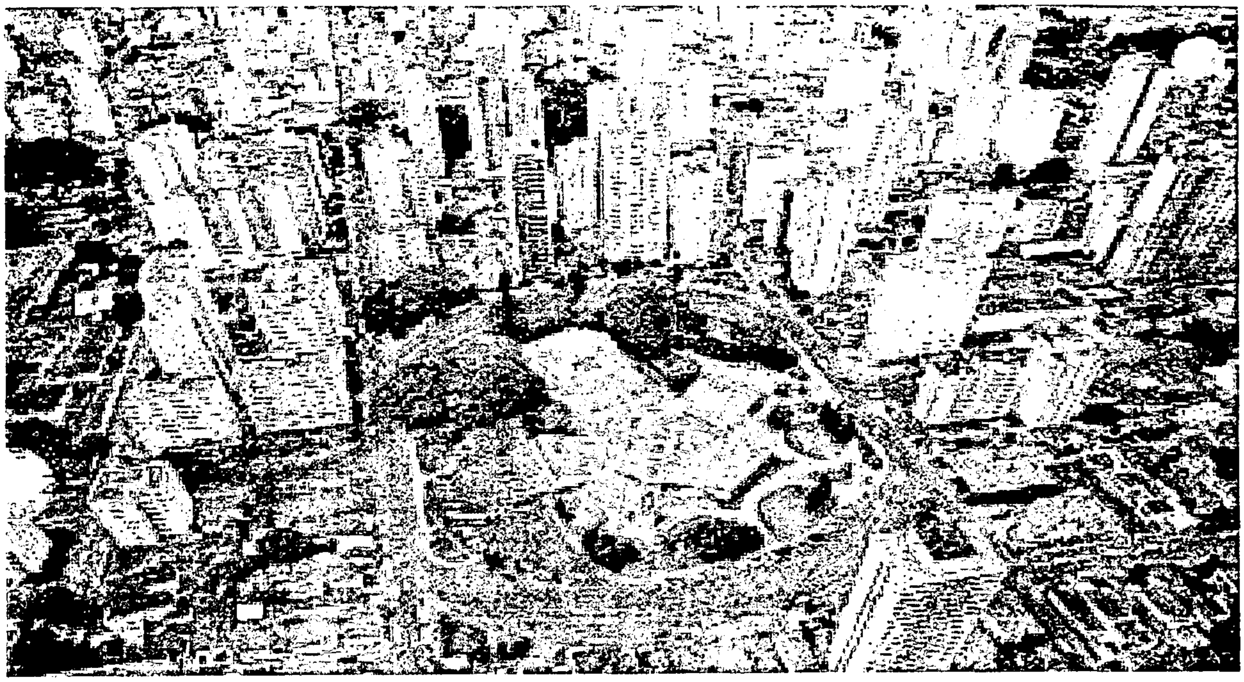

A Preliminary Review of Urban Design Considerations in Transport Planning

By G Gardner (TRL), R Evans and J Witham (Roger Evans Associates)

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TRANSPORT RESEARCH LABORATORY

A preliminary review of urban design considerations in transport planning

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1 Introduction

This guide has been produced to increase the awareness amongst transportation planners and engineers of the contribution they can make towards improving the urban environment. It is intended for widespread use including developing world cities. It is intended to serve as a source of ideas, and to demonstrate that techniques do already exist that can help cities cope with increasing car ownership and use. The destruction of the quality of life in the great cities of the world by road traffic is not an inevitable consequence of economic growth.

The guide includes examples of best-practice in modern industrialised countries. Not all the techniques described have been proven in the particular circumstances of the developing world.

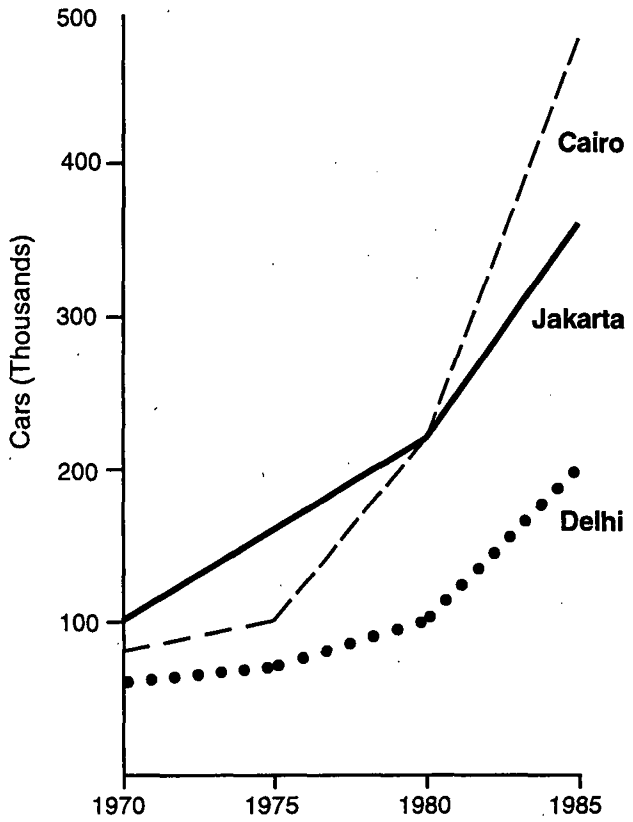


Figure 1.1 The problem: Rapid increase in car ownership in developing countries

1.1 The problem

Many cities of the developing world have now exceeded the population levels that were originally anticipated or expected at the time of their development. There exist cities that were planned during the 1940s to accommodate 400,000, which now have populations approaching six million. This places intolerable strain upon all of the urban infrastructure, not least transportation.

Cities of the developing world are set to grow by what are phenomenal rates by western standards. The major cities of India, for example, are forecast to grow by 60-90 per cent by the year 2015. Vehicle ownership levels are also rising rapidly. Although starting from a low base many cities have car fleets that have doubled in size during the past decade. It would be difficult for the highest standards of urban management to keep pace with this level of growth. In practice, urban design, like many other civic activities, is often neglected.

With high growth, poor infrastructure, and a powerful car-owner lobby, traffic can have an almost free reign to overwhelm the space available. In addition to the problems of congestion, delay and road accidents, the quality of the urban environment is then put under severe pressure. Corridors and city centres which have to handle high levels of demand are prone to endemic and prolonged traffic congestion. This situation can only get worse as cities grow.

Ultimately, if the transport system cannot respond to these pressures, then other land-use developments may take control, leading to unstructured and diffuse city growth and even the atrophy of the city centre. The essence of a city centre is that it is the most accessible point from both within and without the city. This superior accessibility is important for many activities and in particular for those central functions that serve a wide area and/or need a wide labour market: head offices, central government offices, financial and legal institutions, media and entertainment, etc. and all the supporting organisations (catering, hotels, etc.) that exist to serve these central functions.

This is not just an environmental or an aesthetic problem. The cities of Africa and Asia are major generators of national wealth, creating in many countries 75 per cent of total gross national product. It is essential, therefore, that these cities operate as efficiently as possible.

1.2 An approach to the problem

A problem can be regarded as a failure to reach a set of objectives. Therefore, it is necessary to establish what are the urban goals at which we should aim. This was one of the primary issues that the nations of the world addressed at the Earth Summit in Rio de Janeiro in 1992. They adopted a solution based on 'sustainable' development where sustainability is defined as. . .

> *'development which meets the needs of the present without compromising the ability of future generations to meet their own needs' (Brundtland, 1987)*

Urban design practice has much to contribute to the sustainability debate. Urban design strives to create urban areas that are liveable, vital, viable, safe and democratic. This type of high quality urban environment will ultimately contribute towards achieving a more sustainable environment.

An important distinction should be made between access and mobility. The main need is to provide access to basic needs and social interaction. The act of transport, moving around, may not be necessary and may not be desirable.

Sustainable transport requires a worldwide reduction in the use of private cars. It is acknowledged that many of the world's poorest countries have yet to achieve the levels of car ownership that the USA had fifty years ago. The perfect solution would be to impose a cap on car usage at a level that is 'reasonable'. There is little knowledge of what such a reasonable level would be, so the approach taken in this guide is to accept that while *increasing ownership* might be inevitable, widespread and indiscriminate *use* should not be encouraged.

The car is a good means of personal transport well suited to journeys for those who have difficulty using public transport. However, the car is highly unsuitable for mass transport and commuter journeys because of the large land take required, and because of the high levels of emissions per passenger.

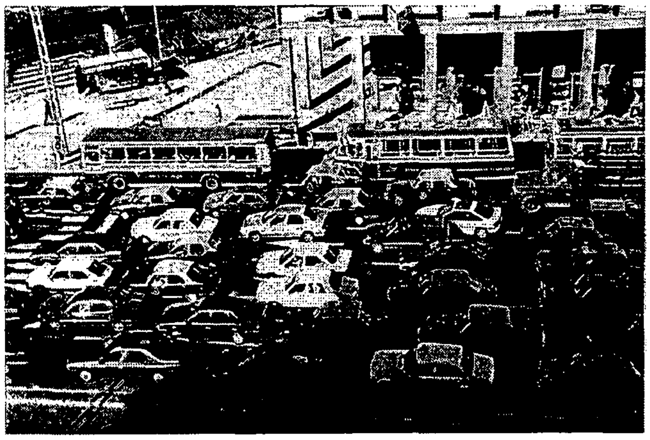


Figure 1.2 The problem: Car domination in Buenos Aires - lack of fresh air? It is a mistake to think that wide streets and one-way systems will improve traffic flows. The road network is only as good as its weakest link. Wide streets destroy urban quality and encourage more people to drive, rather than walk or cycle, hence increasing congestion

2 Urban planning objectives

There are numerous ways in which land use planning can be used to promote 'sustainable' objectives as they relate to the quality of the urban environment. There are three approaches which are particularly supportive of current urban design theory:

1 Avoiding sprawl and 'town cramming' through policies of decentralised concentration;

2 Reducing car dependency through providing a good mix of uses within convenient travel distance by alternative modes of transport;

3 Making urban areas more attractive and user-friendly for non-car users.

Such approaches should be considered at a policy making level, and if considered appropriate, included within the regional or structure plan for an area. Detailed design guidance and rules of thumb are provided in Chapter Four.

Figure 2.1 The problem: Rapid urbanisation and town cramming is common to many developing cities (e.g. Sao Paulo, Brazil). A gridlocked centre fed by overcrowded highways is leading to a deterioration in urban living

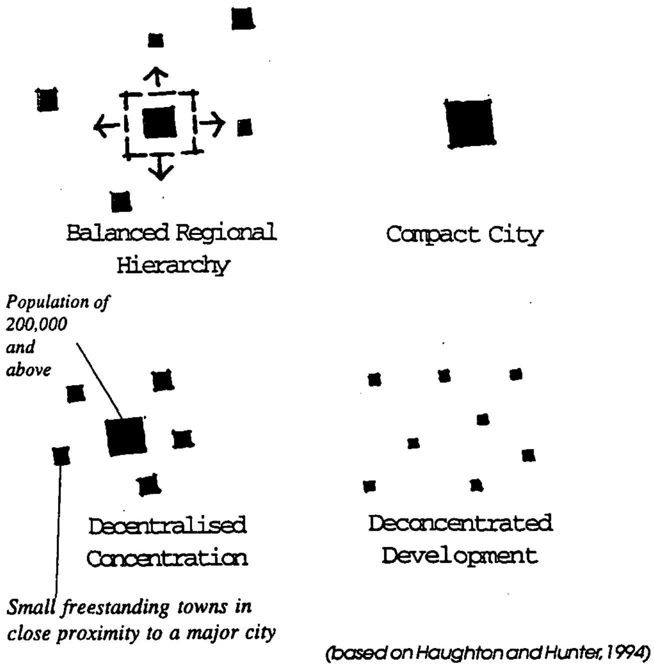


Figure 2.2 Possible solutions: A number of development patterns are currently being debated

Recommendations

1 At a national level, migration should be channelled to small and intermediate-sized towns and cities, away from a dominant metropolis;

2 At a regional level, migration should be concentrated into towns outside the main city and in strong sub-urban centres;

3 Densities should be greatest at the centre of these towns in order to promote public transport and a vital and viable urban environment.

2.1 Development based on decentralised concentration

Two processes might be considered responsible for currently shaping cities around the world; counter-urbanisation and urbanisation.

Counter-urbanisation is occurring in many cities in the developed world. This involves the outward movement of population and jobs from the cities to the suburbs, urban fringes, smaller towns and rural areas. In Western Countries this 'urban sprawl' has increased car dependency and increased energy consumption.

Rapid urbanisation is being experienced in many developing cities at an unprecedented scale. Such a process could see cities such as Mexico City have populations of over 30 million by the year 2000. Urbanisation at this scale is unlikely to be sustainable and likely to result in a reduction of amenity space, and intolerably high densities over very wide areas.

There are a number of approaches being developed to direct growth into more sustainable urban forms. These include:

A balanced regional hierarchy which involves decentralisation of population from the main urban areas to a hierarchy of communities throughout a region;

The compact city which encourages a more intensive use of existing large urban centres (Commission of European Communities, 1990);

Decentralised concentration which seeks to promote development in a few medium-sized sub-cores whilst maintaining a strong central core (Breheny, 1992);

Deconcentrated development which seeks to uniformly disperse population across the land within very small, but viable, communities.

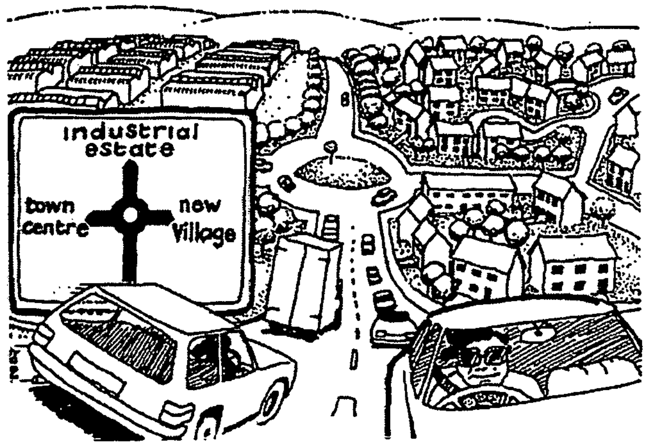
An urban form based on decentralised concentration would seem to be an appropriate strategy for many developing cities faced with massive population increases, town cramming and sprawl. Such a strategy would direct growth both into separate towns outside the main city and in strong suburban centres. This approach may be more sustainable by potentially reducing energy usage and encouraging greater use of public transport. Development should be generally highest at the centre of these growth poles and this is where public transport interchanges should be located.

2.2 Local neighbourhoods which contain a fine grain mix of uses

Cities which have grown organically are made up of a large number of overlapping neighbourhoods providing a variety of uses. People may belong to many different neighbourhoods at the same time, ranging from the city neighbourhood down to the local street neighbourhood. In recent years planners and designers have attempted to create 'ideal neighbourhoods' separated from each other by 'buffer zones' and comprised of one main predominant use. Industrial and other employment generating uses are increasingly zoned to the edge of the city whilst commercial activities are concentrated in malls. Although protection from heavily polluting industries is essential, too much segregation often produces unsuccessful environments for a number of reasons:

- Single-use areas are typically only used for part of the day, thus creating security problems outside these hours;
- Single-use areas tend to produce uniform and often monotonous places;
- The separation of uses results in ever greater commuter trips, car dependency, fuel consumption and congestion;
- The separation of neighbourhoods into discrete units present fewer and fewer opportunities for social interaction.

In response to this, good urban design supports fine grain mixed uses. This has the effect of maximising social interaction whilst at the same time minimising necessary travel. In other words, placing a variety of activities within easy walking distance of the home.



(Responsive Environments, 1985)

Figure 2.3 The problem: A rigidly zoned city reduces social interaction and increases trip generation

Recommendations

1. The widest range of compatible uses should be encouraged within a neighbourhood to reduce the need for people to travel;
2. Appropriate densities and levels of compactness should be encouraged to reduce car dependency;
3. Robust city blocks of a human scale should be provided which can incorporate a variety of uses over time.

Photo: Roman Malecek

Figure 2.4 A solution: Neighbourhoods which are varied, accessible, have a visual logic and are attractive (Attractive, fine grain mixed use streets in Prague)

Photo: Armstrong-Wright

Figure 2.5 The problem: Increasingly unintelligible neighbourhoods lacking visual cues. (S. Korea)

2.3 Public streets and spaces which are accessible, legible and attractive

A city should facilitate the enjoyment of all its occupants; there should be open access to all important spaces and it should be easy for pedestrians to find ways through. This is not always the case where streets are designed primarily for vehicles.

Cities are becoming increasingly inaccessible as many urban environments become fragmented into enclaves. Enclaves may be in the form of shopping malls, exclusive housing developments or squatter settlements. What they all have in common is that restrictions are placed on entry. Shopping malls often only allow entry at certain times of the day, which effectively means that at night time, they become barriers to movement across towns. Exclusive housing areas restrict entry to 'the right sort' in order that 'undesirables' are kept out. In extreme cases, such enclaves are gated, walled and protected by sophisticated security devices. Culs-de-sac are a less extreme example of the same thing which by virtue of their layout discourage anyone other than residents. Squatter settlements are

photo: Gardner

Figure 2.6 The problem: Increasingly the public realm is taken out of public ownership; private enclaves reduce accessibility

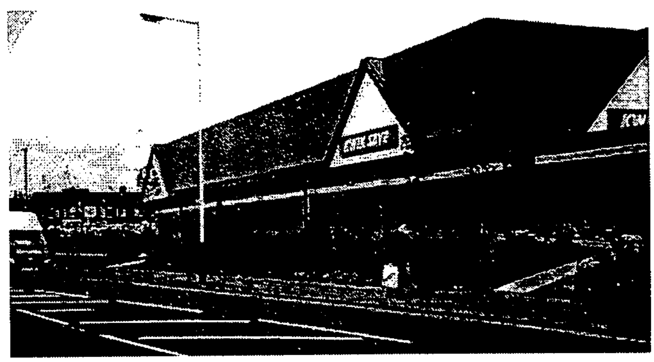


Photo: Gardner

Figure 2.7 The problem: Increasingly new development is designed for the convenience of car users over pedestrians. A busy road and a blank wall result in shopping being an unpleasant experience for pedestrians enclaves by virtue of the fact that they are often located at the end of a feeder road on parcels of land at the edge of towns. This physical separation from the rest of the town serves to isolate them and polarise their problems. All forms of enclave development contribute to an increasingly impoverished urban form and in the long term lead to areas of the city becoming blighted.

Cities are also becoming increasingly unintelligible to their users. Important structuring elements in the built environment such as public places and simple landmarks are being lost. Without such elements orientation becomes difficult and users must rely on street signage.

Cities are becoming less attractive places for pedestrians. Whereas in the past streets and buildings were designed with pedestrians in mind, more recently they have been designed for the convenience of the motorist. This has frequently meant that buildings and public spaces are at a larger scale than in older parts of the city. Building forms have also changed in recent years, with stand-alone, pavilion type buildings being an increasing feature of the urban landscape. This type of building will typically have fewer entrances which means that much of the outer envelope of the building is blank and inactive. Pavilion buildings are hard to incorporate into the traditional street pattern of towns and result in the definition between the private and public realm being lost. As buildings become taller, the micro-climate at the base of the building changes and needs careful testing to avoid turbulence. All these factors contribute to make walking a less desirable modal choice.

Recommendations

1 The street network should allow full access to all;

2 The built environment should be intelligible to all users through a structure which is familiar to pedestrians;

3 The public realm should be redesigned as a place for people and society, not just for vehicles and 'the right sort'.

3 Transport objectives

It is apparent that the land use planning system alone cannot achieve the goal of complete sustainability, but must be supported by a transportation planning system with similar objectives. These objectives should include:

1 Optimising the existing network for the movement of people not vehicles;

2 Restraining car usage (so avoiding the mistakes made by cities such as Los Angeles);

3 Having accepted the inevitability of increasing car ownership, optimising the efficiency of the road network.

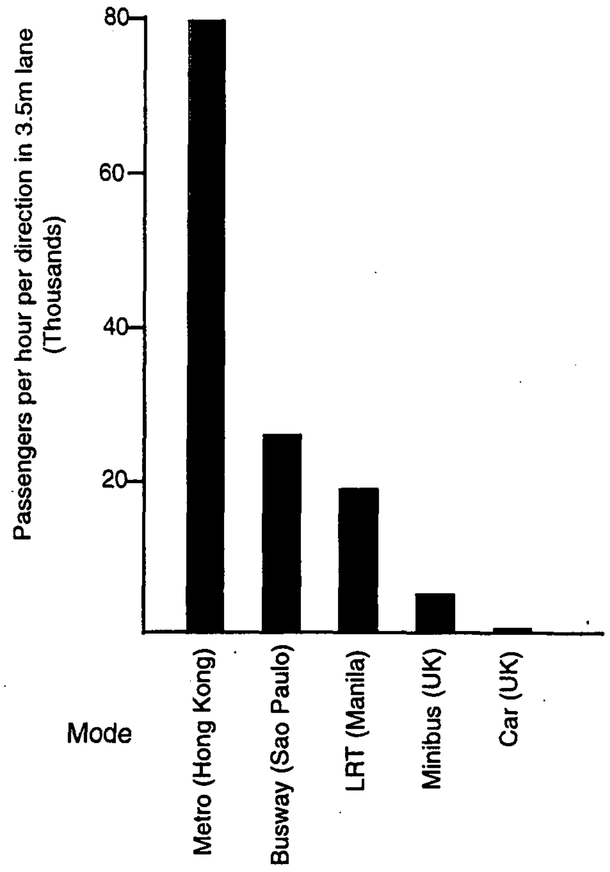


Figure 3.1 The problem: Cars have a very low carrying capacity when compared to other modes of transport

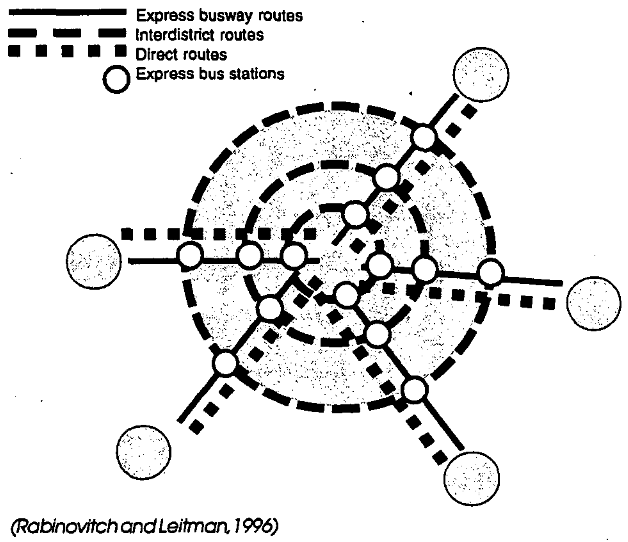


Figure 3.2 A solution: A mass transit based transport system. Curitiba in Brazil is an excellent example of how an appropriate low-tech approach to public transport provision has dramatically improved the quality of urban living for its two million inhabitants. Urban growth has been focused on five prescribed structural axes, each served by express bus lanes

3.1 Optimising the network for movement of people not vehicles

As car use increases its modal share, the carrying capacity of the street network decreases and hence it becomes more difficult for everyone, including the car users, to move around the city. Such a trend is happening simultaneously with an increased demand for movement, as many of those facilities which people require on a regular basis are spread further and further apart. It is therefore important when examining the transport needs of an urban area to match the demand for movement with the supply of transport capacity.

An important concept in optimising movement (rather than access) is the idea of transport capacity. This looks not just at the number of vehicles passing through an area, but at the number of people carried. An optimal transport network, therefore, will be derived from a well-constructed network using the high-capacity options for trunk services and lower-capacity, but also more flexible, options for feeder services. This inevitably means that public transport should take a greater priority because these modes have a higher carrying capacity. If used only by cars, even a six-lane highway will have a lower transport capacity than a 3.5m bus-way.

A road for general traffic is a very inefficient means of moving the large flows of people common in developing cities. It is therefore not possible, and is certainly not desirable, to attempt to create a transport supply for a city based upon mixed-use lanes. The ordinary bus, given sufficient priority over other traffic, has a very high capacity and although it may not be very glamorous, it offers the best (perhaps the only) means of reducing congestion in developing cities.

Where there is overlap between the options for a particular journey, then policies should attempt to favour the more environmentally friendly and sustainable modes. This will include non-motorised options, but will also include motorised public transport.

Recommendations

1 Overall movement should be increased by favouring high-capacity modes;

2 High capacity public transport modes should be used on high demand corridors in preference to widening roads;

3 Preference should be given to environmentally sustainable modes

3.2 Restraining car use

Throughout the world there is increasing dependency on the car. The car is an almost perfectly convenient mode for short access trips which are non-radial, require the carriage of heavy luggage or for those with mobility impairment. There may be no alternative public transport service to some rural areas particularly at night and at weekends. In the poorest countries, doctors and other essential users need a car, as alternatives are just not practicable. Therefore, owning a car is not necessarily the problem.

It is the indiscriminate use of cars for non-essential journeys which is the problem. The economic, social, and environmental costs of congestion are unacceptably high. Increasing infrastructure provision has served to tear communities apart. The congestion caused by high levels of low-capacity vehicles can increase the generalised cost for essential road services such as goods and public transport.

Since increasing the supply of roads has failed to balance demand and supply, greater consideration has recently been given to the possibilities of containing the demand by methods generally referred to as traffic limitation, demand management or restraint. This inevitably involves making tough decisions on when to accommodate the car and when to restrain. A number of techniques have been developed to restrain the car and thus improve public amenity, protect the environment and improve road safety. These include parking control, supplementary licensing and road pricing.

Photo: Toronto Transit Commission

Photo: Toronto Transit Commission

Figure 3.3 The problem: Cars have a very high land take when compared to other modes of transport. The ordinary bus is not a cause of congestion but can be a cure for it. All of the drivers in the photograph above could fit into the one bus (top)

Photo: Gardner

Figure 3.4 A solution: Car restraint in urban areas. The Singapore traffic restraint system requires that vehicles display a restricted and expensive supplementary licence to enter the central area when the restrictions are in operation. Public transport is exempt

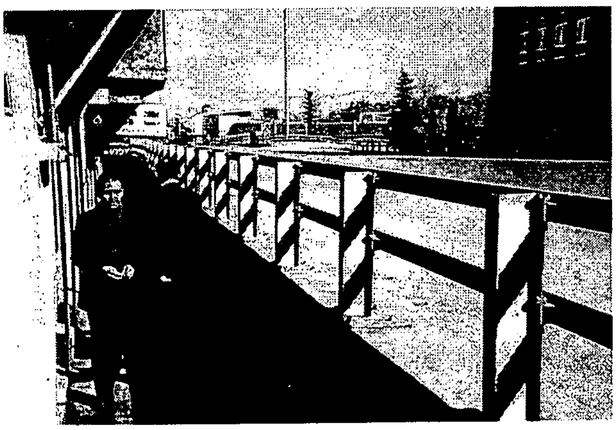


Photo: Gardner

Figure 3.5 The problem: A clear example of clash between design and function of a road. Strict adherence to standards of road widths and an obsession with grade separation can result in pedestrians becoming squeezed out. The entire area becomes less attractive for walking and cycling as a result. (Turkey)

Recommendations

1 It must be accepted that a certain amount of car ownership is inevitable and necessary;

2 A distinction must be made between car ownership and car use;

3 Restraint should be placed on non-essential car use.

3.3 Establishing an appropriate road hierarchy

Even with good land use patterns and a good public transportation system, an efficient road network will be needed for essential users such as public transport and goods vehicles. Outside of this core network, opportunities will exist for reclaiming space for social activities. In order to ensure a balanced and carefully-planned approach to road network improvements, the use of a road hierarchy is recommended.

Roads have a number of possibly conflicting functions including carrying through-traffic, providing access for essential goods and services and providing a democratic setting for public life. As the need for movement increases and as demand increases for lower capacity modes such as cars, these conflicts worsen. The preparation of a road hierarchy provides a basis to examine the function and character of roads, and thus make important decisions about the principal function of a street, upgrading it or downgrading it accordingly.

A hierarchy analysis allows the existing pattern to be compared with an ideal pattern in which roads are used optimally for road safety, movement, social and environmental requirements. Comparison between the ideal and actual case can identify deficiencies requiring immediate remedial action.

Recommendations

1 Roads can be placed in a hierarchy corresponding to their function and also to their physical design;

2 If there is a mismatch between these two hierarchies, these should be resolved between the traffic engineer and urban designer/planner.

4 Planning and design guidance

In Chapter Two, a number of land use planning objectives have been outlined. These include:

- Regional development based on decentralised concentration;
- Local neighbourhoods which contain a fine grain mix of uses;
- Public streets and spaces which are accessible, legible and attractive.

This chapter provides detailed design guidance related to achieving these objectives. It is intended that this guidance should be useful for traffic and highway engineers, planners and urban designers.

4.1 Regional settlement patterns

Guidance here is based on the principle of decentralised concentration, in order to avoid the worst excesses of town cramming and urban sprawl.

4.1.1 Settlement size

Many authors have tried to establish threshold levels at which point it is appropriate to pursue a policy of decentralised concentration. Recent guidance in the UK suggests that when population levels for a mono-centric urban area reach around 200,000, development should be directed into urban sub-cores. Below this, urban areas should pursue a policy of urban concentration and rural restraint (Barton et al, 1995).

Research has established that above a population of 200-250,000, cities become increasingly inaccessible, consume greater levels of energy and suffer from diseconomies of scale. Five kilometres is considered a suitable radius for a city as it is a distance which cyclists, pedestrians and public transport users can conveniently travel.

Having reached the critical size at which to pursue a policy of decentralised deconcentration, a number of policy options are available. In a country where one urban centre predominates, a policy of promoting secondary cities may be appropriate. Such towns should act as a counter-magnet to the existing centre. Alternatively, a policy may be pursued which seeks to promote a number of urban sub-cores in close proximity to that centre, all serving a secondary function to the centre.

4.1.2 Secondary cities

Secondary cities might be defined as smaller than the largest metropolis to which the benefit of economic assistance has usually flowed, but large enough to perform important economic and social functions for their own populations and those in the surrounding areas (Rondinelli, 1983). Many commentators feel that strengthening the network of intermediate cities would 'have the dual advantage of dispersing urban populations, perhaps thereby reducing the flow towards the primate cities; and, building up other centres of urban activity which can serve as regional catalysts and accelerate the geographical spread of development.' (Lubell, 1979).

4.1.3 New and expanding towns

In the UK new towns tend to be large and isolated settlements with a high degree of self-sufficiency. Governments have promoted these types of settlements to act as growth poles. In many developing countries, new cities have sometimes become inefficient distant satellites, with people needing to commute back to the original centre on a daily basis. This may not be sustainable. Figure 4.1 gives suggested criteria for successful design.

- A majority of full time employed residents to work in the town;
- The town centre to have good transport centrality and a mainline railway station;
- The town to be compact in form, maximum radius 5km, preferably less than 3 km;
- The distance to the main city centre, or to other town centres in a cluster, to be relatively short, e.g. a public transport time of less than 30 minutes;
- Local facilities include a good spectrum of durable as well as convenience retailing at the heart of the town, secondary and tertiary educational facilities and a range of cultural leisure facilities;
- The planned population level is at least 25,000

Figure 4.1 A number of criteria are suggested for the design of a new town in the UK by Barton et al, 1995. Although the exact dimensions will differ for developing cities, the principles will hold

4.1.4 Urban sub-centres

An alternative to new and expanding towns is the promotion of a series of small freestanding towns in close proximity to each other and perhaps a major city. This is perhaps the most energy-efficient form in a society that is dependant on the car for most travel because the distances to travel for everyday needs are minimised (Bannister, 1992).

4.2 Neighbourhoods and communities

Neighbourhoods are physical, social and economic continuities. Neighbourhoods which contain a variety of uses should be promoted.

4.2.1 Local neighbourhood size

It is important that neighbourhoods are enhanced and supported in order that people can obtain most of their needs locally. Research has shown that people generally find that 400m represents a comfortable walking distance of five minutes. Therefore ideally the aim should be to provide as many of those facilities which people require on a daily basis within this distance. If older parts of a city are examined which have been allowed to evolve over time, it is possible to identify neighbourhoods which do provide a good range of facilities within this 400m radius. Neighbourhoods of this size ideally support a population of around 7,000 people. This can be considered a good population size in that everyone is likely to be no more than one person removed from knowing everyone else. This engenders community cohesiveness.

If a typical walking speed is about 5km/hr, most people can travel about 1km in under 10 minutes. A typical cycling speed is 20km/hr and so cyclists can travel approximately 4km in the same time. These are useful dimensions on which to base the design of a neighbourhood, and ensure that most daily needs are within 10 minutes travel time from the home.

4.2.2 Density

For the most part, the densities of many urban areas within developing countries have emerged unplanned. Many cities have urban areas whose densities far exceed those promoted in the west. What would be considered a high density in one country could be viewed as low in another. It is important that countries promote standards appropriate to local conditions. This will inevitably be an extremely complex and controversial process. Where densities are too high this can result in overpopulation, slums and town cramming. If density standards are too low, this may result in developments such as housing becoming more expensive, land use less efficient, public service provision more expensive and, ultimately, promotion of urban sprawl.

A simple technique for establishing appropriate density levels involves identifying densities in existing parts of the city which work particularly well in terms of urban quality, and adopting these densities as standards for new development. It may be useful to identify three bands of density for a particular area and place the highest density band along key frontages and public transport routes. Densities ideally should be greater around the nucleus of a particular community and gradually decrease away from the centre.

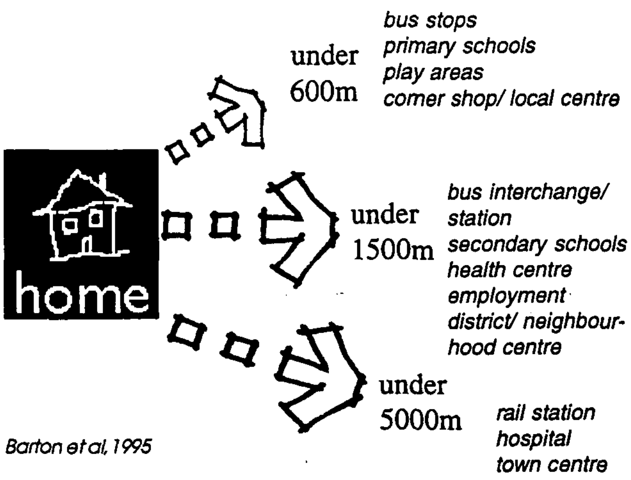


Figure 4.2 Neighbourhood size and proximity of uses based on comfortable walking distances

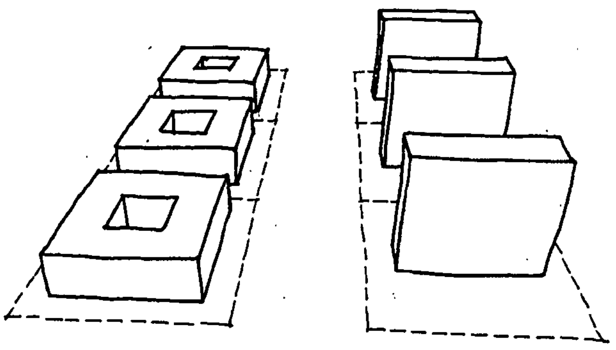


Figure 4.3 The perimeter block is a flexible and efficient form of layout, producing a street network that is enjoyable to live in. The drawing compares 4-storey perimeter blocks with eleven storey point blocks. The floor area and density is the same in each example, but the perimeter blocks define streets, accommodate mixed uses more readily, and create a better micro-climate than the wider open spaces between tower blocks

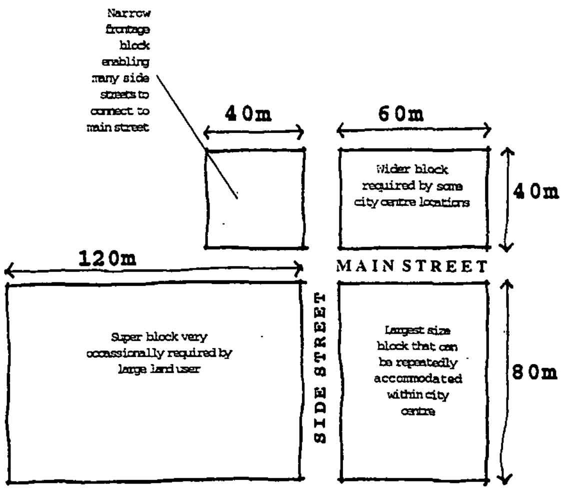


Figure 4.4 Perimeter blocks: typical block sizes

4.2.3 Perimeter blocks

The perimeter block is highly versatile and lends itself to a variety of pedestrian-friendly layouts. Unlike the barren wasteland around high-rise towers, the space between perimeter blocks results in a network of streets at a human scale. Perimeter blocks should always be considered when considering new or re-development. They can provide privacy within the block and can accommodate a variety of different uses over time. Some block sizes are more appropriate to certain uses than others.

In many rapidly growing cities around the world, a large proportion of new development is within point blocks. Architects are under pressure to build tower blocks and skyscrapers taller and more prestigious than the last. This has resulted in many cities having dramatic skylines. However, the micro-climate at the base of these buildings is poor in comparison to urban areas comprised of perimeter blocks.

Blocks can be organised within a grid structure. A fine grain grid is desirable because it allows maximum movement and connectivity throughout an area. The shape of the grid need not necessarily be straight and uniform, but may take on a distorted form to suit topography or other constraints. Ideally the grid should accommodate a variety of block sizes and public open spaces.

Ideally, block sizes towards the centre of urban areas should be smaller than those on the periphery to allow for greater permeability and activity. Blocks should be oriented in such a way that accessibility to main streets is maximised, therefore, the short side of any block should be adjacent to the main street. Perimeter block development can generate densities just as high as single point tower block development. A typical arrondissement in central Paris with development in seven storey perimeter blocks has a similar density to central New York.

4.3 Public streets and spaces

The aim should be to provide an accessible and legible network of public spaces which is attractive to all users but primarily to pedestrians.

4.3.1 Accessibility and street pattern

Streets and paths can be categorised as either a lattice or a tree structure. The lattice provides a far higher level of connectivity and hence availability. Figure 4.5 illustrates seven nodes with linkages in the form of a tree structure. The other half of this figure shows the same number of nodes, but linked together as a lattice. The tree structure has six linkages whereas the lattice has twenty. Trees and lattices work in very different ways:

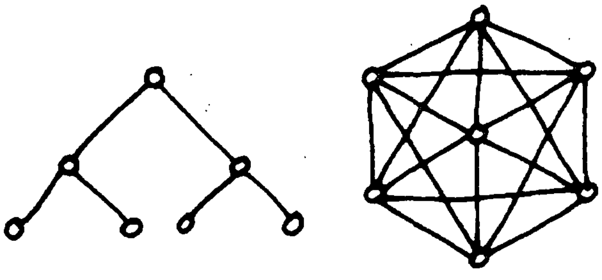
ISSUE	TREE	LATTICE
movement:	segregation	shared streets
traffic:	concentration	dispersal
land use:	zoned	mixed
street pattern:	enclaves	connectivity
community:	isolation	society

Tree structures reduce movement on the lower branches (culs-de-sac) and concentrate movement on the higher branches. Lattice structures disperse movement more evenly throughout the street network.

So-called 'un-planned' cities always organised streets in a lattice structure and so provided a high degree of connectivity which allows free and easy access to all parts of the city by a choice of direct routes. This ensures that street environments are both vital and viable, and that no link in the system need carry so much traffic that it effectively becomes a pedestrian barrier.

A lattice street-structure may give concern to road safety as there are a large number of cross-road junctions and therefore points of vehicular/pedestrian conflict. Tree structures result in fewer crossroads and enable vehicular traffic to move safely and quickly without interruption on the higher branches of the system. Tree structures have therefore found great favour in situations where access is preferred to passage. However, tree structures can result in the roads on the higher branches of the tree becoming car dominated with pedestrians disadvantaged and forced to use either underpasses or overpasses to cross such roads.

A tree structure may overlap a lattice. Cars may be restricted to suitable roads, with a more direct lattice network for the use of pedestrians, cyclists and essential services and public transport. This may have advantages for ease of vehicular movement and road safety in some situations.



TREE LATTICE

Figure 4.5 Street pattern: Tree structures and lattice structures

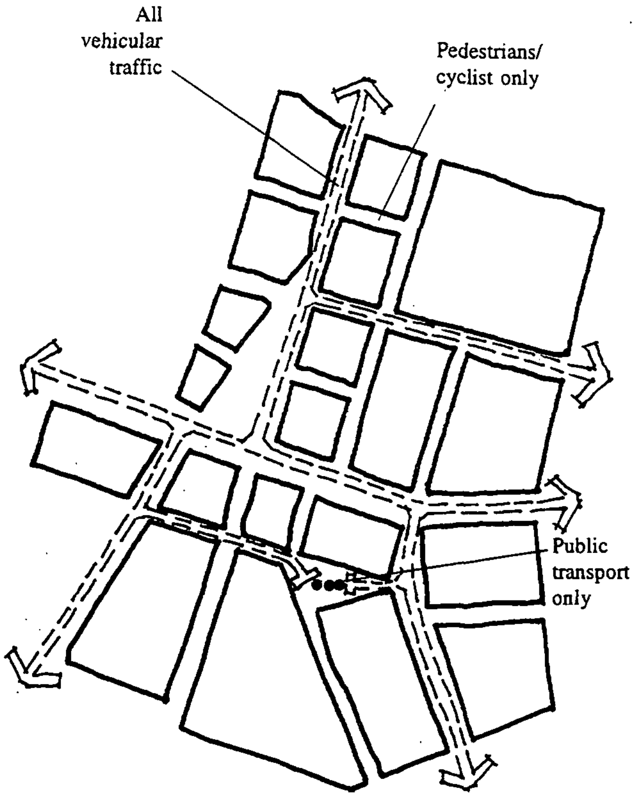


Figure 4.6 Plan for a new residential neighbourhood (Warwickshire, UK) showing tree-structured traffic management network overlaid on a lattice grid of perimeter blocks. Such an arrangement maximises pedestrian accessibility and safety

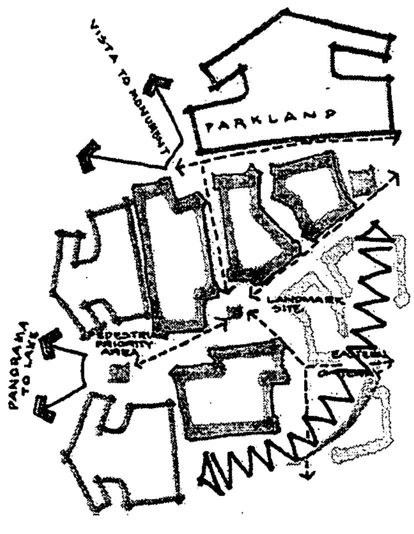


Figure 4.7 An example of a typical urban design site appraisal. This is an assessment of the extent to which built form, landscape, transportation routes and visual qualites contribute towards a legible environment. Urban features such as paths, nodes, landmarks, edges and districts are identified. Each of these features assists in orientating oneself within our towns and cities. Where such features are lacking, the urban designer produces proposals to reinstate or create new features. This may involve opening up vistas, building landmark buildings at key corner positions, or improving the pedestrian environment along a street

19th century

20th century

urban design proposal

Figure 4.8 Orientation: Figure-ground drawings can be produced to graphically demonstrate changing urban grain over time (The example here is from Worcester, UK). The first shows a nineteenth century fine grain street pattern ideally suited to pedestrians and slow moving forms of transport. The second shows the impact of road schemes and associated re-building during the latter part of the 20th century and the resulting loss of legible street pattern. The third drawing shows proposals to re-plan the area using perimeter blocks which re-define a grid street structure

4.3.2 Legibility and orientation

People tend to orientate and find their way in an urban area by reference to five key physical elements (Lynch, 1960):

- **Paths** (streets) which channel movement;
- **Nodes** (squares) which are focal places;
- **Landmarks** which are key points of reference;
- **Edges** which define neighbourhoods;
- **Districts** which are areas of a city deriving an identity through the unique composition of paths, nodes, landmarks and edges.

These elements need to relate in a logical way in order to form an intelligible plan which gives people a 'mental map' of an area. (See also Hillier, 1984)

4.3.3 Street design

If walking and cycling are to be promoted as an attractive alternative to other forms of transport, it is important that the pedestrian environment is considered at the highway design stage and continually monitored. The following checklist can be applied to most situations.

Context

The character of a street will be primarily determined by its context within the surrounding street structure and its place within a street hierarchy. It is useful therefore to prepare a classification of street types based on pedestrian character and economic potential as well as transport considerations.

Scale

The scale of the street, as evidenced by a simple cross-section, should accord with its context within the street hierarchy. Dimensions will need to agree with local cultures and conditions, but the following table may serve as an example:

Street type	**Corridor width**
Boulevard	25m - 40m
Avenue	20m - 25m
Main Street/High Street	15m - 20m
Side street	10m - 15m
Pedestrian alley	6m - 10m

Proportion

The height of the buildings bordering the street should be sufficient to visually contain the space. While quite narrow streets can be pleasantly defined by five storey development, low rise is quite unsuitable for a wider street-type.

Alignment

Horizontal alignments, which follow a series of fairly straight lines with small changes of direction at junctions, are generally preferable to centre-lines which follow a radius determined by the design speed of vehicles. Changes of direction at junctions, e.g. a 'dog-leg', also serve to reduce traffic speeds by reducing forward visibility; an even curve derived from highway standards tends to maintain forward visibility and hence speed.
In traffic calming schemes, changes in horizontal road alignments may be preferable to vertical alignment changes, although the latter may be inevitable in carrying out improvements to existing streets.

Land use

The land uses bordering the street will influence its character through the types of use, the sub-division into different frontages and the 'activity' of the edge according to the number of entrances into buildings. Pleasurable streets for pedestrians have many, narrow frontage buildings, many entrances and display areas, and public uses.

Activities within the street

Streets may provide space for traders, markets or fairs. These uses can conflict with traffic, but can also often be managed by keeping them within a specific area or restricted to specific times of the day or week. Street activities, while sometimes a nuisance to traffic, are generally highly attractive to pedestrians.

Landmarks and marker points

Popular and familiar cities are those where most of the buildings behave as 'background architecture' and a few stand out as landmarks. Streets where every building strives to become a landmark often lack coherence. It is useful to consider where the main landmark buildings, and smaller 'marker points', should be sited within a plan. These locations will often be at street corners, where the street changes direction, or at the end of a vista along a street.

Sunlight and shade

Careful orientation should ensure that streets are appropriately designed for their climate. It may be possible, for example, to orientate key streets against prevailing winds in cooler climes and with prevailing winds in hot climates. In temperate climates people prefer to walk on the sunny side of the street and areas in permanent shadow may be little used. Buildings which are located to the north of their lots have the advantage of sunny outdoor spaces. Ground shadow can be minimised if buildings are orientated east-west rather than north-south, and also if building envelopes step back on northern elevations. Conversely, these techniques can be used to maximise shelter from the sun where required. Streets in hot climates may benefit from tree planting and architectural devices such as colonnades and canopies.

Airflow

Tall buildings can create unexpected air turbulence which may deter pedestrians. Buildings in the path of strong winds cause zones of low pressure on their lee side, increasing turbulence. Gaps between elevations accelerate wind speed, so spaces between tall blocks, or the areas below them if on piloti or stilts, are often wind swept. Tall buildings greatly increase wind speed around their edges, a problem which may be further compounded if tall and low buildings are unfortunately juxtaposed. Continuous street frontages comprising buildings of similar height are less likely to create airflow problems. If deviating from this, wind -tunnel checks may be advisable.

Personal safety

Personal safety in the street can be improved through 'self policing', where occupied buildings overlook the street. Cities designed to be used 24 hours a day thus help avoid certain areas becoming dangerous ghettos outside the working day. Opportunities for crime should be 'designed out'. Measures may include:

- replacing pedestrian underpasses and bridges with controlled surface-crossings;
- providing low level pedestrian street lighting;
- maximising the numbers of windows and doors which open onto public spaces thus increasing natural surveillance;
- introducing close circuit television (CCTV) in areas deemed unsafe;
- maximising linkages between new and existing developments;
- locating important facilities such as public transport stops in busy, well surveilled areas.

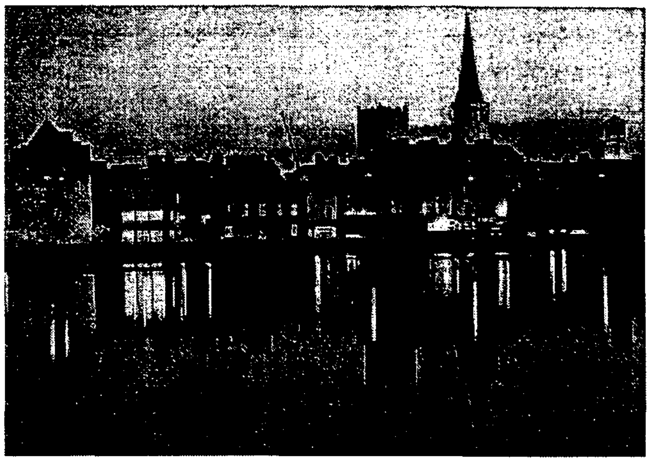


Figure 4.8 The water's edge and city skyline can be powerful elements contributing to our orientation within towns and cities

Figure 4.9 In hot countries, it is clearly desirable for a town's main shopping streets to be oriented to take full advantage of the shadows cast by buildings. Buildings oriented N-S cast a larger area of ground shadow over the day than E-W oriented buildings

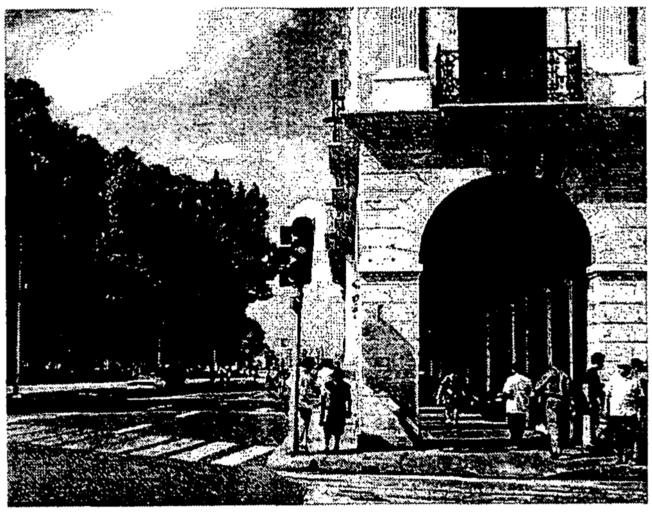


Figure 4.10 The nature of the building/street interface is a very important design consideration. Arcades provide shade from both sun and rain, and are preferable to the alternative of an introverted shopping centre

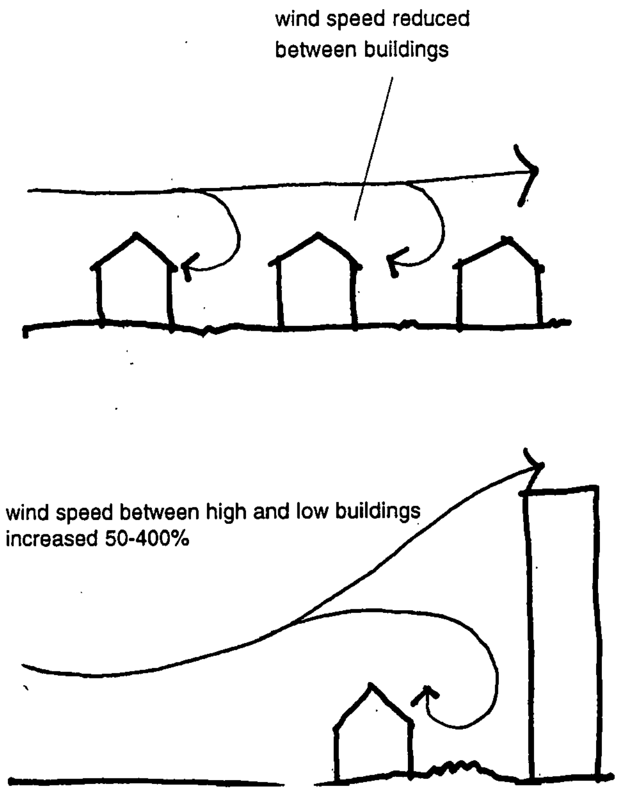


Figure 4.11 Airflow

5 Traffic planning

In Chapter Three, a number of transportation objectives have been outlined. These include:

- Optimising the network for the movement of people not vehicles;
- Restraining car use;
- Establishing an appropriate road hierarchy.

This chapter provides more detailed guidance on how to achieve these objectives. It is intended that this guidance should be useful to traffic and highway engineers, planners and urban designers.

5.1 Measures to optimise the network for the movement of people not vehicles

In most developing city streets a 'natural' priority has evolved whereby the largest, fastest, or most numerous, road-user takes priority over those beneath him in the traffic hierarchy. Priority schemes aim to redress this balance by engineering means in favour of the most deserving road user in terms of efficiency and/or road safety. Increasingly, road space released by network optimisation measures is being used to permit traffic calming on roads not suited to fast through-traffic.

5.1.1 Mass transit

Mass transit is the term used for high-capacity public transport systems. The main options for this are elevated or underground heavy rail (Metro), Light Rail Transit (LRT) and Busways.

A metro system can have a very high capacity (in Hong Kong flows of around 80,000 passengers per hour per direction are reached). Such high flows would not be possible to achieve using any other technology. A metro can, therefore, help to sustain the city centre as a focal point for a city. However, a typical metro can cost more than one billion US dollars, and it is not known whether this money would be better spent in other ways, nor how desirable are such high levels of activity.

Photo: Gardner

Figure 5.1 Light rail transit in a mixed priority street (Slovak Repubilic)

A network of busways, i.e. buses operating on segregated tracks, can provide a comprehensive transit system at very low cost (1 to 5 million dollars per kilometre). Local buses and construction methods can be used and hence operating and installation costs are low. Flows of 18 to 20,000 passengers per direction per hour are possible at speeds of 18-20 kph (Gardner et al, 1991). However, the bus has a very low image in many developing cities.

Special provisions for buses feature prominently in the excellent planning successes of Curitiba in Brazil. A network of high-capacity busways is provided, with interchange facilities permitting transfer to feeder-buses at no extra charge. Higher than normal density development has been encouraged around trunk routes and at interchange stations.

One reason for the high demand for Light Rail Transit systems is that they cost less than a full metro, but have a higher image than a busway. An LRT usually operates at surface level, and can comfortably share space with other road users, including pedestrians as it has no on-street emissions. LRT can still cost more than 25 million dollars per kilometre, however, and actual measured performance in developing cities has proved disappointing (Gardner et al, 1994).

5.1.2 Bus priority measures

For a long time to come, the majority of residents of developing cities will depend on the ordinary bus for their primary transport needs. It is therefore essential that the bus is given due attention in any urban planning scheme. Bus lanes and bus-only streets can help productivity as can special traffic signal timings. Efficient bus operation and planning through ticketing and careful scheduling of routes and location of stops are also critical to good transport services. (For more details see TRL, 1993).

i	With-flow bus lanes.
ii	Contra-flow bus lanes (lanes reserved in a one-way street for buses travelling in the opposite direction to the general traffic).
iii	Reserved bus lanes on freeways (sometimes reversible for tidal-flow operation).
iv	Bus-only streets.
v	Busways (segregated roads for buses only).
vi	Priority at traffic signals (eg automatic adjustment of timings to favour approaching buses).
vii	other bus priority measures, for example, parking restrictions near bus stops and traffic management measures specifically applied to bus routes to facilitate the passage of buses.
viii	Comprehensive schemes incorporating bus priority and town and traffic planning measures.

Figure 5.2 Bus priority measures

Rate of flow pers/min/m width of walkway	Quality of flow
1.5 or less	completely open
1.5-6	unimpeded: free movement, walking groups are easily maintained
6-18	impeded: groups must change and reform
18-30	constrained: groups cannot be kept, cross flows cause conflicts
30-42	moderately congested: bodily contact inevitable, frequent conflicts throughout the stream
42-54	heavily congested, even the slowest walkers are obstructed
>54	jammed: enforced movement at a standstill

Figure 5.3 Calculating pedestrian footway widths

Because buses are more efficient users of road space than private cars (a bus may carry thirty times as many passengers as a car, yet it only contributes three times as much to congestion) the freeing of buses from delays caused by other traffic can in many cases produce a net economic benefit.

Of the bus priority methods listed, with-flow bus lanes are perhaps the most common. In addition to these bus priority measures, bus use can be made a more attractive modal choice through:

- integrating bus routes with other modes of transport;
- providing high density uses close to public transport stops;
- providing convenient, well designed bus stops with good accessibility;
- optimising levels of service and cost.

5.1.3 Pedestrian priority measures

Even in the developing countries with the fastest growing vehicle ownership, walking is likely to remain the dominant form of transport. In a selection of African and Indian cities, walking accounted for between 20-40 per cent of all trips (Maunder and Fouracre, 1989). In many cases the sheer numbers of pedestrians will be enough to create their own priority, (although this can often be seen to be rudely violated by quite small numbers of motor vehicles).

One common problem in large cities is that because of the very large numbers of pedestrians, a nominal 2 metre footpath is often insufficient (if it exists at all). An estimate of a required pavement size can be obtained from Figure 5.3.

Obstruction of footpaths by parked cars, rubbish and itinerant hawkers inhibit pedestrian flow sometimes to the extent that pedestrians are forced to (and sometimes habitually) walk on the road edge. Thus, both vehicles and drivers are subject to hazard and delay. In situations where pedestrian/vehicular conflicts are severe, a number of pedestrian priority measures may be considered:

Pedestrianisation

Selective pedestrianisation of a street may bring environmental improvements, and may be acceptable in areas with severe conflict between pedestrians and vehicles. Careful planning is needed as accessibility is reduced, and removing the traffic will have implications for neighbouring streets which must then take more traffic and may be even less suitable. Large areas that are segregated for one category of user also risk being barren when those users are not present (e.g. pedestrianised shopping streets at night). Full pedestrianisation should therefore take place only within a framework of a carefully planned road hierarchy.

Vehicles legally restricted and streets traffic calmed

In this, only service vehicles or public transport are admitted into the scheme, or service access is restricted to certain times of the day. If it is not possible to pick up or set down public transport passengers within 400 metres of a pedestrian area, permitting public transport entry to the scheme will have to be considered. Such compromises can still represent a major improvement on the status quo.

Vehicles discouraged and street traffic calmed

This approach makes clear to motorists that pedestrians have priority, and that vehicles are only acceptable if travelling at walking pace. Vehicular access is maintained though restricted in numbers, and speeds limited to that of walkers. Pedestrians are encouraged to accept priority in the road space. Practically, such a solution is only applicable to residential areas where traffic flows are less than 250 vehicles per hour rather than busy commercial areas. Shared streets should be designed to encourage users to proceed cautiously. It is not known to what extent driving styles in developing cities will be compatible with shared streets, and these should therefore be used with caution and carefully monitored.

Pedestrianisation measures should only be used after the alternatives of discouraging or restricting traffic have been explored. It is not always possible (or desirable) to pedestrianise streets which were conceived and developed to carry vehicles. If the scale, proportion, alignment and evenness of the streets edges have been designed for fast moving traffic then the spatial qualities are unlikely to be conducive to pedestrians unless considerable remodelling takes place.

Where the waiting time to cross a road is no more than 10 seconds, although that road will be a nuisance to pedestrians the delay time will not be long enough to encourage usage of subways or footbridges, and surface crossings remain preferable. There are some instances where the use of subways and footbridges are unavoidable. The most attractive subways from the pedestrian's viewpoint are those which give him the impression of staying at ground level so that the experience is more like going under a bridge than through a tunnel. This can be aided by:

- minimising the horizontal deviation from the desired line of movement;
- minimising vertical deviation;
- giving sight of exit paths from opposing entrances;
- minimising subway length;
- maintaining an adequate level of lighting.

5.1.4 Two-wheeler priority measures

The bicycle is an almost-perfectly efficient and environmentally sustainable form of transport which could be well suited to almost all developing countries. Although negligible in some African countries, bicycles and motorcycles are a prominent form of transport in many Asian cities, and exceptionally high levels of motorised two-wheeler ownership have been predicted for Indian cities by the year 2000. Some physical segregation of bicycles from other traffic has been introduced in many Chinese and European cities.

Careful reference to the transport capacity plan will be needed, since very large numbers of bicycles (for example in China) can block road users that are even more efficient such as mass transit vehicles. Bicycles should then be encouraged to be used as a feeder service to the higher capacity mode.

i including cycling and pedestrian facilities in new highway improvements, environmental improvements and traffic management schemes;

ii providing improved cycle parking facilities at major employment centres, retail centres and recreational centres;

iii improving direction signing and pedestrian and cycle access at transport interchanges;

iv identifying and promoting long distant cycle ways linking with neighbouring facilities;

v promoting the cycle as a suitable means of transport, irrespective of gender or social standing.

Figure 5.4 Practical measures to promote cycling

5.2 Measures to restrain car use

It is now generally agreed that increasing the supply of roads to meet demand merely results in more demand.

Since increasing the supply has failed to balance demand and supply, greater consideration has recently been given to the possibilities of containing the demand by methods generally referred to as traffic limitation, demand management or restraint. In congested conditions each vehicle trip imposes delay (cost) on other vehicles in the network, which in total may exceed the net value of the trip to the individual concerned. The individual does not pay for such community costs himself and thus they have no bearing on his decision to travel or choice of mode.

5.2.1 Parking control

This is the most common form of demand management. It goes beyond the usual localised objective of parking control and attempts to limit the total number of parked vehicles in a central area so as to limit traffic volumes in the city as a whole. Costs are usually adjusted so that short term parking for economically important activities is not significantly affected. Longer term parking, particularly for the period covered by the working day, is positively discouraged by means of a discriminatory scale of costs.

5.2.2 Supplementary licensing

This requires a vehicle to display an additional licence when using the restraint area. Licences can be obtained on a monthly or daily basis from a licensing office or various trade outlets. Any vehicle found without a valid licence anywhere within the restraint area is subject to prosecution. One of the most successful examples of this is in Singapore. The licence scheme was complemented by increased parking rates and, most important, good alternative public transport. A study (World Bank, 1978) carried out after the system was introduced showed that revenues were almost nine times costs and that the rate of return on investment (about $2.7 Million) was about 77 per cent per annum.

5.2.3 Congestion pricing

In this system, on-street or in-vehicle detectors sense when congestion is occurring and a charge is levied accordingly. Detectors can operate so as to generate a charge related to the distance travelled within the area. It has been shown that such a scheme would be technically possible in Hong Kong and that benefits (in terms of reduced congestion and revenue received) would be several Million HK$ per day. However the scheme was shelved highlighting the importance of political acceptability of such a scheme.

5.3 Measures to establish an appropriate road hierarchy

Measures have already been outlined to encourage the use of high capacity sustainable modes of transport and to restrain the use of the car. However, the continued use of the private motor car is inevitable and therefore measures must be taken to ensure that it is accommodated appropriately. This involves making decisions about which streets are suitable for through traffic and on which streets through traffic should be discouraged. The production of a road hierarchy diagram is a useful design tool in this respect. Decisions must be made about the function of each link in the network based upon its geometrical properties and use-characteristics. A plan should then be prepared showing each category of road illustrated using a different pattern or colour. A separate plan can be produced showing an 'ideal' layout in which the form and function are compatible. In some cases it will be clear that the existing hierarchy is not ideal, for example housing streets used as 'rat-runs'. What should emerge from this process is the need to strategically upgrade certain roads in order that they can carry through traffic efficiently whilst strategically downgrading others to discourage their use by through traffic. There are a variety of measures available to do this:

Street upgrading: improving vehicular flows on through routes:

- Junction design
- Parking controls
- Traffic signals
- Urban traffic control

Street down grading: restricting vehicular flows on local routes:

- Traffic calming measures
- Speed controls
- Partial closure - e.g. bus gate

The advantages of preparing a hierarchy for a town are:

- it provides illustration of the existing road layout in a manner that can readily identify omissions, irregularities and duplications;
- it allows the existing pattern to be compared with an ideal pattern in which all roads are used optimally for road safety, movement, social and environmental requirements;
- comparison between the ideal and actual case can identify deficiencies requiring immediate remedial action;
- long and medium term improvements can also then be focused on the strengthening of the ideal hierarchy;
- it provides a useful mechanism for examining elements of the streetscape;
- it can provide a common language for discussion between the different interested parties that are responsible for the development of the urban area.

Although a road hierarchy can be planned and analysed using nothing more complex than coloured pens on a map, the study of large complex networks may require a transport model.

Models use the following as inputs:

- the dimensions of the roads;
- the population densities by zone;
- current traffic flows;
- unobstructed speeds.

Models provide the following as outputs:

- estimates of the actual journey times;
- queue lengths on each road.

Once calibrated, population growth-estimates then permit flow calculations for future years. This can be very useful for predicting the impact of changes, and for testing alternative strategies without construction. A good model will also indicate how roads can be narrowed or closed for environmental reasons, without detrimental impact on essential users.

Commonly used traffic management models in the UK include CONTRAM (Leonard & Gower, 1982) TRIPS (MVA, 1996) and SATURN (Hall et al, 1980). Each of these has its own strengths and weaknesses (Allsop et al 1986) though each of them tends to be quite hungry for reasonably accurate data and skilled staff - not always available in developing cities.

5.3.1 Street upgrading: improving vehicular flows on through routes

Each city will have varying road widths, some two-way and some one-way streets, and different types of junction control. The combination of these will directly affect the efficiency of movement and hence the biggest improvement in traffic circulation will derive from their optimisation. Until the network is optimal in this way, it would be meaningless to introduce new road-building or other expensive infrastructure investments.

Junction design

In an urban area, a large proportion of all delays occur at junctions. Junction improvements can therefore reduce traffic congestion, whereas widening of the roads between junctions may have no benefit.

A possible conflict arises in that there is a direct relationship between junctions and accidents. Junctions are unavoidable in a network, but they also have a beneficial effect in that they aid orientation and are an important part of the streetscape. The conflict of objectives is particularly severe in the case of crossroads. These are statistically among the most unsafe layouts, and yet have a critical role in the streetscape and morphology of the urban area. Crossroads have for a long time been important landmarks in towns and cities and points for social congregation. There is considerable need, therefore, for traffic engineers and urban designers to work on new designs of junction layout, such as the traffic square, which have the potential to cater for traffic and improve the urban space.

There is general agreement that the solution to junction problems is not (as was found unsuccessfully in the UK in the 1960s) creating segregated pedestrian crossings in the form of underpasses and overpasses. Yet this approach is still common in developing cities (See Figs. 2.4 and 3.5). Grade separation is expensive, visually obtrusive and requires a large land-take. Large size roundabouts are also incompatible with a tight-knit urban area, and their success at improving traffic flow can be a disadvantage for pedestrians trying to cross, and can increase the risk of accident for two-wheelers.

Instead of tackling the junction on its own, a hierarchy study may be able to identify closure and re-routing possibilities for non-essential motorised traffic. At-grade signalised junctions, if working efficiently, can nearly equal the capacity of some developing city flyovers.

Parking control

Considerable space is taken up in an urban area by parked vehicles. Poorly positioned parked cars can considerably reduce the efficiency of the carrying capacity of a street. On routes designated as through- routes, carefully designed car parking bays should be used in order that flows are unhindered and the carrying capacity of the street is optimised.

Traffic signals

Traffic signals are used throughout the world for the control of traffic at junctions. Their use in developing cities is likely to increase, despite some doubts as to their effectiveness, and safety if used incorrectly. Traffic signals enable pre-determined levels of priority to be given to each approach to a road junction. Originally, the length of green time given to each arm was determined by trial and error. More recently, mathematical theory, and improved technology have led to control methods which minimise vehicle delays. Such methods for improving the performance of traffic signals have been developed at the Transport Research Laboratory (TRL, 1996).

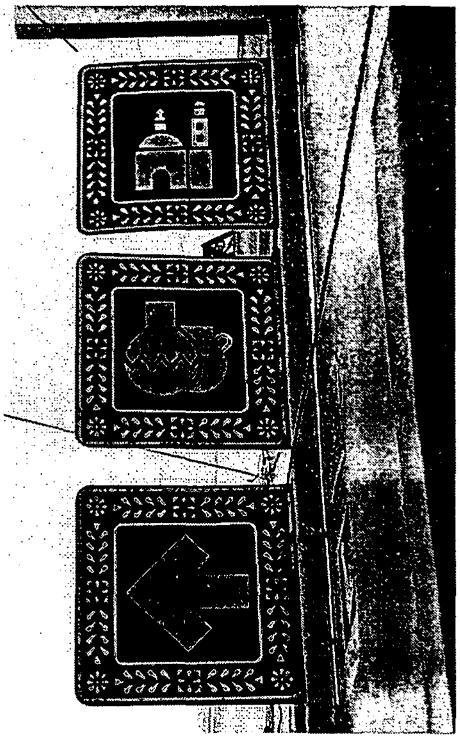


Figure 5.6 Visual clutter can be reduced within the street by attaching features such as signage and lighting to buildings rather than being pole-mounted. Careful design can increase the legibility and attractiveness of street signage (Meridia, Mexico)

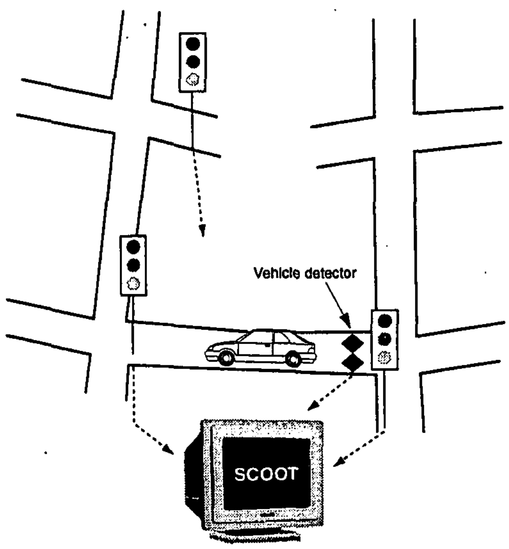


Figure 5.5 Network Improvements: The linking together of signals using SCOOT software can improve the capacity of a network, without new construction. Alternatively it can be used to restrict access to environmentally sensitive areas

Urban traffic control

For junctions in a network where the demand at one set of signals is influenced by another set nearby, the synchronisation of the timings of the signals in the network can further reduce congestion and delay. This process of linking signals is known as Urban Traffic Control, or UTC. Fixed time systems such as TRANSYT (Robertson, 1969), use traffic count information for the network to establish the settings for each signal. Since its development, TRANSYT has established itself as the world standard; a well set up fixed-time UTC system is still both difficult, and expensive, to improve upon.

Adaptive Control Systems constantly alter signal times to suit measured prevalent traffic conditions without manual intervention. The best method of adaptive control is SCOOT developed by TRL (Hunt et al, 1981). SCOOT is capable of highly sophisticated manipulation of traffic including, for example, minimising flows into designated areas that are environmentally sensitive.

5.3.2 Street down grading: restricting vehicular flows on local routes

One of the advantages of preparing a road hierarchy is that it identifies not just areas for improvement, but also possible areas for downgrading a road so as to favour more socially desirable functions.

A wide variety of traffic calming techniques is available to alleviate the impact of vehicular traffic and improve the pedestrian environment. These techniques are generally appropriate in residential areas and shopping streets where traffic speeds are restricted to 20 or 30 mph and it is desirable to discourage through traffic. The most common ways of calming traffic are by vertical and horizontal shifts in the carriageway, restricting forward visibility and utilising a change in surface material. (For a full description and detailed diagrams and photographs of traffic calming in the UK see CSS, 1994).

Vertical shifts in the carriageway

This may be an appropriate technique to use in local streets where traffic is travelling at 20 mph and below, although they may be used at speeds up to 30 mph and along bus routes if vertical shifts are reduced. Techniques include humps, cushions and plateaux (of which there are a variety of designs). All three techniques can be used at junctions. Humps and cushions may also be used between junctions. Road humps should always be used in conjunction with other speed reducing features. They do, however, have some disadvantages like localised increases in noise and vibration and visual intrusion, and emissions.

Horizontal shifts in the carriageway

This is an appropriate technique to use in local streets where traffic is travelling at 20 mph and below. The more severe forms are not suitable along bus routes. The carriageway may be laterally shifted both at junctions and between junctions. Techniques include pavement extensions, central islands and chicanes. Chicanes are a form of pinch point implemented on alternating sides of the carriageway. Road widths need to be wider than at normal pinch points because of the difficulty involved in manoeuvring around them.

Pinch points

Pinch points can be used to slow traffic down at key locations, define parking bays and provide opportunities for environmental improvements such as tree planting. They can be used at junctions to aid pedestrian crossing and can be integrated into pelican/zebra crossing designs and bus stop design. By passes for cyclists are needed.

Carriageway narrowing

The potential exists to narrow many local streets and hence reduce traffic speeds and increase the space designated to pedestrians. Carriageway dimensions will depend on the volume and type of traffic, the speed limit in force and the road classification.

Photo:Gardner

Figure 5.7 Street downgrading: This may involve removing traffic altogether (Bursa, Turkey). The viability of many urban areas depends on the accessibility to them by all modes of transport and therefore the decision to pedestrianise a street should not be taken lightly. Other approaches such as traffic calming should be investigated first

Figure 5.8 Street downgrading: Vertical shifts in the carriageway are often used to traffic calm existing streets. Road humps are not always popular with residents and they should not be used excessively, or without consideration of alternatives (Cancun, Mexico)

Figure 5.8 Street downgrading: On-street parking can reduce vehicular speeds through carriageway narrowing and promoting driver caution. It is a preferable solution to large surface or multi-storey car parks and provides users with more direct access to homes or shops. On-street parking is common in the centres of many historic European cities and can be both attractive and safe (Oxford, England)

Restricting forward visibility
Traffic speeds can sometimes be reduced and driver concentration enhanced by re-introducing physical and visual obstacles into the environment, thus removing the 'racetrack' feel to many urban streets. Car drivers ought then to proceed with greater caution. Measures include providing right angled or echelon parking along the street edge and providing strategically placed trees, lighting and street furniture. Often in tight and congested urban areas it is not possible to provide extensive visibility. In such instances efforts are required to reduce traffic speeds as they approach a junction, hence reducing the visibility splays required.

Rumble strips
Rumble strips are made by changing the surface material of the carriageway, to introduce a type of noise and vibration that contrasts with the normal road surface. This has the desired effect of slowing the traffic down and, equally important, raising driver awareness. They can be constructed from concrete block pavers, cobblestones, granite setts and bricks. The use of a contrasting colour and good lighting are important. If designed appropriately they can be used on both high and low speed roads.

Changed road surface
Strips across the carriageway, or whole lengths of carriageway, can receive a changed road surface in order to promote caution and lower speeds. However, such a measure is predominantly a driver alerting device rather than a speed reduction device, and hence should be used in conjunction with other techniques if speed reduction is the main objective.

Road closure
Although a primary aim should be to maintain pedestrian and cyclist access through a lattice structure of roads, it may be necessary in some instances (such as within residential areas) to restrict access to motorised traffic through road closure. The decision to close a road must be well considered as it will have significant implications such as increasing travel distances and increasing congestion on surrounding streets. Provision should be made for cycle, bus and emergency vehicle access.

Small turning circles
Many road junctions have been designed for ease of vehicular traffic movement and hence have very large turning radii (e.g. 7m and higher). In local streets, turning radii may be considerably reduced (e.g. to 1m), thus enabling pedestrians to cross along desire lines and reducing the danger of cyclists being 'cut out' by turning vehicles.

Junction design
Most of the techniques outlined above can be used at traffic junctions in conjunction with measures which close one or two arms, provide traffic islands at the arms or in the centre and provide mountable shoulders.

Planting
Tree planting can be a very effective speed reduction measure. In practice it can be very difficult and costly to plant new trees in existing urban areas due to the large number of utilities which will exist under ground. Planting may be either within pedestrian footpaths or within a former vehicular carriageway. Trees should be at least heavy standards, physically supported in the early stages and will require kerbs to prevent vehicle over-run. The distance the tree is planted from the kerb line will depend on the size the tree will grow to and the height of the canopy in relation to passing traffic. Water supply may also be an important consideration in some countries. Street lighting may have to be re-designed to take into account reduced lighting levels caused by tree planting.

Lighting
Lighting has a very dramatic impact on the quality of the built environment. The following issues require consideration:

- control of traffic speed (if used appropriately, lighting can be used to slow down traffic in key areas);
- prevention of light pollution through correctly designed fittings;
- attention to illumination of pedestrian pavements as well as carriageways;
- attention to quality of lighting in the built environment, e.g. floodlighting of buildings, colour quality particularly for illumination of planting.

NB Specific guidance on road lighting in developing cities is given in TRL/ILE 1990.

Figure 5.9 Street downgrading: reducing forward visibility through tree planting can promote greater driver caution thus reducing traffic speeds. It can also dramatically improve the street scene, reduce localised pollution and enhance pedestrian comfort (Seville, Spain)

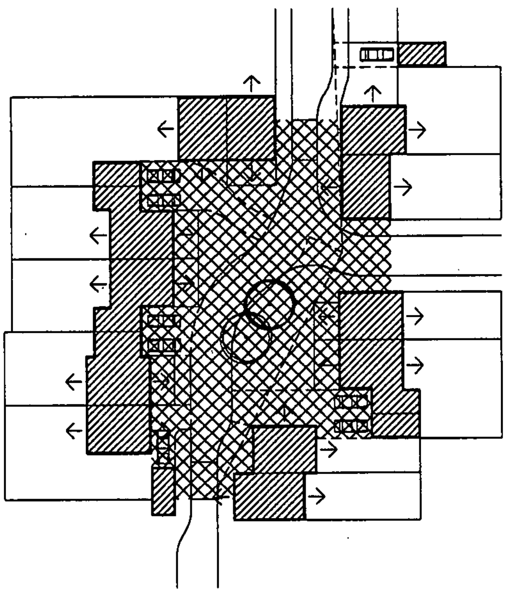


Figure 5.10 Street downgrading: Junction design. A nodal point in a street network should be made a memorable place. In a residential neighbourhood, squares may be placed at street junctions. The square should be defined through careful positioning of building frontages and street furniture

6 Procedural and organisational change

The World Bank found that more of its traffic improvement projects failed because of institutional problems than directly due to the failure of engineering measures (Barrett, 1988).

6.1 Mission statements

Agenda 21 of the Rio Conference states that sustainable development requires the involvement of all sectors of society in agreeing objectives, designing means of achieving them and implementing national and local policies. One way to achieve this is through a collaborative process where a mission statement or a 'sustainable development plan' is formulated. UN guidance states that such a plan or mission statement should address the environmental issues of energy generation and use, global climate change, bio-diversity, water resources and quality and minerals, as well as the transport issues outlined in this report.

The aim of such a collaborative process should be to involve as broad a cross section of ideas, skills and powers as is possible. Although this type of 'round table' approach is commonplace in countries such as Canada and the Netherlands, it may well prove to be an alien concept in many other countries. Nonetheless, it is a very useful way exploring differing perspectives and then of agreeing a common approach to important issues, and as such, its use should be considered very carefully by politicians.

Recommendations

1 The mission statement should reflect a broad public and government consensus about the future planning of the urban region;
2 The statement should reflect the sentiment of Agenda 21 of the Rio Earth Summit and the Habitat II Conference;
3 The statement should outline an action plan or strategy for achieving goals and performance;
4 There must be indicators to measure the degree to which these goals have been achieved.

6.2 Land use planning and transportation planning through urban design frameworks rather than traditional masterplans

In many countries, effective land use planning powers do not exist. In such countries, transportation planning to a large part dictates where new development takes place. Transport networks must therefore be planned with an understanding of their likely impact. Often this is not the case, as demonstrated in many developing countries where 'new roads have attracted dense borders of low-grade commercial and residential building within a few years, generating volumes of pedestrians and cyclists, parked vehicles and animals that soon prevent the streets from performing the function for which they were intended' (Thompson, 1983).

In other countries, land use planning powers are very effective although often too prescriptive and rigid. Such powers enable transport systems to be developed with some degree of certainty to serve new development locations. However, this traditional type of master-plan has been responsible for a large number of planning failures as they are conceived diagramatically in two-dimensions, and are fairly unresponsive to economic and demographic changes. Traditionally they have led to the separation of land uses which ultimately has increased trip generation and led to a poorer urban environment (fig. 2.3).

An urban design framework provides the opportunity to successfully integrate land use and transportation planning in a way that is sustainable and effective. It can be seen as the translation of principles and objectives contained within the mission statement into three-dimensional site specific proposals. As such, it provides potential developers and the public at large with a clearer indication of intent than a local plan, which tends to explain policy in fairly general terms and is more open to misinterpretation. A framework can be responsive to economic and demographic changes and enables development to proceed incrementally on a block by block basis over time. The framework provides an urban structure which can accommodate a wide variety of uses and as such allows for flexibility.

Recommendations

1 Urban design frameworks should be used to translate the objectives contained within the mission statement into site specific proposals;

2 Urban design frameworks provide better instruments for achieving an integrated solution rather than a traditional master-plan or blueprint for an area (i.e. they are more sensitive to local needs and are able to adapt to changes over time).

6.3 Area based, multi-disciplinary teams

In general, local government has tended to be organised along professional lines. This has limited integration across large, and sometimes bureaucratic, departments and has made policies far removed from the public. Consequently, the quality of local knowledge of a site specific nature has been lacking. Agenda 21 has addressed this problem by putting forward the principle of 'subsidiarity'. This entails policy formulation, decision-making and administration taking place at the lowest level possible. The exact status will depend upon local governance issues and cannot be specified in detail here. This has implications for the structure of local government. In the UK, for example, many services have become increasingly decentralised. Some authorities have established area-based multi-disciplinary teams in order that officers have a more immediate relationship with an area so that problems can be tackled creatively and holistically.

Recommendations

1 Implementation of policies should take place through locally-based multi-disciplinary teams;

2 Land use planning and transportation departments should be represented within such teams to ensure that common objectives are pursued;

3 Public participation should be encouraged to ensure that user needs are met.

Public participation and the provision of information are an extremely important aspect of any sustainable development plan. Consensus building behind a set of shared values is an invaluable process. Although some degree of public participation should take place at all levels of decision making, undoubtedly the most effective way of involving the public is at a community level. Education should be perceived as a two-way process with the public supplying information on local concerns and culture and the team supplying the broader, global picture and expertise gained from other areas.

6.4 Financing initiatives

It is inevitable that progress in urban design will require sources of funding. The involvement and interests of funding agencies are often critical to schemes in developing countries. For this reason, every effort will be needed to use all available sources of funding in the most effective and creative manner.

In the UK, the mechanism of planning gain is well established and may prove useful to many developing countries. It involves a developer contributing financially to mitigate against undesirable impacts of that development. In this way, local authorities can secure funding for road building, infrastructure provision, provision of community facilities, environmental enhancements etc. The main requirement is that planning gain should be related to the planning permission and should not be used to fund unrelated projects. The process should be highly visible so as to discourage corruption.

Incentives are another way of steering and promoting sustainable development. Curitiba in Brazil has developed a number of incentive programmes. One programme allows owners of land in the city's historic district to transfer the building-potential of their plots to other areas within the city thus preserving historic buildings.

Recommendations

1 Partnerships between public, private and voluntary sectors should be encouraged

2 All processes should be highly visible and accountable so as to discourage corrupt practices.

3 Implementing authorities should be encouraged to provide good quality, accurate, easily accessible information about development opportunities;

4 Implementing authorities should consider the principle of planning gain, particularly to support sustainable development.

6.5 Urban design as the linking element between a wide variety of disciplines.

This guide has outlined some of the transportation aspects of urban design. However, urban design has a much greater remit than this and it is important that policy makers and civic leaders appreciate the wider contribution urban design can make to solving its urban problems. Urban designers are able to take an overview of often complex issues involving different disciplines, and can identify opportunities which can span professional interests. A thorough understanding of the development process is required, and prime importance must be given to developing sound implementation strategies as an integral part of any plan. Urban design can successfully be used to facilitate public participation processes and generate community-led proposals. The success of this approach can be measured in terms of the community support it engenders and the popularity of the environment that emerges.

Recommendations

1 An urban design framework should not only address transportation problems but issues of economic viability, ecological carrying capacity, aesthetics, community development, energy consumption, personal safety etc.

7 Conclusions

The motor car has reached its centennial, and there now exists around the World many examples of different approaches to the management of motorised traffic. Many cities have fallen into the trap of trying to build enough roads to cater for the full demands of private transport. Although understandable, it is now clear that this is simply not possible, and that trying to do so will ruin both the quality and the efficiency of a city. This is the most important point related to traffic to learn for planners, engineers and decision makers in cities around the world.

The only sustainable approach to cater for the access needs of urban dwellers is to balance urban form and transport. It is possible, as many historic examples demonstrate, to have urban areas that are efficient and which foster a community spirit. These areas also traditionally have low average journey distances and a high proportion of trips by sustainable modes such as on foot. With suitable attention to good design, this pattern can be preserved in existing areas and recreated in new developments. If done properly, there should be a positive social cost-benefit and good urban design should not therefore be beyond the means of developing cities.

Good transport planning should not be seen as simply installing traffic signals or building overpasses. A holistic view is needed that starts from the viewpoint of why a journey is needed at all. The roadspace should be seen as a valuable resource, and priority accorded to those who make best use of it, either from an efficiency, or a sustainability, point of view.

Many years of isolated specialisation by highway engineers, planners and architects have resulted in approaches that often are not just at variance, but are in fact contradictory. The skyscraper and the cul-de-sac are examples of design that pleases some and displease others. In many cases, cooperation between disciplines can lead to a satisfactory compromise. This document has been produced by a multi-disciplinary team. It is hoped that this might help others be guided to an approach that will be of benefit to the residents of cities around the world.

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