PEDESTRIAN SAFETY MEASURES FOR URBAN MAIN ROADS

Study of European practice for HFA

Tim Pharoah

January 1994

(Note: the report below contains only the contribution of Tim Pharoah to the overall study undertaken by Halcrow Fox Associates for the Department of Transport)

(4.3)
EU ACCIDENT REDUCTION PROGRAMMES

Targets

The GB target of a third reduction of road accidents from the early 1980s levels by the year 2000 is one of the largest proportional reductions set by countries in the EU. The Dutch Government set a 25% target over the same period. The French Government set a target of 10% in the early 1980s. Not all countries have adopted targets for accident reduction, though this does not imply any lower commitment to accident reduction. There is scepticism about single figure targets in that they do not resolve, and may even distract from, certain key issues. These include:

- Reduction of accident severity is more important than reduction of accident total;
- Recorded accidents do not give an accurate picture of total accidents, with large under-reporting especially in the "slight injury" category. This makes targets somewhat arbitrary and difficult to monitor;
- Accidents do not reflect the degree of perceived safety, nor the level of convenience of road users, and these are probably more important in determining behaviour;
- The principle that the creators of danger should bear the brunt of the risk (i.e. the "polluter pays" principle) means that priority should be given to reducing risk and accidents to vulnerable road user groups (pedestrians, cyclists, bus passengers, etc);
- Safer conditions may result in more pedestrian activity, which may be an improvement even if accident totals are not reduced (i.e. greater exposure to lower levels of risk).

Such considerations have implications for the type of safety programmes adopted, including the allocation of funds.

Speed Management

The most important feature developed on the near-continent is "speed management". Increasingly roads are classified in terms of their non-traffic as well as their traffic function, and this is expressed in terms of a desirable maximum speed. A "speed management classification of the road network was clearly articulated in Denmark, but is also found in Germany and the Netherlands for example. This is

described in "Traffic Calming Guidelines", which the present author developed for Devon County Council, who have also now adopted a speed management framework.

Demand Management

Increasingly the concept of demand management is seen as an important contributor to giving pedestrians more safety and freedom. This is based on the realisation that safety is influenced by the amount of travel and the mode of travel, as well as by the design of specific roads.

Integrated approaches

A distinguishing feature of practice on the near continent is the adoption of an integrated approach to urban traffic problems, where safety and accident reduction objectives are pursued alongside other objectives, notably:

- Noise reduction
- Reduction of air pollution
- Improved urban quality
- Promotion of "environment friendly" alternatives to the car.

The Dutch Government adopted an integrated policy in 1976, and has since strengthened the demand management element, including targets for reducing the rate of traffic growth, and a regional approach to transport planning incorporating local traffic reduction targets.

Whether the integrated approach has resulted in a better accident reduction result has not been evaluated. Advantages may include a greater enthusiasm and acceptance of measures which bring visible quality improvements, and hence a greater likelihood of money being voted for scheme implementation. It is clear, however, that evaluation of schemes designed to serve a range of objectives cannot be realistically evaluated on the basis of accident savings alone. Cost benefit analysis may be carried out in other countries, but not normally as the main determinant of whether a scheme is justified.

In 1990 the OECD published a report advocating "Integrated traffic safety management in urban areas". This report was prepared by representatives from 13 countries (including the UK). Three types of integration were identified that would be needed to maximise safety improvement:

- Between safety measures themselves
- Between safety and other policy objectives
- Between different levels of authorities involved

(4.4)
EU POLICY INITIATIVES ON MAIN ROADS

Main roads in urban areas are not usually "non-residential roads". In Germany for example,20% of the urban population lives on main traffic roads. In Britain the figure exceeds 10%.

It is therefore recognised that measures to improve safety in local "residential areas" which involve diversion of traffic onto "main roads" are of questionable benefit unless counter measures are taken on the main roads also. This issue has been the subject of strong debate in European countries. Points of consideration are that 60-70% of urban accidents occur on main roads, despite their relatively small proportion of road mileage (20-30%), and Main roads already suffer the highest noise and air quality problems.

In most countries, the emphasis in speed management has shifted from residential to main roads since about 1985. A region with many examples of main road schemes is the German state of Northrhine Westfalia, where grants have been available for such schemes since 1985.

Mixed priority roads

A key feature of near-continent practice is the identification and treatment of "mixed priority" sections of main roads. It is recognised (e.g. in D, DK, F, D) that traffic does not have to be accorded continuous priority throughout the main road network. At locations where there are shopping, commercial or other activities generating a lot of local activity (especially pedestrian activity), priority can be changed to favour these local activities. This does not mean restriction the movement of through traffic, but designing the area to encourage or ensure that drivers adopt a slower, calmer, tolerant driving style through the sensitive section.

These considerations are applied to urban and suburban through roads as well as urban main roads

> (*Not available:* Figure from Northrhine Westfalia (ILS) document showing typical main road situations)

This concept has been studied and applied by the present author in Britain also, notable the East London Assessment Study for the Department of Transport (1990), Devon County Council (1991) and Birmingham City Council (1993). From these studies it appears that such "mixed priority" areas could be beneficial for about 10% of urban main road networks.

"Mixed priority" is generally achieved through a combination of speed management, space management, and conventional traffic management techniques.

Network density

Another debate concerns the density of the main road network. This is based on the

observation that accident rates tend to be higher in those cities which have created large networks of main roads (for example cities reconstructed following war damage). The Figure shows this relationship.

> (*Not available*: Figure showing accident rates by main road density. Source: Just, 1992)

Responses include the progressive removal of roads from the network. Pedestrian zones, and car limited zones or streets are becoming common in continental cities. For example, Enschede (NL) has a permit system to limit traffic in the inner area. Downgrading of traffic roads can follow from traffic reduction or pedestrianisation. The Zeil shopping street in Frankfurt used to carry 33,000 vehicles a day and is now pedestrianised. All the former main roads in Nuremburg city centre have been removed from the network.

Conflict observation

Safety issues are often addressed through conflict observation techniques, usually from video analysis, developed in Sweden and the Netherlands. A distinction is drawn between the level of conflict, and the probable severity of a collision resulting from the conflict. Conflict is categorised according to behavioural responses and outcomes.

Overall design

Near-continent practice is often characterised by policies for overall design, or "gestaltung" as it is called in Germany, for which in this context there is no true English translation. Especially in the "mixed priority" roads described above, schemes are designed using a holistic approach to architecture, townscape, landscape, traffic functions, other functions, and so on. The design may be integrated with land use functions and neighbourhood layout, for example by planning pedestrian crossing places as part of pedestrian route planning.

This overall design concept also contributes to the objective of speed management and accident reduction. The aim is to influence the perception of drivers so that their driving style is calmer and more tolerant of other activities and road users. All speed reduction techniques are based on driver perception, and it has been found that, as well as measures like chicanes and humps, optical and aesthetic measures can lead to slower driving.

Many ideas and techniques for improving the situation on urban main roads have been developed and tried over the last 10-15 years. The general view from those contacted in other countries is that the future direction of development will be more widespread application of techniques already developed, with modification and refinement as more experience is gained of their effects. It must be emphasised again, however, that pedestrian accidents (or safety in general) are not seen as the motivation for action is isolation from other issues affecting main roads.

NB The draft outline structure does not easily accommodate a review of specific techniques and measures from other EU countries.

URBAN MAIN ROAD IMPROVEMENT TECHNIQUES:
PRACTICE ON THE NEAR CONTINENT

This section firstly describes in brief the concepts involved in improving safety and efficiency in urban main road design, and secondly describes specific measures that have been or could be tried. The concept(s) to which each measure relates is noted.

Concepts in urban main road design

The concepts are drawn from knowledge of European experience in general. No attempt is made to identify the historical or locational origin of these concepts, which in most cases have evolved over several years of international debate.

1. CONSPICUITY & AWARENESS

Aim is to reduce conflict by each road user being aware of the presence and actions of other road users, and in time to be able to adjust speed, path, action.

2. PREDICTABILITY
Conflict will be reduced if the actions of road users are predictable.

3. SPEED MANAGEMENT
Aim is to reduce conflict and the severity of collision outcomes. Also, to gain space (see 4.)

4. SPACE MANAGEMENT & OVERALL DESIGN
Apportioning street space according to functional priority. Designing traffic arrangements as part of integrated street (urban) design for multiple objectives including safety.

5. FLOW MANAGEMENT
Organisation of pedestrian and vehicle flows to create opportunities for safe crossing, bus user convenience etc.

6. OTHERS
Maintenance etc.

Specific measures

CENTRAL STRIPS/RESERVATIONS (Concepts 1, 2, 3, 4, 5)

Designed to improve possibilities for pedestrians to cross, and to make crossing safer by enabling people to cross each traffic direction separately. (This measure must be distinguished from dividing strips used on dual carriageway traffic priority roads.) Evaluation in Germany and Netherlands suggests reduction in pedestrian casualties of 50% or more are possible. Related to "soft separation" measures, see below.

SOFT SEPARATION (Concepts 3, 4)

Reducing the barrier effect of divisions between vehicles and pedestrians (and cycles) using low kerbs, bollards, no guardrails. Reduces the perception of the road by drivers as their own exclusive domain, and hence promotes more moderate and tolerant driving. Rarely adopted as a stand-alone measure.

"TWO PLUS TURNS" (cf. Pharoah, SOBETMA, 1993) (Concepts 2, 3, 4)

Reduction of carriageway to one running lane in each direction (with divider), except at junctions where extra lane(s) is provided for turning traffic and/or queuing, or for buses. Space taken out of main carriageway use reallocated for other purposes, in particular, wider footways especially at crossing places, parking bays, loading bays, bus lanes and stops, cycleways, soft landscaping.

Because of kerbside parking, most so-called 4 lane roads operate with only 2 streams of traffic anyway. This design formalises this to produce numerous functional and safety gains. The path of vehicles becomes predictable. Drivers do not obstruct the single lane available, so traffic flow is improved.

"ALMOST FOUR LANES" (cf. Topp) (Concepts 3, 4)

Reducing width of 4 lane roads to about 10 metres (5m each direction), plus central strip. This allows cars four abreast, but large vehicles two abreast. Carriageway may be marked as four or two lanes. This design is based on provision for majority vehicle dimensions rather than maximum vehicle dimensions (most roads have HGV flows of less than 10%). Will operate off©peak as "2 plus turns" road, but cars will go slowly two abreast at peak times. Capacity loss is small. Dependent on and contributing to slower driving speeds.

CARRIAGEWAY NARROWINGS (Concepts 1, 2, 3, 4)

Where pedestrians cross, at formal crossings or other locations, narrowing the carriageway has beneficial safety effects: Reduces the width pedestrians have to cross, and hence reduces the time they take, and brings pedestrians forward of parked vehicles whilst still on the footway, so they can see and be seen by drivers. The approaches to crossings can also be narrowed (footway extended over area occupied by zig-zag markings) since parking in this area is in any case prohibited.

NARROW CARRIAGEWAYS/LANES (Concepts 2, 3, 4)

Carriageways reduced in width to accommodate traffic at slower speeds, without dividers. Where carriageways are reduced to less than about 5.5 metres (two way traffic), "occasional strips" are provided at either side (see below).

OCCASIONAL STRIPS (Concepts 1, 3, 4)

Where carriageways/lanes are narrowed to accommodate the majority rather than maximum vehicle dimensions, extra room is needed to accommodate the larger

vehicles (lorries, buses etc). This is provided in the form of "occasional strips" either at each side of the road (eg. Dortmunder Strasse, Recklinghausen). This strip is multi©purpose and may be described as providing "elbow room". (see Devon Traffic Calming Guidelines for illustrated description) Occasional strips provide for greater safety for pedestrians, cyclists, and drivers.

Elbow room is also useful in the centre, where for example vehicles turn into driveways and access roads. It will also provide for large vehicles to pass one another where the general carriageway width is too narrow.

ROUNDABOUTS (Concept 3)

Roundabouts were first used widely in the UK. In recent years roundabouts have been introduced throughout Europe. However, the purpose of roundabouts in continental countries is often for the purpose of speed reduction rather than increasing junction capacity. This has implications for their location and design.

It should be noted that in the UK, roundabouts are the only locations where priority is accorded to traffic joining the main stream. In Europe the default priority is given to traffic joining from the right, a rule which reduces traffic speeds at junctions.

PEDESTRIAN PRIORITY AT SIDE ROADS (Concept 5)

In Germany and the Netherlands, for example, pedestrians crossing side roads have priority over vehicles turning into the side road, even when that turn occurs on a green traffic signal. In the UK, the Highway Code exhorts drivers to give way to pedestrians in this situation, but this is not backed up in traffic law. The ambiguity of this situation can lead to pedestrian accidents. It certainly is the cause of much aggravation and confusion.

REMOVE TRAFFIC FILTERS UNLESS PEDESTRIAN MOVEMENT CONTROLLED BY "GREEN MAN" (Concept 5)

Situations where traffic is stopped in one direction, to allow a turning movement from the opposite direction are inherently confusing for pedestrians trying to cross, and are apparently not found in Germany unless pedestrian signals are included.

"GREEN MAN" PROVISION AT TRAFFIC LIGHT JUNCTIONS (Concept 5)

Pedestrian crossing movements are more often controlled by lights in some European countries, for example Denmark, Germany and the Netherlands. In the UK there are still many busy light controlled junctions where no "Green Man" is provided, which means there is no guaranteed safe crossing time allocated in the cycle. Particularly for the less fit and agile, this is inherently unsafe.

PEDESTRIAN CROSSING LOCATIONS (Concept 5)

Planning of pedestrian routes rather than crossings as isolated facilities. Crossings relate to desire lines, which in turn relate to neighbourhood layout and land use. Development opportunities used to improve pedestrian routes, and main road

crossing locations. (eg. Kalker Strasse, Cologne)

INFRARED CAMERAS TO DETECT PEDESTRIANS (Concept 1)

Use of special cameras to detect presence and movement of pedestrians, which can then be used to warn drivers, change signals. (Netherlands)

LATERAL SHIFTS IN CARRIAGEWAY AND/OR LANES (Concepts 1, 3, 4)

Lateral shifts can help to moderate vehicle speed, both by the lateral force exerted on the driver by the turn itself, and by restricting the forward view. Usually the need to accommodate large vehicles restricts the strength of the shift, but this can be tightened by narrow carriageway with rough "run over" areas for larger vehicles (Argeles, S. France). Lateral shifts can be used also to align drivers' sight towards pedestrians. Lateral shifts are usually achieved by the introduction of central islands combined with side build©outs such as parking bays, bus boarders etc.

SET-BACK STOP LINES (Concept 1, 5)

At junctions and pedestrian crossings, stop lines set further back from the area inhabited by pedestrians can reduce intimidation of pedestrians by drivers, and introduce further safety margin in braking for pedestrians. (eg. Dusseldorf)

WIDE PEDESTRIAN CROSSINGS (Concept 5)

Pedestrian crossings that are wide (from the pedestrians' viewpoint, or from the drivers' viewpoint, long!) reduce the time for a given platoon of pedestrians to cross. It also reduces the risk of collision between pedestrians on the crossing itself. The widest known to the present author is in Dortmund, Germany, but the practice is common in many countries, eg. Switzerland, Netherlands and Sweden.

BUS STOPS LOCATED IN SINGLE LANES (Concept 5)

To prevent or reduce dangers to bus passengers joining or leaving buses, bus stops can be located in single lane sections so that other vehicles cannot overtake the bus at the stop. If a pedestrian crossing place is located in front of the bus stop, the driver can wait until passengers have crossed to the centre island before leaving the stop. This is particularly valuable at stops used by schoolchildren. The techniques also ensures that the bus does not waste time having to rejoin the stream of traffic. Bus boarders can also achieve this effect. (eg. Mainz Bretzenheim, and Langenfeld, Germany) Speed tables or cushions located at or in front of the bus stop will add further safety without inconveniencing buses which are moving slowly at these locations anyway. (cf, Bundesminister fur Verkehr)

SEPARATE BUS SIGNALS/LANES (Concept 5)

Junction design which integrates bus stop with bus priority departure through the junction, and pedestrian crossing phase. (eg. Munster, Esslingen, Duren, Germany)

MODE-SPECIFIC SPEED LIMITERS (Concept 3)

Objections to vertical shifts in the carriageway can often be overcome by the use of cushions and other mode-specific speed reduction devices. Vertical shifts can also be used to deter unauthorised vehicles from bus lanes or bus stops (where alternate lanes are available for other vehicles). Mostly in Northrhine Westfalia. In the Netherlands, a device called the "bus sluice" is totally effective in keeping cars out of bus-only roads. With careful siting, the location of bus routes and stops can be planned to provide safer pedestrian (bus passenger) movements.

OPTICAL WIDTH (Concept 3, 4)

Drivers' speed is influenced by the so©called "optical width" of the street, namely the width between vertical elements, and the relationship of this dimension to the height of the vertical elements. In a wide street, the optical width can be reduced by tree planting avenue©style at the sides of the carriageway, and/or within a central strip. Trees are the most valuable for this purpose because of their aesthetic, ecological and other merits such as improvement of microclimate. Germany
and the Netherlands have both produced manuals concerning the location, planting and specification of street trees.

GATEWAYS (Concepts 3, 4)

Gateways, or gateway effects produced by strong vertical elements or arches which demarcate areas where extra moderation, tolerance, care is required. Not sufficient as a stand©alone measure.

OBLIQUE CENTRE RESERVE AT PEDESTRIAN CROSSINGS (Concept I)

To improve visibility between pedestrians and drivers (eg. Vinderup, Denmark).

CHANGES OF SURFACE MATERIAL (Concept 1, 4)

Design of surface materials can help to convey the function and expected behaviour in different parts of the road. Crossovers warn pedestrians that vehicles cross, light coloured surfaces at pedestrian crossings help visibility, and so on.

LIGHTING (Concept 1)

Organisation of lighting of places where pedestrians are walking and crossing. Separate lighting for footways and carriageways, and for centre islands/strips. Light quality different for pedestrians and vehicle traffic.

MAINTENANCE (Concept 6)

Poor quality surfaces and construction can be dangerous for pedestrians as well as uncomfortable. Much of what prompts admiration of streets in continental cities is to do with high quality construction and maintenance standards rather than design features themselves.

AMBULANCE SERVICE IMPROVEMENTS (Concept 6)

Reduced pedestrian (and other road) fatalities in Germany are attributed partly to improved ambulance services, both in terms of response times and life©saving capabilities of the ambulance equipment and crews.

Basic References

(German) Bundesministers fur Raumordnung, Bauwesen, und Stadtbau, und fur Verkehr, 1993, "EAHV" (Empfehlungen fur die Anlage von Haupverkehrsstrassen), Bergisch Gladbach. (draft report)

Bundesminister fur Verkehr, 1986, "Forschung Stadtverkehr" (Heft 37).

Danish Ministry of Transport, 1993, "An Improved Traffic Environment: A Catalogue of Ideas" Report 106, Copenhagen.

Fachgebiet Verkehrssesen, Universitat Kaiserslautern, 1991, "Einsatzbereiche des Entwurfsprinzips 'Weiche Trennung' an innerortlichen Hauptverkehrsstrassen". [Design principles for "soft separation" applied to urban main roads.]

French Ministries of Housing, Planning and Transport, 1987, "Ville Plus Sure; Quartiers Sans Accidents".

ILS (Institut fur Landes und Stadtentwicklungforschung des Landes Nordrhein Westfalen), 1986, "Hauptverkehrsstrassen und Verkehrsberuhigung", Dortmund.

Just U, 1992, "Local Transport Strategies in Northrhine Westfalia", in Whitelegg J (ed) "Traffic Congestion", Leading Edge.

OECD, 1990, "Integrated traffic safety management in urban areas", Paris.

Pharoah T, "Traffic Calming: and East London Case Study" in Danish Road Directorate, 1990, "Speed Management" proceedings of conference in Copenhagen, 14-16th May 1990.

Pharoah T, et al, 1991, "Traffic Calming Guidelines", Devon County Council.

Pharoah T, (with Huddart and Wenban-Smith), "South Birmingham Environmental Traffic Management (SOBETMA)", paper to PTRC Summer Annual Meeting, Manchester September 1993.

Pharoah T and Russell J, 1989, "Traffic Calming: Policy and Evaluations in Three European Countries", South Bank Polytechnic.

Topp H, "Traffic safety, Usability and Streetscape Effects of New Design Principles for Urban Arterial Roads", in proceedings of International Congress "Living and Moving in Cities", Paris January 1990.