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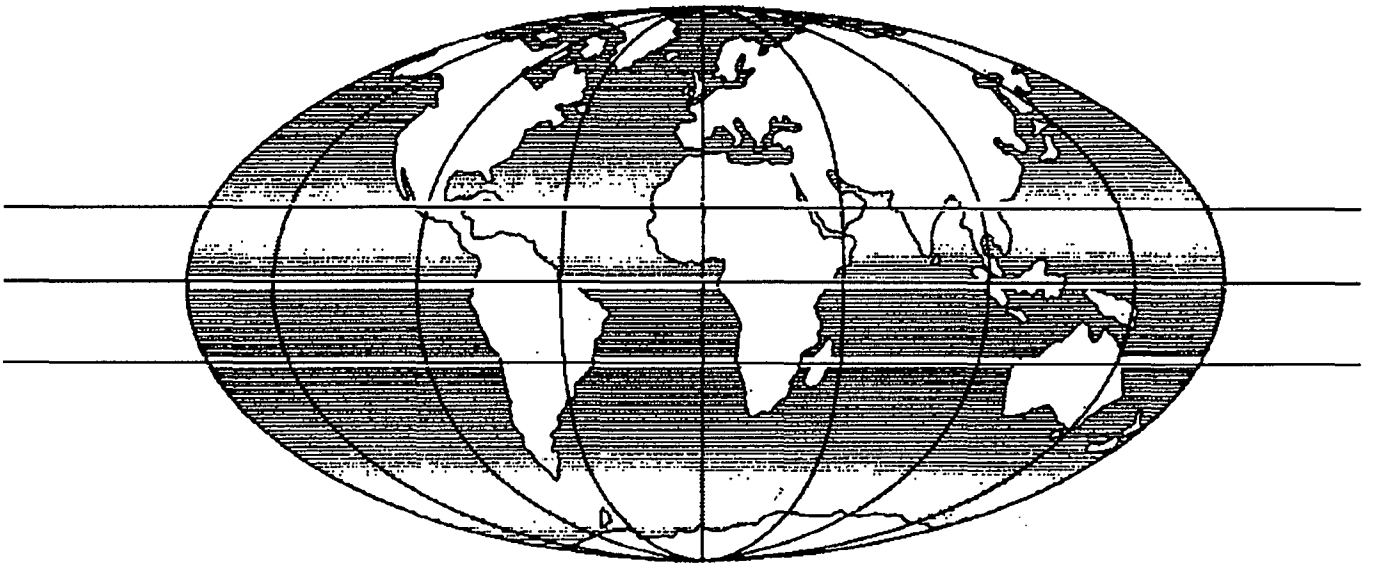

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ROAD SAFETY IN DEVELOPING COUNTRIES : AN OVERVIEW

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1 INTRODUCTION

The Overseas Unit of the Transport and Road Research Laboratory (TRRL) undertakes research, funded by the Overseas Development Administration, as part of the British Government's overseas aid programme to find practical solutions to the transport problems of developing countries, particularly in the road sector. The research programme, which is largely directed towards the special conditions of tropical and sub-tropical environments, covers the planning, design, construction and maintenance of roads, the safety and operation of vehicles using the road network and the environmental impact of vehicles and roads.

Road safety research began in 1972, following a number of requests for help from developing countries. Initially, the research was directed at determining the magnitude and the nature of the road accident problem. More recently, to meet the need to find practical solutions, the emphasis has been placed on monitoring road accident trends, improving accident data collection and analysis systems, and developing and evaluating appropriate low-cost countermeasures. This paper describes some of the main features of the work and it highlights key information on:

1) the seriousness of the road accident problem in developing countries

2) the nature of the problem

3) the Microcomputer Accident Analysis Package (MAAP), developed by the Unit

4) countermeasure research and its implications for road safety improvements.

2 THE MAGNITUDE OF THE ROAD ACCIDENT PROBLEM

Studies carried out by the Unit have demonstrated that road accidents in the Third World are:

1) a major cause of death and injury - typically they account for almost ten per cent of deaths reported in the 5-44 year age group (Jacobs and Bardsley, 1977)

2) a considerable waste of scarce resources, typically costing at least one per cent of a country's GNP per annum (Fouracre and Jacobs, 1976)

3) a serious problem in terms of fatality rates, with rates at least an order of magnitude higher than those in industrialised countries (Jacobs, 1986).

The fatality rates used for comparison were based on the annual number of road accident deaths per 10,000 vehicles licensed in each country. The rates for a selection of countries are shown in Figure 1. This measure of accident rate is far from ideal

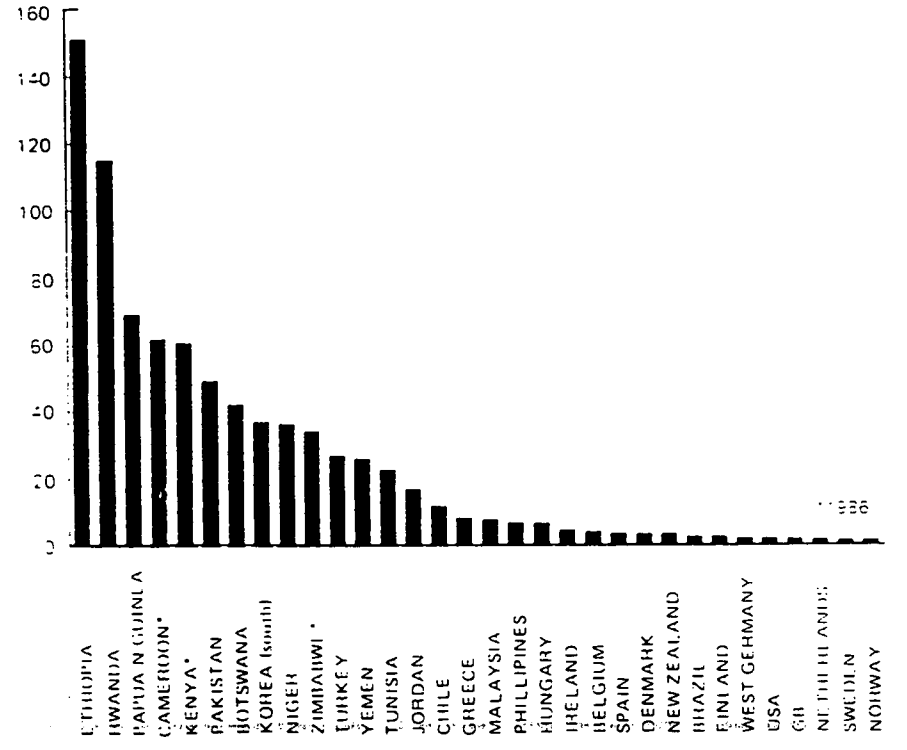


Fig.1 Road accident fatality rates (deaths/10 000 vehicles) for 1987/88

as an indicator of relative safety of different countries but unfortunately, few developing countries collect the necessary travel data to allow for travellers' exposure to accident risk. Indicators which express road accident fatalities as a function both of vehicles licensed and persons resident in a country have

also been examined (Jacobs, 1986) and the results supported those in Figure 1, i.e. that African and Asian countries have considerably higher road accident fatality rates, often by more than 10 times, than European or North American countries. Figure 2 shows that road accident fatalities over a number of developing countries are still increasing annually. There is thus great need for efforts to reverse this trend, as appears to have been achieved in many developed countries.

In a recent article by the World Bank (1990) it was estimated that 500,000 people are killed in road accidents each year and 350,000 of these die in developing countries. If one assumes a minimum cost of road accidents to be one per cent of GNP (found empirically to be of this order over a wide range of countries), then the total cost for countries with a GNP of less than 3,500 US dollars per capita is approximately 25 billion US dollars per annum. Thus, if the reduction in the substantial pain, grief and suffering caused by road accidents in the Third World is not sufficient motivation, there is also a very strong economic case to be made in terms of the significant waste of resources each year due to accidents.

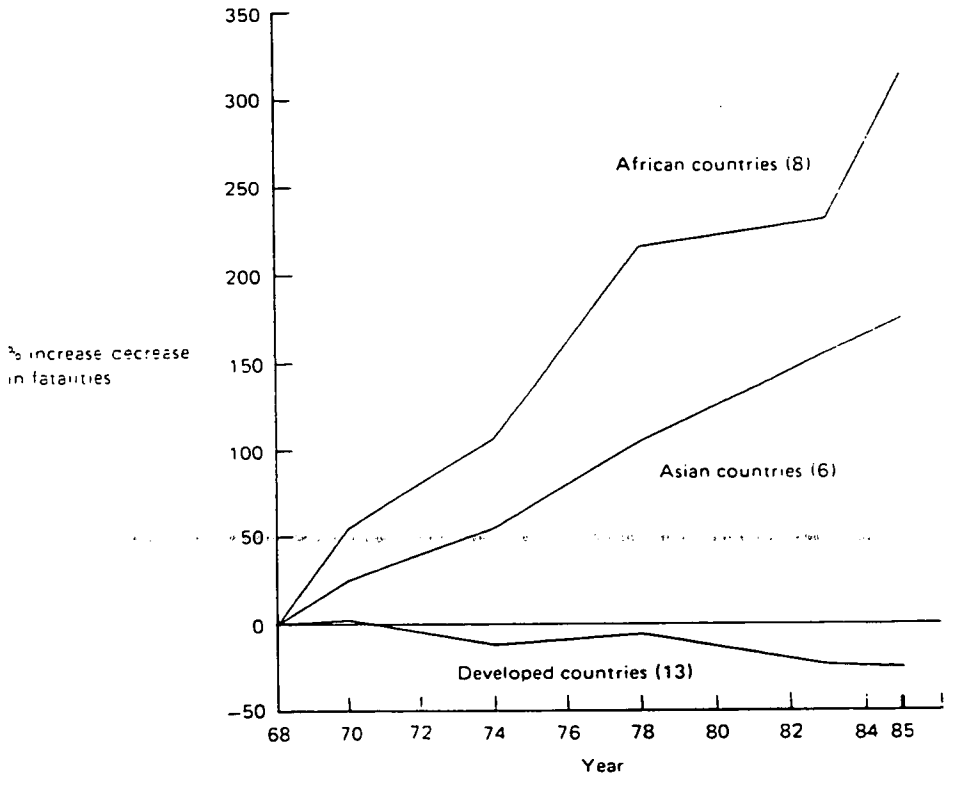


Fig.2 Percentage change in road accident fatalities

3 THE NATURE OF THE ROAD ACCIDENT PROBLEM

3.1 ACCIDENT PATTERNS

There are some accident characteristics which are common to a number of developing countries and yet are somewhat different from those in developed countries. For example, in the Third World (see Fig 3 and Table 1), a relatively high proportion of fatalities are pedestrians and children aged under 16 years, and many fatal accidents involve trucks, buses and, other public service vehicles (Downing, 1991).

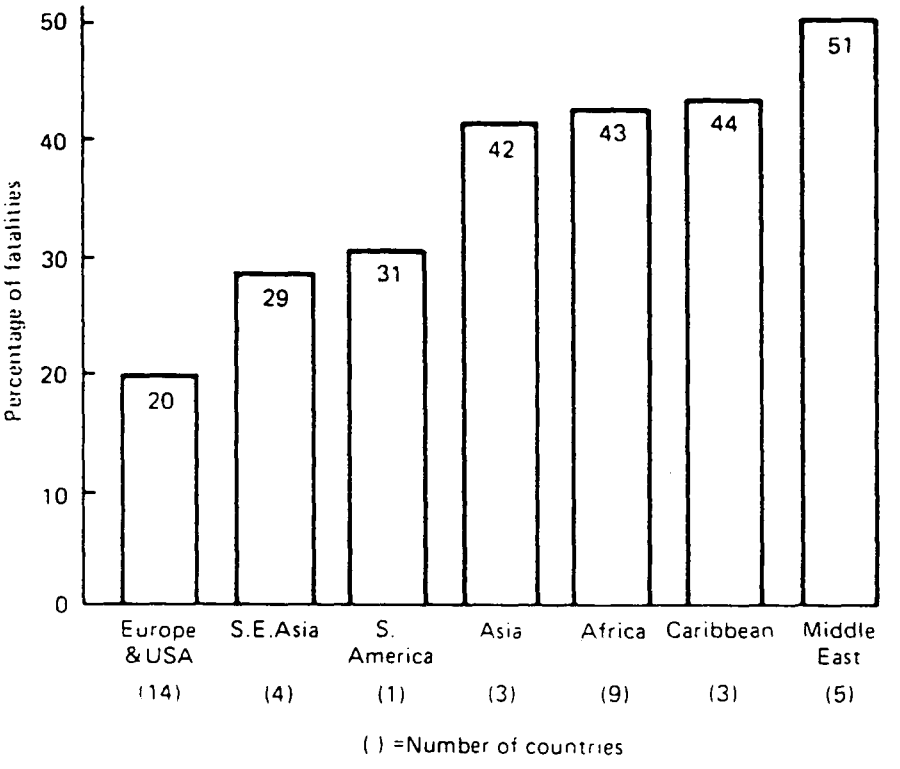


Fig. 3 Pedestrian fatalities as a percentage of all road accident fatalities

In many cases these higher percentages are an obvious consequence of the differences between the traffic and population characteristics of developed and developing countries. For example, the average percentage of the population aged 5 to 14 years in a sample of 16 developing countries was 28 per cent compared with 15 per cent for 9 developed countries (Downing and Sayer, 1982). As pedestrians, children and professional drivers constitute such a large proportion of the accident problem, it is clear that many Third World countries need to give priority to improving the safety of these particular three groups.

3.2 CONTRIBUTORY FACTORS

In most countries, police road accident reports give some information about the factors or causes which contributed to the accidents. In general these data have to be treated with some caution as the police investigating the accidents are unlikely to have been trained as engineers and they may therefore underestimate the contribution made by road engineering problems. Their main aim is usually to determine whether there has been a traffic violation and therefore the emphasis of the investigation is likely to be placed on detecting human error and apportioning blame.

In the United Kingdom in the early 1970's, a more reliable approach, namely 'On-the-Spot' investigation, was carried out by a research team from TRRL in an area of South East England (Sabey & Staughton, 1975). This study demonstrated the importance of the road-user factor which contributed to 95 per cent of the accidents and the strong link between road-user error and

TABLE 1
Characteristics of fatal accidents

Country		Percentage of fatalities which:	
		were children under 16 years	involved trucks and buses
Botswana	(1988)	16	25
Egypt	(1984)	12	37
Ghana	(1989)	28	50
Pakistan (Karachi)	(1988)	14	44
Papua New Guinea	(1987)	20	37
Zimbabwe	(1989)	11	45
United Kingdom	(1988)	9	21

deficiencies in the road environment, which together contributed to over 25 per cent of the accidents (see Table 2). Constraints of expertise or funding currently prevent a study of this type in developing countries, so police reports are the only source of information available. From Table 2 it can be seen that, in general, the data highlight the seriousness of road-user errors in developing countries but give little indication of any road

environment factor other than in the case of Iran. It seems likely that the road environment factor has been considerably underestimated by the police in their statistics. The condition of main roads is poorer in developing than in developed countries (see, for example, Harral and Faiz, 1988) and the pace of introducing engineering improvements to reduce road accidents is considerably slower in the Third World.

TABLE 2

Causes of road accidents as determined by the police in developing countries

Country	Main Cause of Accident (%)			
	Road-user error	Vehicle defect	Adverse road conditions or environment	Other
Afghanistan 1984	74	17	9	-
Botswana 1982	94	2	1	3
Cyprus 1982	94	1	5	-
Ethiopia 1982	81	5	-	14
India 1980	80	7	1	12
Iran 1984	64	16	20	-
Pakistan 1984	91	4	5	-
Philippines 1984	85	8	7	-
Malaysia 1985	87	2	4	7
Zimbabwe 1979	89	5	1	5
TRRL On-the-Spot Study 1975*	95	8	28	

* In about 30% of accidents, multiple factors were identified

3.3 ROAD USER BEHAVIOUR AND KNOWLEDGE

Preliminary studies of road-user behaviour (Jacobs et al, 1981) at traffic signals and pedestrian crossings indicated that road-users tended to be less disciplined than in the United Kingdom. Table 3 shows that fewer drivers chose to stop for pedestrians on uncontrolled pedestrian crossings and, not surprisingly, fewer pedestrians made use of such crossings compared with the UK. Also, observations in Pakistan (Downing, 1985) demonstrated relatively high proportions of drivers crossing continuous "no-overtaking" lines (15 per cent) and not stopping at stop signs even when traffic was near (52 per cent). Although the relationship between these differences in behaviour and accidents has not been determined, the results suggest that road safety measures which are not self enforcing, such as road signs and markings, may be much less effective unless they are integrated with publicity and enforcement campaigns.

TABLE 3

Road-user behaviour at pedestrian crossings

City	% of drivers choosing to stop	% of pedestrians using crossing
Bangkok	16	48
Colombo	11	43
Cairo	Under 1	n/a
Kingston	10	n/a
Karachi	Under 1	20
Nicosia	17	n/a
Surabaya	Under 1	n/a
London	40	89 (UK mean)
Reading	72	

Poor road-user behaviour exhibited by drivers in some developing countries may be due to their lack of knowledge about road safety rules and regulations or their general attitude towards road safety matters. A study of drivers' knowledge in Jamaica, Pakistan and Thailand (Sayer and Downing, 1981) indicated that there were only a few topics where a lack of knowledge was

widespread. One such example was stopping distances where 87 per cent of the drivers underestimated the distance required to stop in an emergency when travelling at 30 mph. Answering questions on stopping and following distances also proved to be a problem for professional drivers in Cameroon and Zimbabwe (Downing, 1991), with truck and bus drivers unable to answer more than half the questions on driving knowledge and skills correctly.
Other areas of driver behaviour, such as not stopping at pedestrian crossings, traffic signals and stop signs were found to be due to poor attitudes rather than to poor knowledge. Although attitudes are notoriously difficult to change, there would seem to be some potential for improving them by introducing publicity and enforcement campaigns.

Another area of concern in some, but not all, Third World countries is the problem of alcohol and road-users. From Table 4 it can be seen that the blood alcohol levels found in accident fatalities in Trinidad (Simmons, 1990) and Zimbabwe (Sandwith, 1980) were considerably higher than those found in Great Britain (TRRL, 1990). In addition, recent roadside alcohol surveys in Papua New Guinea at weekends between 10pm and 2am found that 24 per cent of drivers were over 80mg/100ml (the UK legal limit). This is much higher than the figure of 2 per cent found in similar surveys in the United Kingdom (Everest, 1991).

TABLE 4
Blood alcohol levels in road accident fatalities

Country	Road-user type	Percentage with BAC exceeding(mg/100 ml)	
		0	80
Trinidad (1988)	driver	-	41
	pedestrian	-	41
Zimbabwe (1979)	driver	56	-
	pedestrian	72	-
Great Britain (1988)	driver	31*	20
	pedestrian	37*	28

(* = Over 9 mg/100 ml)

Thus, overall there are wide differences between developed and developing countries in the behaviour, knowledge, attitudes and

culture of the road-users, in the conditions of the roads and the vehicles, and in the characteristics of the traffic. Consequently the effectiveness of transferring some developed country solutions to developing countries is uncertain and their appropriateness needs to be considered in relation to the problems and conditions prevailing in individual countries.

4 INSTITUTIONS AND INFORMATION SYSTEMS

4.1 ORGANISATIONAL REQUIREMENTS

In road safety matters, as in many other sectors, there is a need to strengthen the institutions responsible and to increase their capability for multi-sectoral action. The whole process of planning and implementing road safety improvements should be multi-disciplinary and dynamic. Road safety organisations should be established on a full time basis and be capable of:

1) diagnosing the road accident problem

2) drawing up an integrated plan of action including the setting up of goals and objectives

3) coordinating the work of all organisations involved

4) procuring funds and resources

5) producing design guides

6) designing and implementing improvements

7) monitoring implementation and evaluating measures

8) feeding back information from the evaluations and amending the action plan as necessary.

In a survey of African countries' road safety activities (Yerrell, 1991), 35 per cent of the countries reported active national road safety organisations. Although this level of activity appears very encouraging, it should be noted that these reports were not independently verified. In many cases the functions of road safety organisations were somewhat limited and clearly more institutional improvements are still necessary in many countries.

4.2 ROAD ACCIDENT DATABASES

One of the key activities listed above was the diagnosis of the road accident problem. The most important source of data for this activity is the police road accident report. In the early 1970's, a survey of road accident information systems in use in developing countries (Jacobs et al, 1975) indicated that only 15 per cent of the countries had adequate accident report forms and

none had computer analysis facilities. Therefore, to help countries improve their accident investigation and research capability, the Overseas Unit developed its Microcomputer Accident Analysis Package (MAAP), initially in collaboration with the traffic police in Egypt, (Hills and Elliott, 1986). It is now in use in over twelve countries. It is the nationally adopted system for Botswana and Papua New Guinea, and regionally adopted in most of the other countries; major cities in which MAAP is established include Bandung, Beijing, Karachi and Islamabad. The languages that MAAP operates in include Arabic, Chinese, French and Spanish.

MAAP is a powerful yet simple system which enables users to:

1) obtain good data for diagnosis, planning, evaluation and research purposes

2) set up low-cost engineering improvement schemes similar to those which have proved so successful in developed countries (see Section 5 below).

It consists of two key components: a police report booklet or form with a recommended structure, although details can vary considerably; and a set of software programs for data entry and analysis. The relatively low-cost and increased availability of microcomputers means that individual highway authorities can analyse their own data to help identify hazardous locations, the nature of the problems, choose appropriate countermeasures, and assess their effectiveness, all with increased efficiency and, therefore it is hoped, accuracy.

5 ROAD SAFETY IMPROVEMENTS

In the Third World evaluation of improvements is essential because of the lack of data on the benefits (or otherwise) of road safety measures. It is recommended that improvements are introduced on a pilot basis and evaluated before being implemented nationwide.

The Overseas Unit is giving priority to researching road safety countermeasures but, owing to the long term nature of many of the studies and the limited resources available, there are only a few published results.

In spite of this lack of information the remainder of this paper attempts to give an idea of likely priorities for future road safety action and research by reviewing studies of remedial measures in developing countries with reference to developed country findings where appropriate.

5.1 ENGINEERING AND PLANNING

Despite the fact that human error is probably the chief causal factor in most road accidents, there is little doubt that engineering and planning improvements can affect road-user behaviour in such a way that errors are less likely to occur or, when they do occur, the environment can be made more 'forgiving'. Thus, there has been a growth in emphasis on engineering and planning countermeasures over the past two decades both in Europe and North America.

Engineering and planning can improve road safety through two distinct mechanisms:

1) ACCIDENT PREVENTION, resulting from good standards of design and planning of new road schemes and related development and

2) ACCIDENT REDUCTION, resulting from remedial measures applied to problems identified in the existing road network.

Some typical approaches in developed countries are given in Table 5.

5.1.1 Accident prevention

There has been very little research in developing countries into the relationships between highway design standards and accidents rates. As a result, many developing countries have just adopted standards from developed countries or have modified such standards without evaluating the consequences. Often the traffic mix and road usage is very different in a developing country from that encountered in more industrialised countries. Also, there is usually a greater need to minimise costs; the challenge is to achieve this whilst at the same time maintaining an acceptable level of safety. To attain this balance, Hills et al (1984) have suggested that a radically different approach to the geometric design of highways may be required in developing countries, especially for low-volume roads. Studies of the relationships between geometric design and road accidents in Kenya and Jamaica (Jacobs, 1976) and research in Chile and India indicated, not unexpectedly, that junctions per kilometre was the most significant factor related to accidents, followed by horizontal and vertical curvature. Kosasih, Robinson and Snell (1987) have examined geometric design research and standards around the world, and have made recommendations for developing countries. However, much more research is required before optimum standards can be determined for all developing countries. The TRRL Overseas Unit currently has a research programme in Papua New Guinea that

is examining the effects of certain highway design elements on accident rates, in particular the road cross-sectional profile.

TABLE 5
Some recent approaches to improving the safety of the road environment in developed countries

ACCIDENT PREVENTION: Improved planning and design of new roads and developments particularly in urban areas[1]. Basic principles include:

* Land-use should be distributed to minimise vehicle trips and pedestrian vehicle conflicts.
* Networks should be classified into a hierarchy with the emphasis on speed management.
* Layouts of roads in residential areas should be designed to keep out through traffic and keep speeds down to appropriate levels[2]
* New schemes should be checked for safety ie road safety audits[3].

ACCIDENT REDUCTION: Application of cost effective measures on existing roads.

* Low-cost engineering improvements at hazardous locations[4,5].
* Area (urban) wide schemes[6,7,8].
* Traffic calming[9].

References for Table 5:
1 = IHT, 1990 and 1991; 2 = DoE/Dtp, 1977; 3 = IHT, 1990;
4 = Dept of Transport, 1986; 5 = Helliar-Symons & Lynam, 1990; 6 = Mackie et al., 1990;
7 = OECD, 1979; 8 = OECD, 1990; 9 = Tolley, 1990

5.1.2 Accident reduction

The approaches used by developed countries for accident reduction (see Table 5) would also seem to have considerable potential for developing countries. In particular, it is recommended that countries with limited resources should place initial emphasis on introducing low-cost improvement schemes at hazardous locations. Such schemes have proved very effective in industrialised countries; for example, in a survey of UK schemes (Helliar-Symons and Lynam, 1990) First Year Rates of Return were estimated to range from 65 to 950 per cent.

A few developing countries have begun to introduce such schemes on a trial basis and the Overseas Unit is currently carrying out joint research to evaluate their effectiveness in Egypt, Ghana, Indonesia, Malaysia, Pakistan and Papua New Guinea. Emphasis in the trials has been placed on testing self-enforcing measures and some of the schemes often aimed at helping the most vulnerable road-users are described in subsequent papers of this session. These trials, which have been made possible by the introduction of the TRRL Microcomputer Accident Analysis Package (see section 4.2), are still at an early stage with many sites not yet improved. However, preliminary findings suggest that countries which have relatively low levels of road-user discipline are less likely to have success with very low-cost measures such as road signs and markings. For example, a study of the effects of introducing stop lines and lane lines at junctions and no overtaking lines at bends in Pakistan (Downing, 1985) indicated no improvements in driver behaviour apart from a small reduction in overtaking violations from 19 to 14 per cent. On the other hand, preliminary results from Papua New Guinea indicate that the introduction of roundabouts at uncontrolled major/minor junctions has halved the average injury accident rate (Hills et al, 1990).

5.1.3 Guides and manuals for developing countries

It has already been noted that since the 1970's, industrialised countries have benefitted considerably from improvements in engineering approaches to road safety (see references in Table 5). Developing countries on the other hand, have been slower to adopt these approaches. In many locations, roads are being built or upgraded with little consideration given to road safety, and as a result blackspots are still being created. One factor contributing to this situation could well be the difficulty in acquiring information about the latest techniques and standards. To encourage the transfer of suitable technology in this field, the TRRL has just published "Towards Safer Roads In Developing Countries", a road safety guide for planners and engineers. This was produced in association with the Ross Silcock Partnership and is designed to be a first point of reference on road safety issues. It draws upon appropriate material from many existing manuals and standards around the world as well as giving many photographic examples of good and bad practices. The Guide will be described in detail during this seminar.

In writing the Guide, the authors were well aware of the need for much more developing country research; but there is reason to believe that many of the underlying general principles for planning and engineering design that affect safety are to some extent universal. These principles need to be adapted to developing countries conditions where (i) there is a greater need

for low-cost solutions; (ii) the particular traffic mix and road usage in a country must be taken into account; and (iii) there should be greater emphasis on measures that aim to change behaviour to be self-enforcing. The origins of the Guide can be found in figures by Hills and Downing (1980), Ross (1984) and Figure 4, which is taken from TRRL Overseas Road Note 5 (TRRL 1988); it shows in simple schematic form a selection of desirable and undesirable planning and engineering practices relevant to road safety in developing countries.

As a result of the review of geometric design research and practice by Kosasih et al (1987), referred to in Section 5.1.1, the TRRL published Overseas Road Note 6, "A guide to geometric design" (TRRL 1988). This gives guidance on the setting of geometric design standards for single carriageway rural (inter-urban) roads in developing countries.

There are certain fields of engineering where many design standards from developed countries could be applied directly now. One such application would appear to be in the area of street lighting; and a developing country manual has been published by the Institute of Lighting Engineers (ILE, 1990). The manual predicts night-time accident savings of over 30 per cent for road lighting improvements in Third World countries although the costs of the improvements are relatively high compared with other measures.

5.2 VEHICLE SAFETY

Improvements in vehicle design, occupant protection and vehicle maintenance have made a significant contribution to accident reduction in industrialised countries. In developing countries, however, the safety design of vehicles sometimes lags behind that of developed countries, particularly when vehicles are locally manufactured or assembled. Similarly, vehicle condition is likely to be more of a problem when it is difficult to obtain spare parts. Overloading of goods and passenger vehicles is another vehicle factor which commonly contributes to high accident severity and casualty rates.

The benefits to individual road-users of improving vehicle design and of wearing seatbelts and helmets are likely to be much the same from one country to another so the general adoption of both primary and secondary vehicle safety measures is to be encouraged. However, the total benefit of such measures to a developing country as a whole will depend on the characteristics of its accident and casualty problem and in some cases on the degree of road-users' compliance with traffic legislation. Thus, for example, seat belt wearing laws would lead to only small casualty savings if few casualties came from cars or if most drivers and passengers ignored the law.

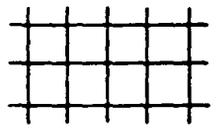
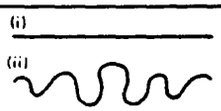
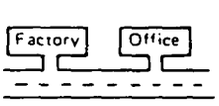
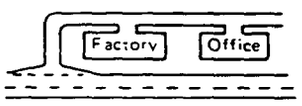
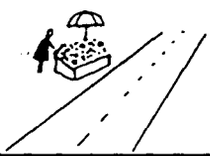
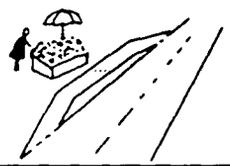
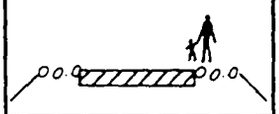
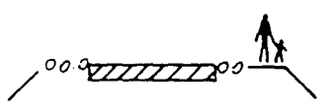
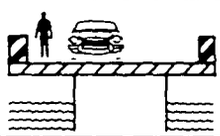
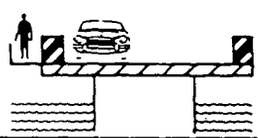
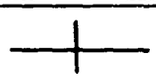
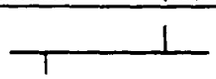
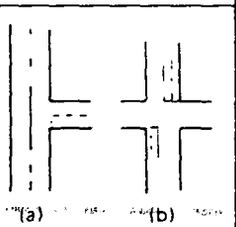
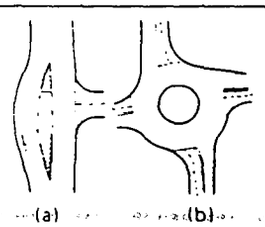
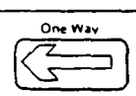
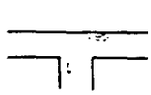
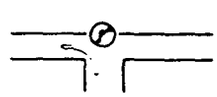
	Undesirable	Desirable	Principle Applied
Route Planning 1		 + Land Use Controls	Major routes should by-pass towns and villages
Town Planning 2			Maximum possible use of cul-de-sacs and loops in residential areas
Road Layout (Rural) 3	 (i) (ii)		Gently curving roads have lowest accident rates
Roadside Access 4	 Factory Office	 Factory Office	Prohibit direct frontal access to major routes. Use Service Roads
			Use lay-bys or widened shoulders to allow villagers to sell local produce
Pedestrian and Animal Footpaths (Rural) 5			Seal shoulder and provide rumble divider when pedestrian and animal traffic significant
			Construct protected footpath for pedestrians and animals on bridges
Junction Layout 6			Avoid crossroads
			For driving-on-the-left, right-hand splayed T-junctions have best safety records
	 (a) (b)	 (a) (b)	(a) Local widening at T-junctions can be highly cost-effective (b) Roundabouts have best safety record in UK
Traffic Management (Urban) 7			Segregate different types of road user with pedestrianisation schemes, cycle or motor-cycle tracks etc.
		 One Way	One way streets also reduce accidents
			For driving-on-the-left, right turn most dangerous manoeuvre

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Fig. 4 Some planning and design principles affecting road safety

From Table 2 it is clear that the police in some developing countries have blamed a relatively high proportion (up to 17 per cent) of accidents on vehicle defects. Although many of these countries may have inadequate controls to ensure minimum safe standards of vehicle condition, it would seem more appropriate that they should start by introducing low-cost random roadside checks using simple equipment rather than expensive networks of vehicle testing centres with sophisticated technology.

The control of overloading passenger carrying vehicles combined with improvements in the design of such vehicles would also seem to have some potential for accident and casualty reduction in many countries. For example, in Papua New Guinea (PNG), it is common for passengers to be transported in open pick-ups and, perhaps not surprisingly, an exceptionally high proportion (45 per cent) of the road accident casualties come from such vehicles. To help PNG deal with this problem, the Overseas Unit and Vehicle Safety Division of TRRL designed a simple, robust protective cage to protect the occupants. Roll-over trials on TRRL's test track demonstrated that the cage provided improved protection and it is planned that the design will be field tested in PNG.

5.3 EDUCATION AND TRAINING

5.3.1 Road safety education

It is important for road-users to be educated about road safety from as young an age as possible. In developed countries a number of approaches have been tried both through school systems and through parents, and most children receive some advice. However, in developing countries where the child pedestrian accident problem is generally more serious (see Section 3.1), a study of children's crossing knowledge (Downing and Sayer, 1982) indicated that children were less likely to receive advice than in the UK (see Table 6).

There is clearly a need to improve road safety education. However, as some countries will have low school attendance figures it is important that education through community programmes is considered as well as through the school system.

With respect to teaching methods, a number of studies in Europe (OECD, 1978) have evaluated teaching environments in terms of children's performances on crossing tests. Overall, the results demonstrated the importance of training on real roads; this need for frequent supervised practice on local roads close to where children live is likely to apply to all countries.

Traffic gardens were usually found to be one of the least helpful

environments and their cost effectiveness in developing countries must be even less certain. However, they may be seen as useful

TABLE 6

The people who had talked to children about crossing the road.

Percentage of 8 to 11 year olds in:	People who had talked to children						
	Mother	Father	Teacher	Police man	Police woman	Friend	Other
Jamaica	63	41	34	28	5	19	7
Pakistan	73	78	37	13	4	16	11
Thailand	53	54	48	7	0	1	1
United Kingdom	95	83	83	64	8	27	57

for raising public awareness and demonstrating governments' commitments to child safety, and investment in traffic gardens may be justifiable on such grounds.

It is recognised that road safety education programmes should be graded and developmental (OECD, 1978; Downing, 1987) and that teachers need guidelines on what and how to teach. To meet these requirements, many countries have produced syllabus documents and teacher guides, including a few in the Third World (Leburu, 1990). However, it is in this area that the transferability of developed country solutions to developing countries is less certain and much more research is needed. Further, studies in Europe (Downing, 1987; OECD, 1986) and to some extent surveys in Pakistan and Zimbabwe, have indicated that measures such as producing teachers guides and making road safety teaching compulsory, were not on their own sufficient to improve greatly the quantity and quality of road safety education in schools. For example, in the UK a 'core curriculum' document circulated to all schools was used by fewer that 4 per cent and in Zimbabwe, a schools 'road safety kit' was used by only 5 per cent of schools. Evidently teacher training and other actions are necessary to promote and increase the provision of road safety education in all countries.

5.3.2 Driver training and testing

In developing countries, the problems of poor driver behaviour and knowledge demonstrated in Section 3.3 are likely to be due, to some extent, to inadequacies in driver training and testing.

Professional driving instruction tends to be limited because:

1) driving instructors are not properly tested or monitored
2) there are no driving or instruction manuals
3) driving test standards and requirements are inadequate.

Consequently, there is likely to be considerable scope for raising driving standards by improving driver training and testing. One recent contribution by the Overseas Unit in collaboration with the United Nations Economic Commission for Africa (ECA), is a driving guide specifically for truck drivers (TRRL, 1990). This group of drivers tends to have a greater involvement in accidents than in developed countries and inadequate training clearly plays some part in this. The guide was designed to be easy to read (average reading age of 9 years) and its usefulness appears promising, as a study by Downing (1991) demonstrated that reading sections of the guide helped drivers improve their scores on knowledge tests by up to 25 per cent on some topics (see Figure 5).

As well as providing such advice on driving standards, many countries need to improve the licensing, training, testing and monitoring of instructors to ensure that these standards are taught. In training systems where learner drivers are free to choose how they learn, it is important that driving tests demand a high standard of driving especially for the practical 'on the road' assessment. More difficult tests should encourage

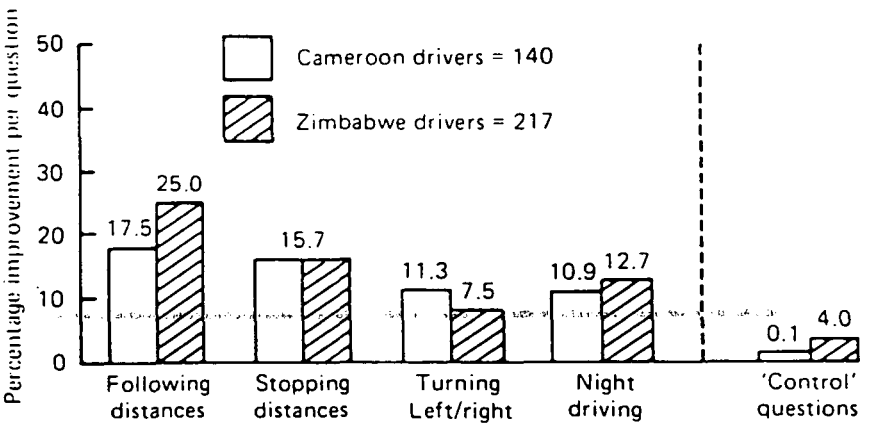

FIGURE 5 The effect of reading the ECA driving guide on knowledge scores

learners to purchase more lessons from professional instructors.

As with other counter-measures, there has been little research on the effectiveness of improved driver training in developing countries and accident savings as a direct result of training are, of course, very difficult to prove. A study of a retraining course for bus drivers in Pakistan (Downing, 1988) failed to demonstrate any accident savings although there was evidence of an improvement in knowledge test scores (13 per cent on average) and a reduction in driving test errors (67 per cent on average). It was also shown that the training had no effect on the drivers' behaviour when they were observed unobtrusively and they clearly returned to their old habits when driving in normal conditions. Therefore, to bring about a general improvement in driver behaviour it will usually be necessary to ensure that drivers are sufficiently motivated, and training courses will probably need to be integrated with publicity campaigns, incentive schemes and enforcement.

5.4 ENFORCEMENT

A large number of studies (OECD, 1974 and Spolander, 1977) have examined the effectiveness of enforcement systems in developed countries, particularly with respect to traffic police operations. Many of them demonstrated that a conspicuous police presence led to improvements in driver behaviour in the vicinity of the police but the evidence for accident reductions was less convincing.

In developing countries, the traffic police are generally less well trained and equipped and often they are non-mobile ie stationed at intersections. Traffic police operating under such conditions are likely to find it difficult to influence moving violations and this was certainly shown to be the case in a study by Downing (1985) of the effects of police presence in Pakistan (see Table 7). However, studies of improved training and deployment of traffic police have indicated large reductions in moving violations (see Downing, 1985). Also, following the introduction of highway patrols on intercity roads, a 6 per cent reduction in accidents was achieved in Pakistan, and a similar scheme in Egypt produced accident reductions of almost 50 per cent (Gaber and Yerrell, 1985). Therefore, it would appear that improvements in traffic policing have considerable potential for both improving driver behaviour and reducing accidents provided that the police's capability to enforce moving violations is enhanced.

Research in developed countries (Mercer, 1985) suggests that changes in the way the traffic police operate need to be well advertised to ensure the maximum effect on road-user behaviour. This finding is likely to be universal and it is therefore

TABLE 7
Percentage of drivers making errors and the effect of police presence

Driver error	Percentage of drivers	Average change in percentage when police present
1Failed to stop at red signal	13	- 3.8 (5)
Failed to give way when turning left on red signal	12	+ 4.7 (4)
Failed to stop at stop sign - traffic near	52	- 2.3 (3)
Cut corner on right turn	48	- 3.7 (3)
Turned right from wrong lane	42	- 7.0 (3)
Failed to give way when turning right	36	+ 1.6 (5)
Drove wrong way down dual carriageway	51	- 4.4 (1)

( ) = number of sites

equally important that developing countries integrate changes in enforcement tactics with appropriate publicity campaigns. In many Third World countries it is likely that such improvements will need to be accompanied by modifications in both the traffic legislation and the ways of dealing with offenders.

6 CONCLUDING REMARKS

Developing countries have a serious road accident problem and more road safety measures need to be introduced. In order to identify priorities for action it is important that there is a clear understanding of the road accident problem and the likely effectiveness of road safety improvements. It is therefore, a priority for countries to have an appropriate accident information system (such as the Overseas Unit's MAAP) and that they carry out research and evaluation studies of remedial measures. Another basic requirement is a well-trained road safety team which is capable of coordinating and integrating a wide ranging programme of road safety improvements which are preferably low-cost.

Although developing countries may have made a late start in road safety, many are now beginning to take appropriate action to reduce road accidents and there are some encouraging signs for the future. For example, a self-completion survey of twenty three African countries (Yerrell, 1991) suggested that nearly half were implementing a wide range of improvements.

In research there have also been some promising developments. For instance, at the Second African Road Safety Congress (Economic Commission for Africa, 1989), one of the key recommendations was the strengthening of research centres at the national or sub-regional level. In a different region of the world, the Sixth Conference of the Road Engineering Association of Asia and Australia dedicated a special workshop to the problem of road safety, (REAAA, 1990). The Organisation for Economic Co-operation and Development has established a small expert group (DC2) to promote and coordinate developing country road safety research.

Developing countries have accelerated their efforts to improve road safety. It is hoped that these trends will continue and that all countries will, through joint programmes of research and development and by sharing information, maintain an effective and scientific approach to reducing road accidents throughout the world.

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8. REFERENCES

DEPARTMENT OF THE ENVIRONMENT/DEPARTMENT OF TRANSPORT, 1977. Design Bulletin 32 "Residential Roads and Footpaths - Layout considerations". HMSO

DEPARTMENT OF TRANSPORT, 1986. Accident Investigation Manual. London: Department of Transport.

DEPARTMENT OF TRANSPORT, 1989. Road Accidents Great Britain 1988. London HMSO.

DOWNING A J and I A SAYER, 1982. A preliminary study of children's road crossing knowledge in three Developing Countries. TRRL Supplementary Report 771. Crowthorne: Transport and Road Research Laboratory.

DOWNING A J, 1985. Road Accidents in Pakistan and the need for improvements in driver training and traffic law enforcement. In: PTRC. Summer Annual Meeting, University of Sussex, July 15-18

1985, Proc of Seminar H. London: PTRC Education and Research Services.

DOWNING A J, 1988. The effectiveness of a retraining programme for bus drivers in Pakistan. In: ROTENGATTER J A and DE BRUIN (Eds). Road User Behaviour: Theory and Research. Assen/Maastricht, The Netherlands: Van Gorcum, 682-689.

DOWNING A J, 1991. Pedestrian safety in developing countries. Proceedings of "The vulnerable road user", International Conference on Traffic Safety, New Delhi. McMillan India Ltd.

DOWNING A J, 1991. Driver training in Africa: the UN-ECA driving manual. Proceedings of the Second African Road Safety Congress. Oslo: Institute of Transport Economics (TOI).

DOWNING C S, 1987. The education of children in road safety. Proceedings of the Symposium 'The Healthy Community. Child Safety as part of Health Promotion Activities'. Stockholm.

ECONOMIC COMMISSION FOR AFRICA, 1991. Conference recommendations. Proceedings of the Second African Road Safety Congress. Oslo: Institute of Economics (TOI).

EVEREST J T, 1991. Drinking and Driving. Safety 91 - Proceedings and Programme. Crowthorne: Transport & Road Research Laboratory.

FOURACRE, P R and G D JACOBS, 1976. Comparative accident costs in Developing Countries. TRRL Supplementary Report 206. Crowthorne: Transport and Road Research Laboratory.

GABER GEN M A and J S YERRELL, 1983. Road Safety Research in Egypt. In: IAATM. 9th International Conference, Mexico, September 1983. International Association for Accidents and Traffic Medicine.

HARRAL C and A FAIZ, 1988. Road Deterioration in Developing Countries - Causes and Remedies. A World Bank Policy Study. Washington, D.C.: World Bank.

HELLIAR-SYMONS R D and D A LYNAM, 1989. Accident reduction and prevention programmes in Highway Authorities - 1987. TRRL Research Report 187. Crowthorne: Transport and Road Research Laboratory.

HILLS B L, Mansfield R S and Robinson R, 1984. Appropriate geometric standards for roads in developing countries. Routes et Development - Comptes Rendu du Collogne International. Paris: Presses de l'ecole national des ponts et chaussees.

HILLS B L and G J ELLIOTT, 1986. A microcomputer accident

analysis package and its use in developing countries. Indian Road congress Road Safety Seminar, Srinigar. Proc of Seminar.

HILLS B L & DOWNING A, 1980 The application of road safety countermeasures in developing countries: a review. (Unpublished) Crowthorne: Transport & Road Research Laboratory.

HILLS B L, THOMPSON N T & KILA K, 1990. Accident blackspot research in Papua New Guinea. Fourth Annual Conference on Road Engineeering, Jakarta. November 19-21.

THE INSTITUTE OF HIGHWAYS AND TRANSPORTATION, 1990. Guidelines for: The Safety Audit of Highways. London: The Institute of Highways and Transportation.

THE INSTITUTE OF HIGHWAYS AND TRANSPORTATION, 1990. Highway Safety Guidelines: Accident Reduction and Prevention - International Edition. London: The Institute of Highways and Transportation.

THE INSTITUTE OF HIGHWAYS AND TRANSPORTATION, 1991. Urban Safety Management. London: The Institute of Highways & Transportation.

THE INSTITUTION OF LIGHTING ENGINEERS, 1990. A manual of road lighting in developing countries. Rugby: ILE.

JACOBS G D and P HUTCHINSON, 1973. A study of accident rates in developing countries. TRRL Laboratory Report 546. Crowthorne: Transport and Road Research Laboratory.

JACOBS, G D et al, 1975. Road accident data collection and analysis in developing countries. TRRL Laboratory Report 676. Crowthorne: Transport and Road Research Laboratory.

JACOBS G D, 1976. A study of accident rates on rural roads in developing countries. TRRL Laboratory Report 732. Crowthorne: Transport and Road Research Laboratory.

JACOBS G D and P R FOURACRE, 1977. Further research on road accident rates in developing countries. TRRL Supplementary Report 270. Crowthorne: Transport and Road Research Laboratory.

JACOBS G D and M N BARDSLEY, 1977. Road accidents as a cause of death in developing countries. TRRL Supplementary Report 277. Crowthorne: Transport and Road Research Laboratory.

JACOBS G D et al, 1981. A preliminary study of road user behaviour in developing countries. TRRL Supplementary Report 646. Crowthorne: Transport and Road Research Laboratory.

JACOBS G D and I A SAYER, 1983. Road accidents in developing

countries. TRRL Supplementary Report 807. Crowthorne: Transport and Road Research Laboratory.

JACOBS G D and C A CUTTING, 1986. Further research on accident rates in developing countries. Accident Analysis and Prevention, 18(2), 119-127.

JACOBS G D, 1986. Road accident fatality rates in developing countries - A reappraisal. In: PTRC. Summer Annual Meeting, University of Sussex 14-17 July 1986, Proc of Seminar H. London: PTRC Education and Research Services, 107-120.

KOSASIH D, Robinson R and J Snell, 1987. A review of some recent geometric road standards and their application to developing countries. TRRL Research Report 114. Crowthorne: Transport and Road Research Laboratory.

LEBURU F M, 1990. Training of Children: Traffic Education in Botswana. Proceedings of the International Conference for Road Safety and Accidents in Developing Countries. Cairo: The Academy of Scientific Research and Technology.

MACKIE A M et al, 1990. Urban Safety Project 3. Overall evaluation of area wide schemes. TRRL Research Report 263. Crowthorne: Transport and Road Research Laboratory.

MERCER G W, 1985. The relationships among driving while impaired charges, police drinking-driving roadcheck activity, media coverage and alcohol-related casualty traffic accidents. Accident Analysis and Prevention, 17 (6), 467-474.

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT, 1974. Research on traffic law enforcement. Paris: OECD.

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT, 1978. Chairman's report and report of sub-group 11 - road safety education. Crowthorne: Transport and Road Research Laboratory.

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT, 1979. Traffic safety in residential areas. Paris: OECD.

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT, 1986. Effectiveness of road safety education programmes. Paris: OECD.

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT, 1990. Integrated safety management in urban areas. Paris: OECD.

REAAA, 1990. Sixth Conference. Proceedings of the Sixth Conference, March 1990. Kuala Lumpur: Road Engineering Association of Asia and Australasia.

ROSS A, 1984. Accident data recording systems/data linkages - the need in developing countries. Proceedings of conference "Transport Safety in Developing Countries", Amalfi, Italy.

SABEY B E and G G STAUGHTON, 1975. Interacting roles of road environment, vehicle and road-user in accidents. In: IAATM. 5th International Conference, London, September 1975. International Association for Accident and Traffic Medicine.

SANDWITH A, 1980. Traffic Safety in Zimbabwe. Zimbabwe Traffic Safety Board Report. Harare: Zimbabwe Traffic Safety Board.

SAYER I A and A J DOWNING, 1981. Driver knowledge of road safety factors in three developing countries. TRRL Supplementary Report 713. Crowthorne: Transport and Road research Laboratory.

SIMMONS V, 1990. Alcohol and Road Traffic Accidents. Proceedings of the First Caribbean Conference on Transportation and Traffic Planning. Trinidad: Caribbean Epidemiology Centre.

SPOLANDER K, 1977. Trafikoevervakning. NRTRI Rapport 139. Linkoeping, Sweden: National Road and Traffic Research Institute.

TOLLEY R, 1990. Calming traffic in residential areas. Tregaron: Brefi Press.

TRANSPORT AND ROAD RESEARCH LABORATORY, 1988. Overseas Road Note 5: A guide to road project appraisal. Crowthorne: Transport & Road Research Laboratory.

TRANSPORT AND ROAD RESEARCH LABORATORY, 1988. Overseas Road Note 6: A guide to geometric design. Crowthorne: Transport & Road Research Laboratory.

TRANSPORT AND ROAD RESEARCH LABORATORY, 1990. Blood alcohol levels in fatalities in Great Britain, 1988. TRRL Leaflet LF 2017. Crowthorne: Transport and Road Research Laboratory.

TRANSPORT AND ROAD RESEARCH LABORATORY, 1990. A Guide for Drivers of Heavy Goods Vehicles. Crowthorne: Transport and Road Research Laboratory.

TRANSPORT AND ROAD RESEARCH LABORATORY, 1991. Towards safer roads in developing countries. A Guide for planners and engineers. Crowthorne: Transport and Road Research Laboratory.

WORLD BANK, 1990. Road Safety a Lethal Problem in the Third World. The Urban Edge, 14 (5), June 1990.

YERRELL J S, 1991. Road safety in Africa - Background and Overview. Proceedings of the Second African Road Safety

Congress. Oslo: Institute of Transport Economics (TOI).