

ADELAIDE IN-DEPTH ACCIDENT STUDY

1975-1979

PART 8: SUMMARY AND RECOMMENDATIONS

by

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ABSTRACT : This report contains a summary of the conclusions and recommendations
from earlier reports on the causes and consequences of a representative sample of road
traffic accidents to which an ambulance was called in metropolitan Adelaide. Brief
comments on the study as a whole are included. The abstracts, tables of contents,
introductions and conclusions and recommendations from Parts 1 to 7 and 9 and 10
are presented in appendices.

*Non IRRD Keywords

The views expressed in this publication are those of the authors and do not
necessarily represent those of the University of Adelaide, the Commonwealth
Government or the Australian Road Research Board.

FOREWORD

This study was conducted by the Road Accident Research Unit of the University of Adelaide and was jointly sponsored by the Office of Road Safety, Commonwealth Department of Transport and the Australian Road Research Board.

The general aims were to evaluate the effectiveness of many existing safety measures and to identify other factors related to accident or injury causation in road accidents in metropolitan Adelaide. The areas studied included characteristics of road users, the vehicles and the road and traffic environment.

To achieve these aims a representative sample of all road accidents to which an ambulance was called in the Adelaide metropolitan area was studied in the 12 months from March 1976. Two teams, each comprising a medical officer, an engineer and a psychologist attended 304 randomly selected accidents and

collected medical, engineering and sociological data.

The findings are presented in a series of reports, each covering a specific topic. Part 1 provides an overview, and is followed by reports dealing with pedestrians, pedal cyclists, motorcyclists, commercial vehicles, passenger cars and road and traffic factors. The final report in the series provides a summary of the findings and recommendations.

Basic data from the study are held on computer by both the Road Accident Research Unit, University of Adelaide and the Australian Road Research Board. Access to these data can be arranged for bona fide research workers on application to the Australian Road Research Board. Further copies of this report and copies of other reports in the series are available from the Office of Road Safety, Commonwealth Department of Transport.

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H.S. Aust and C.T. Hall
(Engineers)

N.D. Brewer and B.L. Sandow
(Psychologists)

J.R. Lipert and P.J. Tamblin
(Medical Officers)

The completion of this study was due mainly to the willingness of these team members to work exceptionally long hours under difficult and often hazardous conditions.

Much of the road and traffic data was collected by W.J. Offler, who also attended the scenes of the accidents during the final three months.

The recorded information was processed by the above personnel, assisted by J.K. Darwin, G.M. Haymes, O.T. Holubowycz and C.A. Latta.

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The St. John Ambulance Transport Division played an essential role in the conduct of this study by notifying the Road Accident Research Unit when an ambulance was called to attend a road accident. The South Australian Highways Department, the Road Traffic Board, and the Police Department cooperated in many ways in the execution of this study, as did the Hospitals Department. The proprietors and operators of towing services and crash repair shops facilitated inspections of the damaged vehicles.

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1. INTRODUCTION

A sample of accidents to which an ambulance was called in the Adelaide metropolitan area was investigated at the scene by multi-disciplinary teams from the Road Accident Research Unit of the University of Adelaide. This survey, which ran for twelve months from 23 March, 1976, was sponsored by the Commonwealth Department of Transport and the Australian Road Research Board. Each accident was studied by an engineer, a psychologist and a medical officer. Their observations at the scene started an average of ten minutes after the ambulance was called and were supplemented by further investigations including interviews with the drivers and other active participants (pedestrians and cyclists), detailed examination of the accident site and observation of traffic behaviour at the same time of day as the accident. The injured persons were examined and interviewed in hospital and the vehicles were inspected in towing service depots and elsewhere.

An eight per cent sample, totalling

304 accidents, was obtained of all road accidents as defined above. The sample was representative of this accident population by time of day and day of week. The aims of this survey, the sampling technique and the method of investigation are described in detail in another report (Part 1: An Overview) together with a review of the types of accidents investigated and an outline of the general conclusions. Table 1 lists the ten reports in the series.

The primary purpose of this report is to bring together in one volume all of the conclusions and recommendations contained in the preceding seven reports. The tables of contents of these reports and those of Parts 9 and 10 are presented in the Appendices to facilitate reference back to the sections that relate to the conclusions and recommendations as well as to provide a comprehensive and detailed listing of the topics that have been considered. Chapter 2 contains new material; a general review of the study that is supplementary to the similar sections of the Overview Report.

TABLE 1: REPORTS ON THE ADELAIDE IN-DEPTH ACCIDENT STUDY

<u>Part</u>	<u>Title</u>
1	An Overview
2	Pedestrian Accidents
3	Pedal Cycle Accidents
4	Motorcycle Accidents
5	Commercial Vehicle Accidents
6	Car Accidents
7	Road and Traffic Factors
8	Summary and Recommendations
9	Accident Descriptions and Scale Plans
10	Data and Data Codes

2. GENERAL REVIEW OF THE STUDY

The reports on the study present one of the most comprehensive and detailed descriptions of serious road traffic accidents that is available. The reports have been, and continue to be, quoted by various public authorities and policy-making bodies (see, for example, reports of the House of Representatives Standing Committee on Road Safety and the report of the South Australian Legislative Council Select Committee on Random Breath Tests). Even so, much more use can be made of the information collected during the study. Further analyses of the computer files (held by the Road Accident Research Unit and the Australian Road Research Board) and of the uncoded data can be expected to continue to be profitable for many years. Comparison of this information with data from other studies has already been shown to yield valuable results in quantifying the association between the risk of accident involvement and a driver's blood alcohol level (McLean, Holubowycz and Sandow, 1980) and in establishing the magnitude and the composition of the financial cost to the community of road traffic accidents (Somerville and McLean, 1981).

The presentation of each of the reports, from the table of contents through to the conclusions and recommendations, is designed to assist the reader to identify those aspects that may be relevant to a particular issue. But this form of presentation is not always an efficient way to help the reader to appreciate the underlying nature of the work, an appreciation that is desirable if the results are to be applied wisely and the data interpreted correctly. The following brief summary of Parts 1 to 7 is intended to go some way towards providing this less formal background to the study.

PART 1: AN OVERVIEW

This report describes the purpose, planning and execution of the study. It then gives an outline of the types of accidents investigated and presents some of the results and conclusions, selected to indicate the range of topics that are discussed in greater detail in the later reports. There is also a brief comparison with certain aspects of the first Adelaide in-depth study that was conducted in the early 1960s (Robertson, McLean and Ryan, 1966).

The Overview Report was not intended to be a definitive summary of the results, partly because it was prepared long before

the first draft of the other reports had been completed. The reader is therefore urged to refer also to the usually more detailed treatment of topics in the later reports. Some of the more general results appear only in the Overview Report: these include whole-sample data on alcohol involvement and on duration of hospital stay and residual disabilities, among other items.

Some general characteristics of the study should be recognized. As noted in the Introduction, the accidents investigated are a representative sample of accidents to which an ambulance was called in a metropolitan area (the nature of the sample is discussed in detail in Chapter 3 of the Overview Report). The study area did not include the outer suburbs that had been developed during the previous ten to 15 years. Its topography is that of a coastal plain, with long, straight roads usually intersecting at right angles. A 60 km/h speed limit applies to very nearly all of the roads and the wearing of seat belts, and crash helmets by motorcyclists, is required by law.

The study was intended to be completed in three years. However work directly associated with it has extended over more than seven years. The initial planning started in November, 1973 and a proposal was submitted to the Sponsors twelve months later. A revised proposal submitted in February, 1975 was accepted in August of that year. Staff were then recruited, equipment obtained and the investigating procedures were established. Accident investigation commenced on March 23, 1976 and continued for 12 months. The following year was almost fully devoted to data processing which primarily consisted of the creation of a series of computer files (the data codes are listed in Part 9). The final draft of the Overview Report was completed in May, 1979. The remaining reports have been completed during the following two years, the work being performed mostly outside normal working hours. It is now apparent that the periods allocated initially to the various stages of the study were not commensurate with the work involved and this should be noted in the planning and funding of any future work of this type.

PART 2: PEDESTRIAN ACCIDENTS

Many of the commonly-observed characteristics of pedestrian accidents are described in this report: children running onto the road, intoxicated adult pedestrians, the

injury potential of the front and bonnet of the striking car, etc. Some other characteristics of the pedestrian accidents in the sample may not be so well recognized. In some instances this could be because of the nature of the study area, as noted in the remarks about Part 1, but our discussion of those characteristics may nevertheless be of wider relevance. For example, to quote from the Conclusions to the report:

All but one of these 40 accidents happened on busy roads, and difficulty in crossing the road was a factor in about one third of the 31 relevant midblock accidents.

These characteristics derive largely from the road and traffic environment. Long straight roads, often multi-lane and very wide, combined with a 60 km/h speed limit, can present a formidable obstacle to the careful pedestrian and an extensive danger zone to the careless child or the drunken adult. While the discussion of these factors in Chapter 6 of Part 2 may be of use in similar situations elsewhere it is possible that the pedestrian accidents that we investigated may be very different from accidents involving pedestrians in minor streets in residential areas. But then again, our data suggest strongly that the serious, injury-producing pedestrian accident is much more likely to be associated with major traffic routes than with minor streets.

There appears to be a tendency to assume that the pedestrian contributes more to the causation of pedestrian accidents than does the driver. While this was found to be generally true in this study, the driver or rider often played an active role:

In more than half of these accidents there was an obvious error committed by the driver or rider whose vehicle hit the pedestrian. ... those drivers whose actions did contribute to the causation of the accident were found to be much more likely to have had a prior conviction for speeding. (Conclusions, Chapter 7)

If these observations can be substantiated, measures that effectively regulate driver behaviour may have a possibly unexpected effect in reducing the frequency of pedestrian accidents.

PART 3: PEDAL CYCLE ACCIDENTS

This report is based on relatively few (22) accidents but some general characteristics could be detected. Child cyclists were usually struck by a motor vehicle because, like child pedestrians, they acted impulsively. They often turned across the path of an overtaking vehicle without looking and without warning. Unlike their pedestrian counterparts, the accidents involving young cyclists mostly occurred on streets in residential areas rather than on traffic routes. The nature and location of these accidents lead to the recommendation (Chapter 9) that:

Consideration be given to an evaluation of the safety implications of allowing cyclists to ride on the right hand side of the road, adjacent to the kerb, so

that they are looking towards, rather than away from, approaching motor vehicles.

This recommendation, for the evaluation rather than the introduction of the proposed measure, may appear to many readers to be foolish. It is included in Chapter 9 not only because it may prove to be of some value in itself but also because it emphasises the nature of the risks inherent in a mix of pedal cycles, particularly when ridden by children, and motor vehicles. A head-on collision between a car travelling at 60 km/h and a pedal cycle travelling at 10 km/h will not be significantly more severe than a rear-end collision in which the speed differential would be 50 rather than 70 km/h. If by riding facing the adjacent traffic the child cyclist is less likely to turn across its path then the net result may well be beneficial.

For somewhat similar reasons it was also recommended that pedal cyclists be permitted, and even encouraged, to ride on the footpath.

Head injuries were the most serious consequence of pedal cycle accidents and so the use of crash helmets is encouraged, together with the recommendation that (Chapter 9):

'... schools consider instituting rental schemes for cyclists' crash helmets for use by their students who cycle to and from school.'

PART 4: MOTORCYCLE ACCIDENTS

Most of the 69 motorcycle riders were young males. This was to be expected because most motorcyclists are young males but we were able to show how other characteristics of these young riders were associated with their accidents. For example, four-fifths of the riders involved in accidents after 8 pm had been drinking and the same proportion of the drinking riders had a blood alcohol concentration that was above the legal limit of 0.08. These illegally intoxicated riders were much more likely to have reported that they had prior convictions for traffic offences than were the other riders.

Alcohol intoxication affected the risk of injury, as well as the risk of being involved in an accident. Intoxicated riders appeared to be less likely to fasten the strap on their crash helmet and so the helmet came off in the crash. This led to the recommendation that:

Simpler methods should be developed, (---) for fastening the chin strap on a crash helmet to ensure that the strap can be secured by an intoxicated rider.

The types of accidents that the intoxicated riders were involved in were consistent with the hypothesis that they were less able to control their machines when simultaneously trying to do something else than a sober rider would have been (see also Brewer and Sandow, 1980).

Being young, many of the motorcyclists

were inexperienced at both controlling a motorcycle and in operating a motor vehicle in traffic. There may be value in encouraging potential motorcyclists to learn the latter skill in a car before learning to ride a motorcycle, an approach that has also been suggested by Coppin (1977).

Many inexperienced riders never used the front brake and even some experienced riders failed to do so in the few seconds available to them before their crash. Licensing tests should include an emergency stop using only the front brake but this problem, which results in much longer stopping distances than if both brakes are used, may only be satisfactorily overcome by the introduction of single-control two-wheel braking on all motorcycles.

There was one accident in which a defect on a motorcycle played a causal role, and that defect was the result of a deliberate modification by the rider. However, fuel leakage after the crash was observed in nearly one-third of the cases, mostly from undamaged fuel systems. This resulted in a fire in one accident but the potential was there in 21 others. Therefore we recommend that:

An investigation be made of the sources of fuel leakage from motorcycles (---).

The motorcyclists in the study were the only road users for whom the head, face and neck were not the most frequently severely injured body regions. There were two reasons for this: the protection afforded by the crash helmet and the exposure of the motorcyclist's legs to the direct force of a collision. The high incidence of very severe leg injuries, and the poor performance of accessory 'crash bars', were the reasons for the recommendation that:

An investigation be conducted to establish the requirements for a device which will minimize the risk of a motorcyclist sustaining a severe leg injury when involved in an accident.

Three characteristics of the study should be remembered when interpreting the significance of the data presented in this report on motorcycle accidents: the study area comprises long straight roads with many intersections and virtually no hills; only two of the 68 motorcycle accidents occurred on wet roads, and only one rider was not wearing a crash helmet.

The major impressions that remain from investigating these accidents are described in the final paragraph of the report:

As a consequence of their accident-involvement, one-fifth of these motorcyclists were prevented from working, or from carrying out their usual activities, for more than three months, and a similar proportion were left with a permanent physical disability, or were fatally injured.

PART 5: COMMERCIAL VEHICLE ACCIDENTS

The term 'commercial vehicle' is used here in a very general sense to refer to any motor vehicle other than a passenger car or a car derivative such as a car-type utility or panel van (or, of course, a motorcycle). There was, therefore, a wide range of vehicles involved even though there were only 29 accidents in this category. Furthermore, not all of the 'commercial vehicles' were being used for commercial purposes at the time of the accident (or at any other time in some cases). Nevertheless there were some distinctive characteristics of the performance of some of these 'commercial' vehicles that are worthy of mention.

Some heavy vehicles were involved in collisions because the drivers chose not to brake hard when traffic signals changed. This may reflect a discrepancy in the braking performance of heavy vehicles and that of passenger cars, both because of the characteristics of the braking systems and because of difficulties in retaining the load on a heavy vehicle under braking. One accident was in fact a collision between a panel van and the load that slid forwards off a truck when the driver braked.

The multipurpose passenger vehicles in the accidents studied appeared to offer a level of occupant protection in a crash that was in some ways inferior to that of a passenger car. Because these vehicles are often used primarily as passenger cars it is recommended that they:

(---) be required to comply with the Australian Design Rules for Motor Vehicle Safety which are applicable to passenger cars.

The report contains other references to relevant attributes of certain types of these 'commercial' vehicles. The characteristics of the drivers are not discussed separately but are considered in the chapter on drivers in the report on car accidents.

PART 6: CAR ACCIDENTS

Most (86 per cent) of the accidents in the Study involved one or more cars. These cars ranged in size from the Leyland Mini to a Ford Galaxie, with the distribution of sizes being midway between that of the car populations of Western Europe and of the United States.

The size of a car is one of many factors that determines the injury outcome for the occupants in an accident. The compulsory fitting and wearing of seat belts resulted in a relatively high wearing rate that should also be borne in mind when comparing this group of car accidents with otherwise similar crashes in many other countries.

Whereas characteristics of the cars themselves were important determinants of injury causation they rarely played a role in the causation of these accidents. This was partly because of the nature of the study area, as noted above in the discussion of motorcycle accidents, but other factors, such as aspects of the road and traffic environment, were more important in this respect than were vehicle defects, etc.

Much of the report on car accidents consists of a review of the performance of the relevant Australian Design Rules for Motor Vehicle Safety. There are recommendations relating to door latches, windscreen glass, instrument panels, steering wheels and to seats and seat belts and the reader will find more information in the text and in the accompanying illustrations. Consequently it is our hope that this report will also provide a basis for further investigations of the crashworthiness of passenger cars and of the value of injury and accident countermeasures such as the Australian Design Rules.

While seat belts were found to afford a high level of protection against injury in a crash there were still many car occupants who were not wearing a belt. While the proportion of 'non-wearers' is likely to decrease with time, as older cars with no belts or with outmoded belt systems are scrapped, our data suggest that persons who are involved in accidents are less likely to wear an available belt than are persons in the general motoring population. Consequently, while acknowledging the considerable benefits that have resulted from the legislation relating to the fitting and wearing of seat belts, it is recommended that:

Passive restraint devices should (---) be considered for possible introduction in Australian passenger cars.

Passive restraints include seat belts that fit in place when the adjacent door is closed, without any other action on the part of the occupant, or air bags that are automatically inflated in front of the occupant in a crash.

A seat belt, or a passive restraint, is unlikely to function as intended if the seat itself fails to support the occupant. We observed some failures of both seats and seat anchorages and we have therefore recommended a review of the strength requirements for these components.

With more than 400 drivers (including 28 drivers of 'commercial vehicles') involved in the accidents it was possible to conduct a more extensive analysis of characteristics that potentially were related to accident involvement than could be done with the much smaller number of motorcyclists, for example.

Alcohol intoxication was one of the major risk factors identified in this group of drivers. Over 15 per cent of the male drivers were above the legal blood alcohol limit of 0.08, compared to 1.5 per cent in a control sample matched by time of day, day of week and location (McLean,

Holubowycz and Sandow, 1980). The intoxicated drivers were more likely to be involved in single vehicle collisions with roadside objects than were sober drivers. While this tended to confine the injurious consequences of the crash to the intoxicated driver and his passengers these injuries were often very severe. We have therefore recommended, together with five other recommendations relating to alcohol intoxication, that:

The continuing search for ways to deter drivers from driving with an elevated BAC should be regarded as an area of prime importance and should be funded accordingly.

We lacked objective tests for the presence of drugs other than alcohol and so our results are based on self-reporting of the usage of prescription, non-prescription and illegal drugs. This self-reporting was interpreted in the light of other information that we had on the events leading up to the accident. While our estimates of drug usage probably are low, there were no accidents in which we had reason to believe that a driver may have been adversely affected by a non-reported drug. Furthermore, in half of the 12 known cases of drug use the effect of the drug was likely to have been beneficial. Nevertheless we have made a recommendation which may lead to a reduction in the risks associated with some prescription drugs.

Some manoeuvres that resulted in accidents did appear to be more common among inexperienced drivers and so it was suggested that:

A special study be made of the characteristics of accidents involving inexperienced drivers so as to identify those areas that should be emphasised in tests for a driver's licence and in road safety publicity and educational programs directed at the inexperienced driver.

PART 7: ROAD AND TRAFFIC FACTORS

The approach that has been adopted in the presentation of this report differs from most of the others in that descriptions of many of the accidents are included. As noted in the Introduction, 'The inclusion of the accident descriptions in the main text, rather than as appendices, has been done to emphasise the many factors that can play a role in accident causation and to try to place road and traffic factors in the correct overall context'.

The reader who wishes to get an overall impression of the nature of the accidents that we studied is therefore advised to read Part 7 and then Part 2, the latter containing descriptions of the pedestrian accidents and a discussion of the related road and traffic factors.

The material in Part 7 is grouped primarily by type of location and type of traffic control. The Chapter on single vehicle accidents is an exception.

These accidents mostly occurred at uncontrolled midblock locations but they form a distinctly different group to other midblock accidents. They were strongly alcohol-related and very often involved a car running off the road and crashing into a pole or tree. Because the roads in the study area are almost all straight and level most of these run-off-road crashes were on straight roads and were the result of a gradual veering to the left rather than a more dramatic manoeuvre.

Many of the intersections in the study area were uncontrolled. While these uncontrolled intersections were mostly on streets in residential areas and traffic volumes were low, they were the site of 20 per cent of the accidents in the study. Extensive additional investigations were conducted on driver behaviour at these locations and it was concluded that about three-quarters of drivers in the general driving population exceed the safe approach speed by an average of 16 km/hour. This means that most drivers would be unable to avoid a collision if another car were to approach on a collision course on the intersecting road. Under such circumstances the 'give way to the right' rule becomes irrelevant. Consequently we have recommended that:

(---) in a metropolitan area, intersections should not be uncontrolled.

However, the traffic engineering warrants require that an intersection must have an accident history before any action can be taken to instal a STOP or GIVE WAY sign. As noted in Section 5.3.7, 'This philosophy is in marked contrast with that now virtually universal in measures aimed at protecting the health of the community, in which a potential hazard, once recognized, is countered before it can cause harm.'

Accidents at sign-controlled intersections rarely involved failure to stop at a STOP sign. The collisions that resulted when a car moved off from such a sign was often with another vehicle that was travelling unusually fast. For this reason, and others, it is noted in Chapter 8 that:

The enforcement of the legal speed limit can be supported as an activity of considerable potential value,...

Accidents at signalised intersections were mostly collisions between an oncoming vehicle and one turning right. There is

an extensive discussion of these 'fail-to-stand' accidents in Chapter 7. It provides the basis for the observation that:

Right turn phases or prohibition of right turns both have undesirable consequences in terms of delays and rerouting of traffic but there is much that should be unacceptable in the existing situation at many signalised intersections.

A summary of the role of road and traffic factors in accident causation is presented in Chapter 8. The factors are listed in broad categories because of 'the way in which the nature of the relevance of a factor may vary according to the circumstances of the accident ...' (Chapter 8).

The role of road and traffic factors in determining the consequences of an accident is also discussed in this report, particularly in relation to single vehicle accidents in Chapter 3 but also in summary in Chapter 8.

EPILOGUE

The reports reviewed above, and the recorded data, represent the output from a study that cost more than \$400,000 during the three years from mid-1975. As indicated at the start of the review, the actual cost and duration of the study are under-estimated by these figures. But the cost to the community of serious accidents in the study area alone is \$188,000,000 per year in 1980 dollars (Somerville and McLean, 1981). This means that an investigation of this type can be conducted in a cost-effective manner if it results in a reduction of even one-tenth of one per cent in the losses due to road traffic accidents in the study area. It is likely that the cost-effectiveness of research of this type may be much greater than is indicated by this example. While this is encouraging in itself, our final observation is that it is not clear that there is any more logical way to approach a problem of this nature than by an investigation of the type reported here.

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APPENDIX 1:

ADELAIDE IN-DEPTH ACCIDENT STUDY, 1975-1979

PART 1: AN OVERVIEW

A.J. McLean

G.K. Robinson

ABSTRACT

This report is a general introduction to, and review of, an in-depth study of road accidents to which an ambulance was called in the metropolitan area of Adelaide, South Australia. A representative 8% sample, comprising 304 accidents, was investigated in the 12-month period commencing March 23rd 1976. The general aims of this study are presented followed by a detailed description of the sampling procedure which was adopted. The method of operation is then described, and the types of accidents investigated are presented in form of the general characteristics of the accidents

and of the drivers, riders, and pedestrians, together with a review of the consequences of these accidents. The major conclusions drawn from the results of the study are described briefly, including the ways in which factors such as alcohol and inexperience affect the safety of road users, the role played by vehicle factors and aspects of the road and traffic environment in accident causation, the main causes of injury to each class of roaduser and the value of helmets and seatbelts. The companion reports on specific aspects of the accidents investigated are listed in the final section.

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INTRODUCTION

The term In-depth Study refers to investigations of road traffic accidents which are conducted by professionally qualified investigators who attend the accident at the scene and who conduct such follow-up investigations as may be necessary to enable them to assemble a comprehensive and detailed account of the crash events, circumstances and consequences. The term 'Level 3' is often used as a more specific reference to this type of study.

The earliest studies of this type were attempted in the United States about twenty years ago, but one of the first projects to obtain a representative sample of crashes from a defined population was conducted in Adelaide from 1962 to 1965 under the direction of Professor J.S. Robertson and with the sponsorship of the Australian Road Research Board (McLean, 1973 and Robertson, McLean and Ryan, 1966). In concept, the investigation which is reviewed in this report was similar to the previous Adelaide study but it covered in greater detail a wider range of characteristics of the road users, the vehicles and the road and traffic environment.

The success of the first Adelaide In-depth Study was due in part to the fact that the Adelaide metropolitan area is particularly suitable for the conduct of an in-depth investigation by virtue of its population size (900,000) and its topography. The study area, which comprised the major part of the metropolitan area, is a flat coastal plain bounded on one side by the sea, on another side by a range of hills and defined on the third side by a major arterial road. There are few natural features on this coastal plain which interrupt the basic rectangular grid of the road network (Figure 1).

The emergency services and other public authorities are organised and function in ways which also facilitate the conduct of research work of this type. One ambulance service, the St. John Ambulance Transport Division, covers the entire area and operates under the direction of a central radio controller. This centralised service permitted a means of immediate notification to the research team of the occurrence of an accident to which an ambulance was called. The area is also covered by one police authority and the regulation of the road and traffic system is in general the responsibility of a centralised body, the Road Traffic Board. All of these factors and, in particular, the willing cooperation offered by these and other organisations greatly reduced the difficulties associated with the

development and conduct of a large scale study of this type.

This study was confined to accidents to which an ambulance was called. This was done for two reasons: there was particular concern that most of the cases investigated should yield information relevant to the study of injury causation, and a reliable and rapid method of notification of the occurrence of an accident was essential. The sampling criteria that were used to decide which accidents should be investigated are described in detail later in this report.

The proposal for this study was prepared in 1974 (McLean, 1974a), and much of 1975 was spent in planning, in particular further developing and refining the lists of data items to be collected and procedures to be followed. During these two years a series of workshops was convened by the Department of Transport with the aim of ensuring that a common core of data would be collected in each of the three in-depth studies that were envisaged at that time: one in Melbourne, a rural study near Brisbane, which did not take place, and the Adelaide study.

When the lists of data items, including these core items, had been finalised for the Adelaide study a start was made on developing the computer codes. The GM Long Form, a code widely used in North America and in Europe, was taken as a basis for the passenger car and crash injury codes, together with an injury coding system developed by Marsh (1972). A modified vehicle damage index (VDI) was developed (McLean, 1975) from the SAE Recommended Practice (1972), the modification being introduced mainly to allow more detailed coding of damage to the side of the passenger compartment.

Two team members, Hall and Sandow, were recruited in mid-1975, and the remaining team members: Aust, Brewer, Lipert and Tamblin, were hired during the six months following the formal commissioning of the study in August 1975. Equipment was acquired during these six months, and the working procedures were established. From March 23, 1976, two teams each comprising a medical officer, an engineer and a psychologist were on call at pre-determined times to go directly to the scene of a road accident on being notified by the ambulance radio controller that an ambulance had been requested to attend. The data collection phase began on March 23rd, 1976, and continued for 12 months, during which time 304 accidents were investigated

at a cost per case of just under \$1400.

The very detailed investigation of a relatively small number of accidents as they occur using this approach is complementary to investigations based on so-called "mass" accident data, such as are contained in police reports on road accidents. An obvious benefit of the in-depth study approach is that it yields a wide range of information that can be obtained in no other way, but the high cost of such an investigation restricts the sample size and this means that some evaluations which can be conducted using mass data cannot reasonably be attempted using this approach. Conversely, the amount of information that can be listed in a police report on a road accident is necessarily very limited and many of the items that are included are required for purposes other than research and evaluation. At the present time, mass accident data files in Australia lack some of the information which is necessary for investigations aimed at identifying the role of the vehicle in accident and injury causation, to take one example (McLean, 1974b).

While the unique contribution which can be made by an in-depth study is associated with the wide range of detailed information which can be produced, it primarily derives from 'the productive synthesis of material not previously recognised as related' and from 'the open-ended observation and description of phenomena to discover variables which

deductively seem to be of importance' (Haddon, Suchman and Klein (1964)). In other words, the in-depth study has the potential to bring about a more intimate understanding of the nature of the road accident problem and this leads, in turn, to the generation of new hypotheses.

Some of the conclusions and recommendations in this series of reports are presented on the basis of very few cases. Their value depends on the accuracy and relevance of the insights which we have gained from our participation in this study, and so they should be regarded as suggestions for further investigation rather than as definitive statements. Some other recommendations we believe to be readily-supportable solely by the data which we have collected.

Finally, many of the variables on which information was obtained in this study have either not been mentioned in the text or have been reported on in isolation, with no reference to their interactions with other variables. Consequently these reports do not exhaust the possibilities for analysis of these data, or for comparisons with additional data on relevant control groups or with data from similar studies, notably the first Adelaide in-depth study. It is our hope that we will have the opportunity to continue working with the information that we have collected, and we offer our assistance to other research workers who may be interested in doing so.

GENERAL CONCLUSIONS

As noted in the introduction to this report, the unique contribution which can be made by an in-depth study is the extent to which it can provide additional insight into the nature of the problem of road traffic accidents. Some previously unrecognized variables or risk factors may be identified, but the value of an in-depth study is more likely to lie in the clearer understanding which it gives into how some risk factors operate. This usually leads to the formulation of new hypotheses, which are best tested in specially-designed experiments or other investigations. While some of the results from an in-depth study may be sufficient basis for the direct introduction of new or modified countermeasures such output is not a direct study objective.

In this section we present a selection of the general conclusions from the study. As was done in the earlier section on the types of accidents investigated, the aim here is to give some indication of the nature of the conclusions which can be found in the other reports in the series. Recommendations for further investigations or for action based on these conclusions are not presented here; they appear in the other reports, and are brought together in the report entitled "Summary and Recommendations". The final part of this section is an assessment of what we have learned about the feasibility of this type of investigation.

7.1 CHARACTERISTICS OF THE ACCIDENTS

Most of the accidents involved ordinary drivers behaving in an ordinary way. There were some others who were intoxicated, or inexperienced, or who were speeding, and the role that they played is noted briefly below. But it would be wrong to assume that the road accident problem can be solved by concentrating solely on these few well-recognized risk factors, important though they are. In the other reports in this series we have attempted to describe the often complex interaction of factors which can result in an accident, and to suggest ways in which driving, or walking, might be made easier and hence safer.

INTOXICATION

Alcohol intoxication was a major factor in these accidents. Blood alcohol (BAC) levels were obtained for 88 per cent of all of the active participants (drivers, riders and pedestrians) and for all such persons in 84 per cent of the accidents.

One or more of the active participants had a BAC above 0.08 in at least 24 per cent of the accidents. The frequency of alcohol involvement was highest in single vehicle crashes, in which at least 50 per cent of the drivers or riders were above 0.08. These crashes usually involved a collision with a roadside object such as a tree or a pole, and the resulting injuries were often severe.

The percentage of intoxicated road users was highest among motorcyclists (19 per cent were above 0.08). Some of these intoxicated riders apparently failed to fasten the chin straps on their crash helmets correctly, the helmets came off in the crash, with fatal consequences in one case. Thirteen per cent of both the drivers, of cars and commercial vehicles, and the pedestrians had a BAC level above 0.08. Only one pedal cyclist had been drinking and his BAC level was 0.01.

Intoxication by drugs other than alcohol appeared to be a relatively minor problem, even allowing for the fact that no quantitative tests were available.

INEXPERIENCE

Child pedestrians and cyclists are obviously inexperienced in dealing with urban traffic, and they were usually involved in accidents as a consequence of impulsive and careless behaviour. These behavioural characteristics are very difficult to modify, and so changes in the traffic conditions may be necessary if the frequency of these accidents is to be reduced.

Inexperience was very apparent as a factor in motorcycle accidents. Many inexperienced riders never used the front brake, believing that it was unsafe to do so, and so their stopping distances were much greater than would have been the case had they used both brakes. Even experienced riders rarely used the front brake in an emergency (in almost three quarters of the collisions involving motorcycles it was the other vehicle which failed to give way).

EXCESSIVE SPEED

Seven per cent of the drivers and motorcycle riders were travelling at a speed which was obviously above the legal limit and which was a factor in their being involved in these accidents. Almost all of the drivers whose vehicles were involved in collisions at uncontrolled four-way intersections (at which they should have given way) and for whom a speed estimate was available were travelling at an

excessive speed, even though it was usually below the 60 km/h speed limit. Subsequent investigations revealed that about three-quarters of all non-accident-involved drivers were also exceeding the safe approach speeds at these uncontrolled intersections. In about one-third of the collisions at sign-controlled intersections there was some evidence that the vehicle on the through road was exceeding the speed limit. The drivers on the through roads were four times more likely to have had at least one prior conviction for speeding than were the drivers who moved off from the STOP or GIVE WAY signs in these collisions.

VEHICLE FACTORS

Forty per cent of the cars in this study had one or more defects, but it was exceptional for a vehicle defect to play a role in the causation of an accident.

The braking system of motorcycles, which requires separate actuation of the front and rear brakes, was not used efficiently by almost half of the riders who braked immediately before the accident.

The Australian Design Rules (ADRs) for Motor Vehicle Safety which relate to seat belts and door hinges and latches appeared to be of most value in the accidents studied. Few of the crashes involving passenger cars were severe, and so the potential performance of ADR 10A and 10B (steering columns) could not be assessed adequately. The performance of some other of the ADRs differed little from that of pre-ADR components probably because the introduction of those ADRs, such as the one relating to safety glass, largely confirmed existing practice. Some deficiencies were noted in the design rules for instrument panels and seat anchorages.

ROAD AND TRAFFIC FACTORS

The absence of controls such as STOP or GIVE WAY signs at four-way intersections was a factor in about one-seventh of the accidents in this study.

Objects at the roadside, and parked vehicles, played important roles in the causation of some of these accidents, either by obstructing vision or simply by being hit and so preventing a straying vehicle from regaining the roadway safely. Collisions with utility poles were particularly severe; they usually involved an intoxicated driver whose car veered off to the left on a straight road.

Almost all of the pedestrian accidents in the study were on busy traffic routes, most of which were undivided multi-lane roads. Some measures designed to increase the rate of flow of vehicular traffic are detrimental to the safety of the pedestrian.

Skidding was a minor problem, primarily because of the very dry climate in Adelaide.

ENVIRONMENTAL FACTORS

Relatively mild and very dry weather prevailed through most of the year in which the study was conducted and so there were very few cases in which rain or a wet road surface was a factor in the causation of the accident. Glare from the sun may have been present in some instances but none of the road users acknowledged it as a problem, whereas glare from oncoming headlights was mentioned by one driver who hit a pedestrian who was standing in the centre of the road.

THE INJURIES

Pedestrians and pedal cyclists were almost always injured and their injuries were often severe, with a head injury usually being the worst. The front of the striking car was the direct cause of the majority of the severe injuries sustained by pedestrians and cyclists. The motor-cyclist, probably because of the protection afforded by his crash helmet, was more likely to sustain a severe leg injury as his worst injury. It was unusual for a car occupant to be severely injured; those who were tended to be unrestrained occupants of cars which crashed into a tree or utility pole.

Twenty per cent of the 931 persons involved in these accidents were admitted to hospital, 68 (or 7 per cent) were left with a permanent physical disability, and eight were killed.

COMPARISON WITH THE FIRST ADELAIDE IN-DEPTH STUDY

There were relatively more motor-cyclists and fewer pedestrians, pedal cyclists and commercial vehicles in the present study than in the one conducted 13 years earlier. These differences may be due to both differences in sampling schedules and to changes in the temporal distribution of accidents to which an ambulance is called.

Overall, 55 per cent of the participants were injured in the accidents in the second sample compared to 44 per cent in the first. This result may be largely an artifact associated with the reasons why an ambulance is called to an accident, but it may also be that the accidents in the second sample were somewhat more severe.

When comparing the percentages of injured persons who were admitted to hospital or who were fatally injured, there was a reduction observed between the two studies for car occupants, from 42 to 29 per cent, and even greater reductions for pedestrians and pedal cyclists. The wider use of seat belts appears likely to have been the major cause of the lower average severity of injury among car occupants. The average injury severity, as measured in this way, did not change significantly for motor-cyclists despite the almost universal use of crash helmets in the second study, because many leg injuries were severe enough to require hospitalization.

There is considerable potential for detailed comparison between the two studies of factors relating to both accident and injury causation.

7.2 THE IN-DEPTH STUDY TECHNIQUE

Our experience in the study has demonstrated that the method of investigation is viable, with some important qualifications which are noted below.

The sample procedure which was developed for the study produced a sample which was adequately representative of the population of accidents that was being investigated. These accidents, to which an ambulance was called, included a high proportion (about one-fifth) of cases in which the ambulance was not required, and so the bias which can arise when studying only accidents which result in injury was to some extent avoided. The success of this sampling procedure depended largely on the willing cooperation of the radio controllers of the St. John Ambulance Transport Division.

The method of investigation, as it existed at the end of the project, was also satisfactory. Funds were not available in the early stages to cover the salary of a traffic engineering member of the research teams and so much of the basic data in this area had to be collected at a later date, a procedure which proved to be complicated by the fact that this person had not attended the accidents at the scene.

Response times for the team to reach the scene of the accident after being notified of the call for an ambulance to attend averaged about 11 minutes. The team had no authority to exceed the speed limit, and we consider such an exemption to be neither necessary nor desirable.

The team members were able to collect the necessary information at the scene of the accidents without interfering with the police or ambulance officers in the execution of their duties, and a high level of cooperation was maintained with these personnel. Almost all of the people who were involved in the accidents were willing to talk with the research workers at the scene, in hospital, and later at their homes in the case of drivers, riders and

pedestrians. The follow-up interviews were very time-consuming, largely because repeated visits had to be made before the person was found to be at home in many instances. This work mostly had to be conducted at night, which meant that, in addition to the irregular on-call hours, these investigators were working almost every night during the week. The engineering members of the team often found it necessary to work continuously for several days to keep up with the need to conduct a detailed examination of the crashed vehicles before repair work commenced. This work load was unreasonably severe, and it is to the great credit of the team members that they were both willing and able to carry out their duties for the full twelve months of data collection. In any future study the case collection rate should be reduced to no more than 100 accidents per team per year.

A large amount of very detailed information can be collected in this way (Appendix B). In the study the processing of this information was delayed until after the data collection period because some of the data codes had not been finalized. It is much easier to develop a satisfactory data code after the data has been collected, simply because there is no longer any uncertainty about the items which will be available to be coded, but it is obviously more efficient to be able to code data as soon as possible after the investigation of an accident has been completed. From the experience which we have gained in this study, we believe that we are now in a much better position to be able to develop useful data codes during the planning stages of an investigation of this type.

The point has been made that one of the major attributes of the in-depth study approach is that it yields greater insight into how recognized risk factors operate. Much of this insight can be presented in formal reports, but a great deal of the return on the investment in an in-depth study depends on the use which the research workers are able to make of the experience which they have gained.

The final observation in this overview report is one made 15 years ago by Haddon et al., 'Without continuing research of this type there can often be no assurance that variables more formally investigated have been realistically or wisely chosen.'

APPENDIX 2:

ADELAIDE IN-DEPTH ACCIDENT STUDY, 1975-1979

PART 2: PEDESTRIAN ACCIDENTS

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N.D. Brewer

B.L. Sandow

ABSTRACT

This report contains descriptions of the causes and consequences of the pedestrian accidents contained in a representative sample of road traffic accidents to which an ambulance was called in metropolitan Adelaide. Reviews of the relevant characteristics of the pedestrians and drivers, the vehicles, and the road and traffic environment are also included. All but one of these 40 accidents occurred on busy roads. Some measures designed to increase the rate of flow of vehicular traffic are detrimental to the safety of the pedestrian, to the extent that some urban arterial roads are very hazardous for some pedestrians, particularly children and the

elderly. The pedestrian was more likely to have been careless, or to have made a mistake, than was the driver, but alcohol intoxication was less apparent as a causal factor in these pedestrian accidents than in other types of accidents covered by this survey. The injuries sustained by the pedestrians were much more likely to be dangerous to life than were the injuries sustained by other road users involved in other types of accidents. The front of the striking car, including the upper surface of the bonnet, accounted for more than half of the injuries. A number of possible countermeasures and topics worthy of further investigation are listed at the end of the report.

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INTRODUCTION

A sample of road accidents to which an ambulance was called in the Adelaide metropolitan area was investigated at the scene by multi-disciplinary teams from the Road Accident Research Unit of the University of Adelaide. This survey, which ran for twelve months from 23 March, 1976, was sponsored by the Office of Road Safety of the Commonwealth Department of Transport and the Australian Road Research Board. Each accident was studied by an engineer, a psychologist and a medical officer. Their observations at the scene started an average of ten minutes after the ambulance was called and were supplemented by further investigations including interviews with the drivers and other active participants (pedestrians and cyclists), detailed observation of traffic behaviour at the accident site and examination of the injured persons in hospital and of the vehicles in towing service depots and elsewhere.

An eight per cent sample, totalling 304 accidents, was obtained of all road

accidents as defined above. The sample was representative of this accident population by time of day and day of week. The purpose of this survey, the sampling technique and the method of investigation are described in detail in another report in this series together with a review of the types of accidents investigated and an outline of the general conclusions.

This report contains descriptions of the 40 pedestrian accidents in this sample of 304 accidents to which an ambulance was called. These descriptions are followed by a detailed review of the characteristics of the pedestrians who were involved in these accidents, and a concise presentation of certain characteristics of the drivers and riders. The consequences of pedestrian accidents are then considered, with particular emphasis on the nature, severity, and causes of the injuries sustained by the pedestrians. The final section of this report deals with the role of road and traffic factors in the causation and prevention of pedestrian accidents.

CONCLUSIONS

Many of these pedestrians were involved in an accident because they were careless or made a mistake. Almost all of the child pedestrians ran onto the road, the elderly very often did not see the vehicle approaching, and other pedestrians chose to stand in the centre of the road, or ran through banked up traffic. About one-eighth of the pedestrians were intoxicated at the time of their accident and they had a history of regular and heavy alcohol consumption. Drugs other than alcohol were not an obvious causal factor.

In more than half of these accidents there was an obvious error committed by the driver or rider whose vehicle hit the pedestrian. No driver appeared to have been travelling markedly faster than other traffic at the accident site, although those drivers whose actions did contribute to the causation of the accident were found to be much more likely to have had a prior conviction for speeding. Less than eight per cent of the drivers or riders had been drinking, compared with 57 per cent of those drivers involved in single vehicle accidents which did not involve a collision with a pedestrian.

Vehicle factors were rarely relevant in the causation of these accidents, but vinyl plasticiser deposits on the inside of the windscreen made it harder for one driver to see the pedestrian at night, when viewed against the glare of oncoming headlights, and one other accident may have been avoided had the location of the horn button been standardized on motor-cycles.

All but one of these 40 accidents happened on busy roads, and difficulty in crossing the road was a factor in about one third of the 31 relevant midblock accidents.

Some measures designed to increase the rate of flow of vehicular traffic are detrimental to the safety of the pedestrian, to the extent that on some of the arterial roads in the Adelaide metropolitan area some pedestrians, including children and the elderly, may have to rely for their safety on the driver seeing them in time to avoid a collision.

The conversion of a two lane road to a four lane Clearway was a factor in two accidents, and the alignment of the lane markings at a signalised intersection was a factor in one other. This accident near a signalised intersection was also characterised by the pavement markings being illegible when wet and by a reduction in the quality of the street lighting near a point where the roadway became narrower.

As is well-known, the provision of median refuges or pedestrian-actuated signals makes it much easier for the pedestrian to cross a busy road safely. Based on the accidents investigated in this study, the provision of a median refuge may have prevented four of the 16 accidents which occurred on undivided roads, and pedestrian-actuated signals may have prevented five of 31 midblock accidents.

While it is not possible to demonstrate conclusively that some of these accidents would not have happened had the striking vehicle been travelling 10 km/h slower, it is likely that a reduction in the urban area speed limit from 60 km/h to 50 km/h could result in a reduction of perhaps one-tenth in the overall frequency of occurrence of pedestrian accidents, and in a corresponding reduction in the severity of the injuries sustained in those accidents which still occur.

The injuries sustained by the pedestrians were much more likely to be dangerous to life than were the injuries sustained by other road users. Three of the 44 pedestrians were killed, one was totally incapacitated and two others were left with severe permanent disabilities. Eleven other pedestrians were disabled to a lesser degree. One third of these injuries were caused by being thrown to the road surface. The remaining two-thirds were caused by the striking vehicle. Ninety per cent of the severe or fatal injuries were directly due to an impact with the vehicle. The front of the car, including the upper surface of the bonnet, accounted for more than half of the injuries. Adult pedestrians were run under by the car, not run over, but small children were thrown forwards along the road, or fell to one side of the striking vehicle.

RECOMMENDATIONS

Child pedestrians often ran onto the road without looking. While educational programmes may be beneficial, there are reasons to believe that the smaller child is particularly at risk of being struck by a vehicle, either as a result of some impulsive act or because he or she is not able to judge accurately when it is safe to cross. Consequently it is recommended that:

Road safety educational programmes and programmes dealing with the general health and well-being of small children stress the need for young children to be under constant supervision when in the vicinity of a busy road.

The need for such careful supervision may well be as great in this situation as it is when a small child is near a swimming pool.

Standing in the centre of the road and crossing between banked-up stationary vehicles were shown in some of these accidents to be hazardous activities, and so it is recommended that:

Road safety educational programmes emphasise that it is dangerous for a pedestrian to stand in the centre of the road or to try to cross through banked-up traffic even, in the latter instance, when waved across by a driver.

Just as the pedestrian is well-advised not to cross through banked-up traffic even when a driver waves him across, it is similarly recommended that:

Drivers should be discouraged from waving a pedestrian across in front of their stationary vehicle if it is at all possible that another vehicle could be about to overtake on the far side.

Most of these pedestrian accidents occurred on busy roads, some of which were difficult for a pedestrian to cross safely. Consequently it is recommended that:

Median strips be incorporated in existing undivided arterial roads in urban areas wherever practicable.

Pedestrian-actuated signals obviously make it easier and safer for a pedestrian to cross a busy road, but their installation is limited by application of the traffic engineering warrants which require certain minimum flows for pedestrian and vehicular traffic. Because of the benefits associated with these crossings it is suggested that:

The likely effects of relaxing the pedestrian and vehicular traffic flow requirements in the warrant for the

installation of pedestrian-actuated signals be reviewed.

The following road and traffic factors also played a role in the causation of one or more of the pedestrian accidents in this study, and so it is recommended that:

Further consideration be given to the safety implications of the legibility of pavement markings in wet weather, of changes in the quality of the street lighting adjacent to an intersection, and of the introduction of Clearways on two-lane carriageways.

The speed of the approaching traffic is an important determinant of the difficulty that a pedestrian has in selecting correctly a safe gap in which to cross the road, and it is also directly related to the severity of the impact, and hence to injury severity, in a pedestrian accident. Consequently it is recommended that:

Consideration be given to the practicability of a reduction in the urban area speed limit from 60 km/h to 50 km/h.

There were three pedestrian accidents in which some characteristic of the striking vehicle was a significant factor in the causation of the accident. In one accident a motor scooter rider tried to sound the horn to warn a pedestrian of his presence but the horn button was not where he had expected it to be. It is therefore suggested that:

The Advisory Committee on Safety in Vehicle Design (ACSVD) consider the advisability of requiring that the location of the horn button be standardized on motorcycles.

Vinyl plasticiser deposits on the inside of the windscreen of a car make it harder for the driver to see a pedestrian at night, particularly when viewed against oncoming headlights, and so it is suggested that:

The wider use of upholstery and trim materials which do not release amounts of plasticiser sufficient to form visible deposits on the inside of the windscreen be encouraged.

Any projection from the side of a vehicle is likely to strike a pedestrian. This alone is reason for concern, but when the presence of the projection is required by law, as in the case of external rear vision mirrors on trucks, it is highly desirable that:

Consideration be given by ACSVD to the advisability of extending the requirements of ADR 14, Rear Vision Mirrors, to include external mirrors on trucks with the aim of minimising the hazard which these mirrors present to a pedestrian standing in the centre of the road or on a median refuge.

The front of the striking car causes most of the injuries inflicted on the pedestrian. Consequently it is recommended that:

The manufacturers of passenger cars, and government regulatory agencies and committees, such as ACSVD, in recognition of the fact that the leading edge of the bonnet and of the front corners of the car can and do hit small children on the head, take what-ever action that may be practicable to ensure

that the design and construction of the car is such as to minimise the severity of the injuries resulting from such impacts.

The adult pedestrian's head is not hit directly by the forward-most part of the striking car, but rather by the rear part of the bonnet or by the area at the base of the windscreen and so, as in the preceding paragraph, it is recommended that:

The car makers and regulatory bodies such as ACSVD, recognizing that the rear section of the bonnet and the area at the base of the windscreen are likely to be struck by a pedestrian's, or pedal cyclist's head, take whatever action may be practicable to ensure that the severity of the injuries resulting from these impacts will be minimised.

APPENDIX 3:

ADELAIDE IN-DEPTH ACCIDENT STUDY, 1975-1979

PART 3: PEDAL CYCLE ACCIDENTS

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ABSTRACT

This report contains descriptions of the causes and consequences of the pedal cycle accidents contained in a representative sample of road traffic accidents to which an ambulance was called in metropolitan Adelaide. Reviews of the relevant characteristics of the cyclists and drivers, the vehicles, and the road and traffic environment are also included. One-third of these 22 accidents involved a child cyclist who was riding carelessly on a

residential street. The other two-thirds mostly involved adult cyclists on arterial roads, and were a consequence of errors made equally by the cyclists and the drivers. Alcohol intoxication was not a significant factor in any of these accidents. Almost all of the cyclists were injured, and their injuries were often very severe. The front of the striking car caused two-thirds of the severe injuries. A number of possible countermeasures and topics worthy of further investigation are listed at the end of the report.

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INTRODUCTION

A sample of road accidents to which an ambulance was called in the Adelaide metropolitan area was investigated at the scene by multi-disciplinary teams from the Road Accident Research Unit of the University of Adelaide. This survey, which ran for twelve months from 23 March, 1976, was sponsored by the Office of Road Safety of the Commonwealth Department of Transport and the Australian Road Research Board. Each accident was studied by an engineer, a psychologist and a medical officer. Their observations at the scene started an average of ten minutes after the ambulance was called and were supplemented by further investigations including interviews with the drivers and other active participants (pedestrians and cyclists), detailed observation of traffic behaviour at the accident site and examination of the injured persons in hospital and of the vehicles in towing service depots and elsewhere.

An eight per cent sample, totalling 304 accidents, was obtained of all road accidents as defined above. The sample was representative of this accident pop-

ulation by time of day and day of week. The purpose of this survey, the sampling technique and the method of investigation are described in detail in another report in this series together with a review of the types of accidents investigated and an outline of the general conclusions.

There were 22 accidents in which a pedal cycle was involved in this sample of 304 accidents. This report contains a general review of these 22 accidents, followed by a detailed presentation of information obtained from interviewing each cyclist. The characteristics of the drivers whose vehicles collided with a pedal cycle are dealt with briefly. The injuries sustained by the cyclists are described, and specific injuries are related to the objects which caused them. A discussion of the possibilities for preventing accidents involving pedal cyclists, and for minimizing the severity of the injuries sustained in those accidents which do occur, precedes the final sections of this report which list the general conclusions and recommendations.

CONCLUSIONS

Many of these accidents were the result of a careless, impulsive manoeuvre by a child cyclist. Their accidents were very similar, in this respect, to those involving child pedestrians, except that the young cyclists were involved in accidents on residential streets, whereas the corresponding pedestrian accidents were all on arterial roads.

The adult cyclists were involved in accidents on arterial roads or on traffic routes in the central city. While most of them made some error which contributed to, or was the major cause of, their accident-involvement, the driver of the car also was likely to have been driving in an unsafe manner.

Three-fifths of the drivers or motorcyclists whose vehicles collided with a pedal cycle were males under 23 years of age. Drivers who committed an offence against the Road Traffic Act were much more likely to be charged than were the cyclists, even allowing for the fact that most of the offending cyclists were juveniles.

Neither alcohol intoxication nor the effect of any other drug was a relevant factor in any of these accidents.

Eight cyclists were relatively inconspicuous when viewed from the approach path of the other party in the collision. Most of these eight riders were adults.

Almost all of the cyclists were injured, and those who were sustained an average of four to five separate injuries per person. The head was the most frequently injured body region, with 90 per cent of these injuries being concussion. One fifth of the riders were hospitalized for more than a month; one third were prevented, by their injuries, from carry-

ing out their normal activities for a period of more than three months, and a similar proportion were left with a permanent disability which in one case was severely incapacitating.

One half of the injuries sustained by these cyclists were caused by contact with the road surface, but two-thirds of the severe injuries were caused by the striking vehicle. The front bumper bar and the leading edge of the bonnet and front mudguards were associated with these severe injuries. The upper surface of the bonnet and the area immediately to the rear, at the base of the windscreen, were contacted by some cyclists, and these impacts were likely to be to the cyclist's head.

The style of the handlebars fitted to the pedal cycle did not appear to be an important factor, with one possible exception. The poor braking performance of calliper brakes in wet weather was the direct cause of one cyclist's inability to avoid a collision which he had anticipated was likely to occur. Another accident may have resulted largely from the unstabilising effect on the cycle of a heavy load on the rear carrier.

The customary road and street layout which makes no provision for separating the cyclist from other vehicular traffic was an underlying factor in many of these accidents. In one accident an irregularity in the road surface near the kerb distracted the cyclist just as a car turned across his path, and the phasing of the traffic signals did not allow enough time for a cyclist to clear a major intersection. Drivers who were exceeding the speed limit by a wide margin contributed to the occurrence of three collisions and the excessive speeds of their cars probably increased the severity of the cyclists' injuries.

RECOMMENDATIONS

Child cyclists are often involved in accidents because they turn, without signalling or looking, across the path of an overtaking car. Even though this essentially impulsive behaviour may be difficult to modify, it is recommended that:

Road safety programmes for child cyclists emphasise the need to look for overtaking traffic and then to signal before starting to turn across a road when the way appears to be clear.

Although the cyclists involved in these accidents were aware of the relevant sections of the Road Traffic Act, only one of the 15 who committed an offence against this Act was prosecuted. On the assumption that this failure to lay charges is likely to encourage continuing disregard of the road traffic laws by these cyclists, we endorse the recommendation of the House of Representatives Standing Committee on Road Safety that:

Stricter enforcement of road rules applying to cyclists be implemented.

Physical separation of the cyclist from other vehicular traffic would eliminate the possibility of the occurrence of many of the collisions observed in this survey. For this reason it is recommended that:

The provision of bicycle paths be encouraged in established areas, and be required in new developments.

Because of the obvious difficulties in providing bicycle paths in established areas, it is recommended that:

It be made legal for a cyclist to ride on the footpath and that, subject to adequate warning of the risk of collisions with pedestrians and with vehicles entering and leaving private driveways, cyclists be encouraged to use the footpath rather than the roadway whenever it is convenient for them to do so.

Child cyclists, as noted above, are often involved in accidents because they turn, without looking, across the path of an overtaking car. Consequently it is recommended that:

Consideration be given to an evaluation of the safety implications of allowing cyclists to ride on the right hand side of the road, adjacent to the kerb, so that they are looking towards, rather than away from, approaching motor vehicles.

The inability of a cyclist, who was turning right, to clear a signalised inter-

section before oncoming traffic was free to move was an important factor in one of the accidents in this survey. The need to allow for slow-moving vehicles when setting the phasing of traffic signals is well-known, but this accident indicates that:

There is a need to ensure that the phasing of traffic signals allows sufficient time for a slow-moving vehicle such as a pedal cycle to clear the intersection safely.

Many of these accidents were, in part, a consequence of the difference in travelling speeds of the pedal cycle and the other vehicle. If this speed differential were reduced, some of these accidents may have been avoided and the severity of the cyclist's injuries would have been reduced in those accidents which still occurred. Therefore it is recommended that:

Consideration be given to a reduction of the urban area speed limit from 60 to 50 km/h.

Three drivers were unable to avoid a pedal cyclist partly because they were travelling at a speed far in excess of the speed limit. The speeding driver may be as great a hazard to other road users as the one who is intoxicated. Therefore it is recommended that:

Measures that can be shown to be effective in reducing the frequency with which drivers travel at a speed far in excess of the speed limit be strongly supported.

The quality of the road surface was not a major factor in the causation of any of these accidents, but it did play a role in one case. Nevertheless it appears to be reasonable to expect that the cyclist will be more likely to keep well to the left, and less likely to be distracted by the need to watch for irregularities in the road surface, if that part of the roadway is well maintained, and so it is recommended that:

An assessment be made of the extent to which the quality of the road surface adjacent to the kerb has safety implications for the pedal cyclist.

The cyclist was relatively inconspicuous in eight of these collisions, and most of these eight riders were adults. While some measures can be taken by the cyclist to improve his conspicuity, such as by wearing an orange vest, it is likely that improvements to the conspicuity of the bicycle will be more effective, if only because they are present regardless of any action on the part of the rider. The Australian Standard for Pedal Cycles (AS 1927) includes specifications for the

placement of reflectors on cycles, and so it is recommended that:

Compliance with AS 1927 be required under Section 62 of the Trade Practices Act.

This recommendation was also made by the House of Representatives Standing Committee on Road Safety. (Section 62 prohibits the supply of goods which the Minister has declared to be unsafe.)

In these accidents more cyclists were inconspicuous in the daytime than at night. The daytime conspicuity of a bicycle is enhanced by the fitting of a fluorescent orange pennant mounted on a 1.5 metre high flexible wand, and so it is recommended that:

The fitting of fluorescent orange safety flags to pedal cycles be encouraged by appropriate publicity campaigns.

One cyclist was unable to avoid a collision because his calliper-type brakes were not effective when wet. This case reinforces the recommendation of the House of Representatives Standing Committee that:

The Standards Association of Australia give serious consideration to amending Australian Standard 1927 (1978) to provide for appropriate levels of wet weather braking performance.

Because child cyclists often turn without first looking for following traffic, it is recommended that:

An evaluation be made of the value of a rear vision mirror on a bicycle.

A heavy load on a rear-mounted carrier may have contributed to the loss of stability of a bicycle on a steep downhill slope. It is therefore recommended that:

The effects of the location and method of attachment of a heavy load on the stability of a bicycle be investigated with a view to the

development of recommendations for safe load-carrying practices.

Head injuries were the most common type of injury sustained by these cyclists, and most of the severe head injuries were caused by striking the head on the road. This emphasises the need for adequate head protection, and so it is recommended that:

Compliance with the Australian Standard for General Purpose Protective Helmets (AS 2063) be required for any helmet advertised or sold for use by cyclists, and that cyclists be encouraged to wear such a helmet.

At least three factors act to limit the use of crash helmets by cyclists. These are: cost, availability and, for children, a need for periodic changes in the size of the helmet to ensure a satisfactory fit. Consequently it is recommended that:

An investigation be conducted into ways to reduce the price and increase the availability, particularly for children, of crash helmets which comply with AS 2063, and that, when suitable helmets become available, schools consider instituting rental schemes for cyclists' crash helmets for use by their students who cycle to and from school.

The front of the striking car caused most of the severe injuries sustained by the cyclists in these accidents. The leading edge of the bonnet and front mudguards fracture the cyclist's femur and the area at the base of the windscreen is struck by the cyclist's head. Consequently, as in the companion report on pedestrian accidents, it is recommended that:

At the initial design stage, account be taken of the need to reduce greatly the injury potential of the front of the car, extending back as far as the windscreen.

APPENDIX 4:

ADELAIDE IN-DEPTH ACCIDENT STUDY, 1975-1979

PART 4: MOTORCYCLE ACCIDENTS

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ABSTRACT

This report contains descriptions of the causes and consequences of the accidents involving motorcycles in a representative sample of road traffic accidents to which an ambulance was called in metropolitan Adelaide. Reviews of the relevant characteristics of the motorcyclists and drivers, and of the motorcycles, are also included. The role of road and traffic factors is discussed in more detail in a separate report in this series. Sixty-eight, or 22 per cent of the accidents in this survey involved a motorcycle. Most of the riders were young males, many of whom were

inexperienced in riding a motorcycle in traffic, and alcohol intoxication was a major factor in those accidents which occurred at night. Few riders were able to make full use of the braking capabilities of their motorcycle in an emergency, and changes are recommended in the method of brake actuation and in motorcycle licence tests. Ninety-six per cent of the motorcyclists were injured. Severe head injuries were less common than were severe injuries to the lower limbs, reflecting the use of effective crash helmets and the high risk of the motorcyclist being struck on the leg in a collision.

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INTRODUCTION

A sample of accidents to which an ambulance was called in the Adelaide metropolitan area was investigated at the scene by multi-disciplinary teams from the Road Accident Research Unit of the University of Adelaide. This survey, which ran for twelve months from 23 March, 1976, was sponsored by the Commonwealth Department of Transport and the Australian Road Research Board. Each accident was studied by an engineer, a psychologist and a medical officer. Their observations at the scene started an average of ten minutes after the ambulance was called and were supplemented by further investigations including interviews with the drivers and other active participants (pedestrians and cyclists), detailed examination of the accident site and observation of traffic behaviour at the same time of day as the accident. The injured persons were examined and interviewed in hospital and the vehicles were inspected in towing service depots and elsewhere.

An eight per cent sample, totalling 304 accidents, was obtained of all road accidents as defined above. The sample was representative of this accident population by time of day and day of week. The purpose of this survey, the sampling technique and the method of investigation are described in detail in another report in this series (Part 1: An Overview) together with a review of the types of accidents investigated and an outline of the general conclusions.

This report contains a brief summary

of the 68 motorcycle accidents in this sample of accidents to which an ambulance was called. Most of these motorcycle accidents are described in a companion report that deals with road and traffic factors (Part 7) and so there is no section on these factors in this report. Some other accidents involving motorcycles are reviewed in the reports on pedestrian and pedal cycle accidents (Parts 2 and 3). The summary of these motorcycle accidents is followed by a detailed review of the characteristics of the riders who were involved, and a concise presentation of certain characteristics of the drivers whose vehicles collided with a motorcycle. The role of the motorcycle itself in accident causation is then discussed, and the consequences of these motorcycle accidents are considered, with particular emphasis on the nature, severity and causes of the injuries sustained by the riders and pillion passengers. The final sections of the report contain the conclusions and recommendations.

It will be apparent that some factors are reported on in isolation, with little or no discussion of their possible interaction with other factors. This largely single-variate approach has been selected because it was thought to be preferable, with the limited resources at our disposal, to present a reasonably comprehensive view of the range and detail of the information that has been collected rather than to concentrate on a more rigorous investigation of a few specific topics. This means that there is much more that can usefully be done with this information.

The Advisory Committee on Safety in Vehicle Design consider ways to further the wider use of single-control two-wheel braking on motorcycles.

Licensing tests include a requirement that the applicant demonstrate that he can perform an emergency stop using only the front brake.

Two accidents resulted, in part, from the rider being confused by the placement of the controls on the motorcycle. Draft Regulation 1805 of the Australian Transport Advisory Council (ATAC) specifies standard locations for the controls on a motorcycle, and it is recommended that:

State motor vehicle registration authorities require compliance with ATAC Regulation 1805 for all new motorcycles.

Fuel leaked from 22 (32 per cent) of these motorcycles after the accident, and one machine caught fire, seriously burning the rider. In about two thirds of these cases there was no damage to the fuel system. Consequently it is recommended that:

An investigation be made of the sources of fuel leakage from motorcycles when they are placed on their side, in order to identify ways of reducing the frequency of such leakage after an accident.

Fourteen motorcycles were found to be defective, in some cases in respect to the absence of some legally-required component such as a rear vision mirror, but a defect was relevant to the causation of only one accident.

These motorcyclists were the only class of road user in this study for whom head injuries were not the most common severe injury. This was due to the protection afforded by the crash helmets which

were worn by all except one of the motorcyclists, and by the high frequency of severe leg injuries. The investigation of the performance of the helmets worn by these riders was greatly hindered by the absence of any markings showing the make, model and compliance with safety standards on most of the helmets. As the continued assessment of the performance of these helmets in crashes is desirable, it is recommended that:

Australian Standard AS 1698 (Protective Helmets for Vehicle Users) be amended to require the affixing to the helmet of a listing of the make, model, year of manufacture and safety standard compliance on the helmet in such a way that it will remain legible for the life of the helmet.

The nature and severity of the leg injuries sustained by these motorcyclists illustrates the need for the development of some form of leg protection. The conventional bolt-on type of crash bar is ineffective, whereas in one accident the protruding cylinder head of a motorcycle engine did appear to protect the rider's leg from being injured in a collision with a car. Therefore it is recommended that:

An investigation be conducted to establish the requirements for a device which will minimize the risk of a motorcyclist sustaining a severe leg injury when involved in an accident.

As a consequence of their accident-involvement, one-fifth of these motorcyclists were prevented from working, or from carrying out their usual activities, for more than three months, and a similar proportion were left with a permanent physical disability, or were fatally injured.

CONCLUSIONS AND RECOMMENDATIONS

Sixty-eight, or 22 per cent, of the accidents in this survey involved a motorcycle, and about two-thirds of them were collisions with another vehicle or with a pedestrian. The other vehicle should legally have given way to the motorcycle in two-thirds of the collisions.

Road and traffic factors are discussed in detail in the relevant companion report in this series (Part 7), but it can be noted here that 40 per cent of the accidents involving a motorcycle occurred at uncontrolled midblock locations. The skid resistance of the road surface did not appear to be an important factor, possibly because 94 per cent of the motorcycle accidents occurred on dry roads.

Twenty-two per cent of the riders may have been affected by alcohol (BAC > 0.04), and their crashes were three to four times more likely to have involved the motorcycle alone than were the accidents experienced by the sober riders. They were also more likely not to have fastened the chin strap on their crash helmets. These intoxicated riders had a (self-reported) history of regular and substantial alcohol consumption, and more than two-fifths of all of the riders in this sample of accidents said that they occasionally rode their motorcycles when they were intoxicated, some of them doing so regularly. This drinking behaviour may be associated with the fact that most of these riders were young males, but the consequences of drinking and riding are often so severe that it is recommended that:

Consideration be given to measures to emphasise to motorcyclists that riding while intoxicated places both them and their pillion passengers at an increased risk of crashing and being seriously injured.

Because the intoxicated rider places himself and his passenger at a greater risk of being injured, measures be taken to encourage the motorcyclist to take the time to fasten the chin strap on his helmet even though it may be difficult to do so after he has been drinking.

Simpler methods should be developed, and incorporated as amendments to Australian Standard AS 1698 (Protective Helmets for Vehicle Users), for fastening the chin strap on a crash helmet to ensure that the strap can be secured by an intoxicated rider.

Measures aimed at detecting intoxicated vehicle operators should not omit the motorcyclist.

Just over a quarter of the riders in these 68 accidents had been licensed to ride a motorcycle for less than six months. The youngest inexperienced riders appeared to have difficulty operating safely in traffic, even when on small motorcycles, whereas many older motorcyclists had had one or two years experience of driving a car in traffic before starting to ride a motorcycle. These older riders were less likely to have been in difficulty in traffic immediately before their accident, but they were more likely to have been on a larger machine. On the basis of registration data, the larger motorcycles were over-involved in these accidents possibly because they were more likely to have been ridden by individuals who had a history of previous violations and accidents (one third of the 69 riders had had at least one previous licence suspension). On the basis of impressions gained in the investigation of these accidents rather than on the formal data presented in this report it is suggested that:

Consideration be given to assessing the value of encouraging potential motorcyclists to gain experience in operating a car in traffic before applying for a motorcycle licence, and of restricting the size of motorcycle that can be ridden in the first two years of holding a motorcycle licence, or after a period of licence suspension.

The conspicuity of the rider and the motorcycle could have been a factor in about one-fifth of the accidents which occurred at night and in about one-eighth of those in the daytime. There were not enough relevant cases to enable a rigorous assessment to be made of the value of the daytime use of headlights, but if all of these riders had ridden with the headlight on during the day, then perhaps ten per cent of the daytime accidents (or four per cent of the total number) may have been prevented.

Almost half of the riders who braked before the accident did not use the front brake. Had they done so, about thirty per cent of these riders probably would have avoided colliding with the other vehicle (a reduction of 15 per cent in the accidents in which the rider braked, or seven per cent overall). The failure to use the front brake was not confined to inexperienced riders, many of whom did not normally use it. Some experienced riders, who used both brakes regularly, used only the back brake in the emergency situation immediately before the crash. A coupled, front and rear, braking system actuated by a foot pedal is available on one make of motorcycle, and so it is recommended that:

APPENDIX 5:

ADELAIDE IN-DEPTH ACCIDENT STUDY, 1975-1979

PART 5: COMMERCIAL VEHICLE ACCIDENTS

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B.L. Sandow

ABSTRACT

This report deals with accidents involving trucks, vans, buses and multi-purpose vehicles, not all of which were being used as commercial vehicles. There were relatively few single vehicle accidents, apart from those involving pedestrians, and the reluctance of semi-trailer drivers to brake hard at signalised intersections and insecure loads of some heavy vehicles distinguished these accidents from those involving only passenger cars. All but one of the drivers of these commercial

vehicles were males, most of whom were aged between 20 and 50 years. None of these drivers were affected by alcohol intoxication to a significant degree, nor was fatigue a factor in any of these accidents. Although none of the commercial vehicle occupants was severely injured, the provision and use of seat belts may have avoided many of the injuries which did occur. Some multi-purpose passenger vehicles are deficient, when compared to passenger cars, in terms of protecting their occupants from injury in a crash.

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INTRODUCTION

A sample of road accidents to which an ambulance was called in the Adelaide metropolitan area was investigated at the scene by multi-disciplinary teams from the Road Accident Research Unit of the University of Adelaide. This survey, which ran for twelve months from 23 March, 1976, was sponsored by the Office of Road Safety of the Commonwealth Department of Transport and the Australian Road Research Board. Each accident was studied by an engineer, a psychologist and a medical officer. Their observations at the scene started an average of ten minutes after the ambulance was called and were supplemented by further investigations including interviews with the drivers and other active participants (pedestrians and cyclists), detailed observation of traffic behaviour at the accident site and examination of the injured persons in hospital and of the vehicles in towing service depots and elsewhere.

An eight per cent sample, totalling 304 accidents, was obtained of all road accidents as defined above. The sample was representative of this accident population by time of day and day of week. The purpose of this survey, the sampling technique and the method of investigation are described in detail in an overview report together with a review of the types of accidents investigated and an outline of the general conclusions. Twenty-nine

accidents, or 9.5 per cent of the total sample, which involved a truck, bus, or multi-purpose passenger vehicle are reviewed in this report.

THE TYPES OF VEHICLES INVOLVED IN THESE ACCIDENTS

The term 'multi-purpose passenger vehicle' is used here to denote a vehicle which is so-classified by the Australian Motor Vehicle Certification Board. This classification results in that vehicle being exempted from the requirement to comply with many of the Australian Design Rules for Motor Vehicle Safety. Not all, or even many, of the multi-purpose vehicles in these accidents were being used as commercial vehicles, but they are included in this report because they do differ from passenger cars in several important respects, such as compliance with the Australian Design Rules.

As can be seen in Table 1, the 30 vehicles which were classified as a truck, bus or multi-purpose passenger vehicle involved a wide range of configurations. The word 'truck' in this Table is used to refer to vans as well as to tray-top configurations. These 30 vehicles represent 7.2 per cent of the motor vehicles, other than motorcycles, which were involved in the accidents covered by this survey.

TABLE 1: TYPES OF COMMERCIAL VEHICLES

<u>Type of Vehicle</u>	<u>No. of Vehicles</u>
Multi-purpose passenger vehicle	6
Light truck, unladen \leq 1780 kg	4
Medium truck, unladen $>$ 1780 kg, GVM \leq 4500 kg	5
Heavy truck, GVM $>$ 4500 kg	4
Semi-trailer	6
Prime-mover	1
Urban bus	3
Four-wheel-drive passenger vehicle	1
<hr/>	
Total	30

CONCLUSIONS

The accidents involving heavy vehicles in this survey were characterised by the relatively poor braking performance of the heavy vehicle, when compared to that of other vehicles in the traffic stream, by insecure loads and by the tendency for the heavy vehicle to over-ride a struck car, or motorcycle, because of the height of its front bumper bar.

The multi-purpose passenger vehicle's accident experience was closer to that of the car, but the basic configuration of

the forward control vehicles and the absence from other multi-purpose vehicles of some now-elementary crash-injury protection features resulted in a higher average severity of injury to the occupants than would have been expected had they been in passenger cars.

These accidents mostly occurred between 8 a.m. and 3 p.m. This time distribution is reflected in the fact that alcohol intoxication was not an important factor and there were, in consequence, few single vehicle crashes.

RECOMMENDATIONS

Heavy vehicles are likely to inflict extremely severe damage to another vehicle in a collision and so it is recommended that:

In addition to actively pursuing all practicable means of further improving the braking performance of heavy vehicles, continuing consideration be given to other measures, such as loading restrictions and differential speed limits, which might decrease the hazards arising from the present discrepancy between the braking performance of heavy vehicles and that of passenger cars.

Two of the accidents reviewed in this report were primarily a consequence of loads shifting. We therefore recommend that:

The consideration being given by the Advisory Committee on Vehicle Performance to the development of a national code of safe loading practice be expedited.

and, in particular, that:

Half-cab trucks which are used to carry cargoes such as lengths of timber be required to be fitted with a forward-mounted barrier which will adequately restrain the load from shifting forwards under heavy braking and in collisions of moderate severity.

In one accident the driver of a bus containing about 70 passengers was thrown onto the floor in a collision at an intersection. While the risk of a bus driver being dislodged from his seat in a collision may be low, the potential consequences could be very serious and so it is suggested that:

Seat belts be provided for the drivers of metropolitan transit buses to protect the driver from injury and to enable him to continue to control the bus after a collision, and that the wearing of these belts be required by law.

In collisions involving such buses the passengers are likely to be thrown against objects inside the bus. It is therefore desirable for:

The fittings and seating of metropolitan transit buses to be designed in such a way as to minimize the risk of injury to passengers who may be thrown against them in a collision.

The accidents in this study which involved a collision with the front of a heavy vehicle showed that there can be hazards associated with the relatively high front bumper bar on these vehicles and with snagging on protruding fittings. It is therefore recommended that:

The Advisory Committee on Vehicle Performance review the desirability of regulating the frontal design of heavy vehicles, including the design of components such as bull-bars, so as to ensure that the damage inflicted in a collision on passenger cars and on other road users, including cyclists and pedestrians, is minimized.

Multi-purpose passenger vehicles are commonly used as passenger cars, but they are permitted to have a level of occupant protection which is below that of passenger cars. The special nature of some of these vehicles does distinguish them from other passenger cars but nevertheless it is suggested that:

Multi-purpose passenger vehicles, and any vehicle which can, in one of its variations, be classified as a multi-purpose passenger vehicle, be required to comply with the Australian Design Rules for Motor Vehicle Safety which are applicable to passenger cars.

Forward-control multi-purpose passenger vehicles may satisfy frontal barrier collision tests but not provide adequate protection against more concentrated frontal impacts. As there is no compliance test relating to such impacts for passenger cars it is suggested that:

Consideration be given to the advisability of introducing a compliance test involving a frontal collision with a narrow barrier, or pole, and that this test be applicable to multi-purpose passenger vehicles in addition to passenger cars and passenger car derivatives.

APPENDIX 6:

ADELAIDE IN-DEPTH ACCIDENT STUDY, 1975-1979

PART 6: CAR ACCIDENTS

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H.S. Aust

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ABSTRACT

This report contains descriptions of the causes and consequences of the accidents involving cars in a representative sample of road traffic accidents to which an ambulance was called in metropolitan Adelaide. The characteristics of the drivers are reviewed in relation to the causation of these accidents and to accident prevention measures in general and the role of vehicle factors in accident and injury causation is discussed with emphasis on the Australian Design Rules for Motor Vehicle Safety. Two hundred and sixty-two, or 86 per cent of the accidents in the survey involved one or more cars. Alcohol intoxication and inexperience in driving in traffic were

the two characteristics of drivers that were most often obviously related to accident involvement. Vehicle defects played only a minor role. Seat belts were found to reduce the frequency and severity of injury; this was particularly so for the later inertia-reel belts which were also more likely to be worn. Seventy-nine per cent of drivers and 65 per cent of left front passengers wore a seat belt where one was available. Door latches and hinges, seat anchorages, and the steering wheel and instrument panel were either deficient in the crash or otherwise were frequently found to be objects causing injury to the occupants of the car.

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INTRODUCTION

A sample of accidents to which an ambulance was called in the Adelaide metropolitan area was investigated at the scene by multi-disciplinary teams from the Road Accident Research Unit of the University of Adelaide. This survey, which ran for twelve months from 23 March, 1976, was sponsored by the Commonwealth Department of Transport and the Australian Road Research Board. Each accident was studied by an engineer, a psychologist and a medical officer. Their observations at the scene started an average of ten minutes after the ambulance was called and were supplemented by further investigations including interviews with the drivers and other active participants (pedestrians and cyclists), detailed examination of the accident site and observation of traffic behaviour at the same time of day as the accident. The injured persons were examined and interviewed in hospital and the vehicles were inspected in towing service depots and elsewhere.

An eight per cent sample, totalling 304 accidents, was obtained of all road accidents as defined above. The sample was representative of this accident population by time of day and day of week. The purpose of this survey, the sampling technique and the method of investigation are described in detail in another report in this series (McLean and Robinson, 1979) together with a review of the types of accidents investigated and an outline of the general conclusions.

Two hundred and sixty-two accidents

involving passenger cars or passenger car derivatives are reviewed in this report. The term 'passenger car derivative' means

a motor vehicle of the kind known as a coupe, utility, or panel van of the same make as a factory produced passenger car, and in which the forward part of the body form and the greater part of the mechanical equipment are the same as those in the said passenger car.

(Australian Transport Advisory Council (ATAC), 1979).

Passenger cars and passenger car derivatives (referred to from here on simply as 'cars') are required to comply with certain specifications set down in the Australian Design Rules (ADRs) for Motor Vehicle Safety by the Australian Transport Advisory Council (1979).

The characteristics of the drivers are presented in Chapter 3 and discussed in relation to their role in the causation of the accidents. The types of cars involved are described in Chapter 4, together with vehicle factors in accident and injury causation and the performance of the relevant Australian Design Rules for Motor Vehicle Safety (ATAC, 1979). The consequences of the accidents are reviewed in Chapter 5 in terms of the nature, severity and causes of the injuries sustained by the occupants of the cars. The final Chapter of the report lists the main conclusions and recommendations.

CONCLUSIONS AND RECOMMENDATIONS

6.1 THE DRIVER

6.1.1 ALCOHOL INTOXICATION

BAC readings were obtained for 85 per cent of the 403 drivers. Males were much more likely to have had a BAC \geq 0.05 than were females (20.5 and 6.0 per cent respectively) and to have had a BAC above the legal limit of 0.08 (15.5 per cent and 3.6 per cent respectively). In view of the demonstrated positive association between BAC and accident involvement in metropolitan Adelaide (McLean, Holubowycz and Sandow, 1980) and the percentage of intoxicated male drivers in these accidents it is recommended that:

The continuing search for ways to deter drivers from driving with an elevated BAC should be regarded as an area of prime importance and should be funded accordingly.

Seventy per cent of the 70 drivers who were found to have a positive BAC said that they occasionally or even regularly drove after consuming ten or more drinks and 40 per cent thought that this quantity of alcohol had little or no effect on their driving performance. These findings suggest that:

There is a need for wider dissemination of information on the effect that alcohol intoxication has on the risk of accident involvement.

Almost half of the drinking drivers had been drinking at an hotel, one-third at a private residence and one-seventh at a restaurant or club. While recognizing that attempts to control excessive drinking at one type of location might well simply change the location at which some drivers drink to excess, these findings suggest that:

An attempt should be made to develop measures that can be incorporated into the criteria for the granting or renewal of a liquor licence and that will reduce the frequency with which patrons drink to excess and then drive.

The proportion of intoxicated drivers in single vehicle accidents was five to six times greater than the corresponding proportion in other types of accident. The intoxicated driver may therefore place himself and his passengers at much greater risk than he does other road users. Therefore it is recommended that:

Measures aimed at detecting drivers who have illegal BACs be supported on the grounds that they protect those drivers and their passengers from injury.

Such measures might well be considered as being distinct from and complementary to other measures aimed at the general deterrence of the practice of driving when intoxicated.

There was a close association between involvement in a secondary activity and alcohol intoxication among drivers involved in single vehicle accidents. A similar, but less marked, association was noted in other accidents. It is recommended that:

The association between secondary activity involvement and alcohol intoxication among drivers involved in accidents be investigated further in the hope of increasing our understanding of the ways in which alcohol affects a driver's performance.

Screening breath tests were administered by the police to 16 out of 280 uninjured drivers who remained at the scene of the accident. Forty-one of the 280 drivers had been drinking and the police identified 12 of the 23 who were above 0.08. This result, together with data from blood samples taken in hospitals, suggests that the routinely recorded data on the incidence of a BAC \geq 0.08 among drivers involved in casualty accidents may be an underestimate by about 20 per cent. For this reason it is recommended that:

Consideration be given to increasing the proportion of uninjured accident-involved drivers who are breath tested by the police, such consideration to include universal testing.

6.1.2 INTOXICATION BY DRUGS OTHER THAN ALCOHOL

Drugs other than alcohol were known to have been used by about one-eighth (12.2 per cent) of the 403 drivers. Even though we had to rely on self-reporting of drug use there were no cases in which a driver was obviously affected by an unknown intoxicant. Most of the drugs that were reported had been prescribed by a medical practitioner and most of them were thought not to have affected the driver's performance. In 12 cases the drug may have had some effect but this effect was probably beneficial in half of these cases. In five of the remaining six cases alcohol had also been ingested and it alone would have been significant, even in the absence of any additive or synergistic interaction with the drug. One of these five drivers was the only one who was known to have used an illegal drug: marijuana, in combination with a BAC of 0.14. The twelfth case involved an overdose of insulin that resulted in the driver collapsing because of hypoglycaemia. From these results it is

concluded that:

Drugs other than alcohol are a relatively minor problem but one that may be subject to control by legislation and by more effective advisory action by medical practitioners. In particular, consideration should be given to making any drug which is known to have a synergistic interaction with alcohol available only on prescription.

6.1.3 DRIVER LICENSING AND EDUCATION

Seventeen drivers had poor vision (static visual acuity worse than 3:12 in at least one eye). This was relevant to the causation of the accident in four cases. Although not a major problem, visual defects are amenable to control at the time of initial application for a driver's licence. The present system in South Australia relies on self-reporting of poor eyesight by the applicant for a licence, or on renewal. That this system is ineffective can be gauged from the fact that only two of the 403 drivers had such an endorsement on their licence. Therefore it is recommended that:

The measures taken to identify persons having defective vision among drivers and applicants for a driver's licence be reviewed.

Newly-licensed drivers (licensed less than two years) were over-represented in the accidents studied on the basis of the number of licensed drivers. Inexperience in driving was an obvious causal factor for nine drivers, three of whom were too young to hold a licence and none had been licensed for more than three months. Turning manoeuvres were characteristic of these nine accidents. It is suggested that:

A special study be made of the characteristics of accidents involving inexperienced drivers so as to identify those areas that should be emphasised in tests for a driver's licence and in road safety publicity and educational programs directed at the inexperienced driver.

6.2 VEHICLE FACTORS

6.2.1 VEHICLE DEFECTS

A vehicle defect in a passenger car definitely contributed to the causation of 0.8 per cent of the accidents in the study and probably contributed to a further 2.8 per cent. Tyre characteristics, both lack of tread depth and mismatch of radial and cross-ply tyres, were the most important single class of defect despite the fact that very few of the accidents occurred on wet roads. There is no system of periodic motor vehicle inspection in South Australia for passenger cars but the police have the authority to examine any vehicle that appears to be defective. It is suggested that:

On the basis of the data collected in this study there is no clear case for the introduction of periodic motor vehicle inspection but an expansion of the existing system of spot checks, concentrating on tyre characteristics, may be worthwhile.

6.2.2 THE AUSTRALIAN DESIGN RULES FOR MOTOR VEHICLE SAFETY,

Not all of the safety-related Australian Design Rules (ADRs) could be assessed in this study. This was mainly because there was no case in which the component or performance characteristic covered by an ADR was relevant to the causation or consequences of an accident. This arose from a low probability of failure (such as ADR 7: hydraulic brake hoses), from the characteristics of the accident sample (being generally low severity impacts) or from the, at that time, relatively recent introduction of an ADR resulting in few cars in the accidents studied being in compliance with the Rule (such as ADR 29: side door strength). The following conclusions and recommendations therefore do not cover all of the safety-related ADRs.

ADR 2: DOOR LATCHES AND HINGES

Door latches and hinges that complied with ADR 2 performed better than did those on earlier-model cars that were not required to comply with the ADR. However one mode of failure of a door latch was observed that is not covered by the ADR and so it is suggested that:

The specification for compliance with ADR 2 be reviewed to incorporate a requirement that the integrity of the door latch be maintained when the latch is loaded towards the interior of the car.

ADR 3: SEAT ANCHORAGES

The seat is an essential component of the seat belt restraint system. If the seat fails the occupant may no longer be restrained adequately by the seat belt. Some failures of ADR 3 seats were recorded in the study even though, as noted above, there were few severe impacts. Therefore it is recommended that:

The specification for compliance with ADR 3 be reviewed to assess the likely value of higher strength requirements for seats and seat anchorages.

ADR 4 to 4C: SEAT BELTS

The injury-protection afforded by the seat belt appears to have improved with the introduction of, and subsequent changes to, ADR 4 based on the accidents in this study. However the wearing rates, overall, were lower than those observed in surveys of the general driving population, to the extent that fewer than half of the left front passengers in these accidents were wearing a seat belt. Therefore it is recommended that:

While the protection against injury provided by seat belts that comply with ADR 4C, and the wearing rates with 4C belts, were both at a high level there were still some front seat occupants in late model cars who were not wearing a seat belt when involved in an accident. Passive restraint devices should therefore be considered for possible introduction in Australian passenger cars.

and,

Because young drivers tend to drive older cars that may not be fitted with seat belts, or with belts that comply with ADR 4C, and because such drivers are at a high risk of being involved in an accident, a case exists for the retrofitting of inertia reel seat belts in older-model cars.

Two cases were observed in which serious injury resulted from the fact that an occupant was displaced from behind the sash of his seat belt and then lacked any effective restraint from the lap belt because the webbing ran through the tongue of the buckle assembly. While recognizing that the following modification would require an additional locking retractor, it is recommended that:

Consideration be given to modifying ADR 4C so that the webbing of a seat belt cannot slip through the tongue of the buckle assembly.

ADR 8: SAFETY GLASS

Disfiguring facial injuries were inflicted by a shattered toughened glass windscreen in one of the accidents in this study in circumstances that were not unusual. Despite the high wearing rate of seat belts in late-model cars, and the consequently low risk of an occupant of such a car contacting the windscreen it is suggested that:

Consideration be given to modifying ADR 8 so as to permit only windscreens that are unlikely to be penetrated when struck by an occupant in a collision.

ADR 10A, 10B: STEERING COLUMNS

There were few frontal impacts in this study that were severe enough to provide a test of the adequacy of ADR 10A and 10B. However there were cases in which significant facial injuries were inflicted from contact with the rim of the steering wheel by restrained occupants. Therefore it is recommended that:

Consideration be given to specifying, as an amendment to ADR 10A, 10B, characteristics for the rim of the steering wheel that will minimize the severity of the injuries inflicted in head or facial contact during a frontal collision.

ADR 21: INSTRUMENT PANELS

Significant injuries were sustained from impacts with the area at the base of the windscreen, both by occupants of the car and by other road users when struck by a car. Therefore it is recommended that:

ADR 21 be reviewed to accommodate the fact that vehicle occupants, in cars fitted with toughened glass windscreens, can and do strike their face or head on the area at the base of the windscreen and that this area is struck by the heads of other road users on being impacted by the front of the car.

APPENDIX 7:

ADELAIDE IN-DEPTH ACCIDENT STUDY, 1975-1979

PART 7: ROAD AND TRAFFIC FACTORS

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ABSTRACT

This report contains a review of those features of the road and traffic environment that were relevant to the causation or consequences of the accidents in a representative sample of accidents to which an ambulance was called in metropolitan Adelaide. The review is presented in the context of descriptions of the accidents in order to demonstrate the interactions between road and traffic factors and those relating to the vehicles and to the road users. Infringement of a traffic rule was the most common factor but this was often more a description of what happened rather than an adequate explanation.

Excessive speed was also a prominent factor, even though the actual speed may have been below the legal limit, in collisions at sign-controlled and uncontrolled intersections. Safe approach speeds to uncontrolled intersections were such that a strong case can be made for the provision of some form of control. Fail-to-stand accidents were the most common type of collision at signalised locations, with auxiliary kerb lanes appearing to exacerbate the problem. Characteristics of the road surface were rarely relevant, possibly because the surface was generally dry and of good quality. Roadside objects played a role in determining the consequences of about one-third of the accidents.

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INTRODUCTION

A sample of accidents to which an ambulance was called in the Adelaide metropolitan area was investigated at the scene by multi-disciplinary teams from the Road Accident Research Unit of the University of Adelaide. This survey, which ran for twelve months from 23 March, 1976, was sponsored by the Commonwealth Department of Transport and the Australian Road Research Board. Each accident was studied by an engineer, a psychologist and a medical officer. Their observations at the scene started an average of ten minutes after the ambulance was called and were supplemented by further investigations including interviews with the drivers and other active participants (pedestrians and cyclists), detailed examination of the accident site and observation of traffic behaviour at the same time of day as the accident. The injured persons were examined and interviewed in hospital and the vehicles were inspected in towing service depots and elsewhere.

An eight per cent sample, totalling 304 accidents, was obtained of all road accidents as defined above. The sample was representative of this accident population by time of day and day of week. The purpose of this survey, the sampling

technique and the method of investigation are described in detail in another report in this series (Part 1: An Overview) together with a review of the types of accidents investigated and an outline of the general conclusions.

This report contains detailed descriptions of most of these accidents, classified as listed in Section 2.1. A discussion of the relevance of road and traffic factors follows each Section. Pedestrian accidents are described in Report No.2 of this series (McLean, Brewer and Sandow, 1979a) and the reader is referred also to the discussion of road and traffic factors in Chapter 6 of that Report. The inclusion of the accident descriptions in the main text, rather than as appendices, has been done to emphasise the many factors that can play a role in accident causation and to try to place road and traffic factors in the correct overall context. The final Chapter represents an attempt to draw together the comments on the relevance of road and traffic factors and to list their relative importance in determining the causation and consequences of the accidents studied. Recommendations based on the findings of the study are included in Chapter 8.

TABLE 8.1: ROAD AND TRAFFIC FACTORS IN ACCIDENT CAUSATION¹

<u>Road or Traffic Factor</u>	<u>Relevant to Accident Causation</u>	
	<u>Yes or Probably</u>	<u>Possibly</u>
Traffic rules : priority	54% ²	2%
other	15	-
Traffic flow characteristics	19	5
Traffic control devices : signals	2	4
signs	2	1
geometric	1	-
road markings	0 ⁴	1
absence of control ³	17	1
Road layout : in general area	0	1
at accident site	3	3
Road surface	2	-
Road works	0	-
Parked vehicles	10	1
Roadside : between property boundaries	4	12
Artificial lighting	5	4

Notes: ¹ Some of the percentages listed here differ from those in a similar listing in Report No. 1 of this series (Table 14) for the reasons noted in the text.

² Percentage of 304 accidents.

³ Refers to uncontrolled intersections.

⁴ Percentage is greater than zero (shown "-" but less than 0.5)

(More than one of the listed factors may have been relevant in a given accident.)

RELEVANCE OF ROAD AND TRAFFIC FACTORS

8.1 ASSESSMENT OF RELEVANCE

In the Introduction it was noted that the inclusion of the accident descriptions in the main text has been done to emphasise the many factors that can play a role in accident causation and to try to place road and traffic factors in the correct overall context. This multi-factorial nature of accident causation means that it is rarely possible to state that a given factor was the most important, let alone the only, one in a particular accident. Consequently, in the assessment of the relevance of road and traffic factors the categories of "yes", "probable" "possible" and "no" have been used in an attempt to rate the probability that a factor contributed to the causation of an accident.

Table 14 of the overview report in this series (McLean and Robinson, 1979) contains a summary of the relevance of road and traffic factors in the causation of the accidents covered by the study. A similar Table is repeated here (Table 8.1) but some of the percentages listed differ from those of Table 14. This is because Table 14 was drawn up during the initial data processing stage of the study. Since then the relative importance of various factors in specific accidents has been more clearly understood as a result of continuing analysis of the data. The criteria for the assessment of relevance to accident causation has also changed, having become somewhat more stringent in most cases.

Any general summary of the relevance of road and traffic factors to accident causation, as in Table 8.1, cannot allow for the fact that the contribution made by a particular factor may vary according to the type of accident or the circumstances under which the accident occurs. For example, the width of the road can be relevant because it is too narrow, as in Accident 026 (see Figure 5 of Report No.2; McLean, Brewer and Sandow, 1979a) in which pedestrians standing in the middle of the road were struck by a car that was forced across to the right by the car alongside it also moving across to pass a parked car, or because the road is too wide, as in Accident 166 (see Figure 3 of Report No.2) in which a pedestrian was struck by a car that was not in sight when the pedestrian started to cross the roadway.

Because of the way in which the nature of the relevance of a factor may vary according to the circumstances of the accident it is not meaningful to state that, for example, wide roads are safer, or more hazardous, without relating the statement to a certain type of accident at a certain type of location. The

relevance of road and traffic factors has been discussed in this Report in relation to specific types of accidents for this reason, as well as for the reason noted earlier in this Section. The Chapter therefore is not intended to be a general discussion of the relevance of road and traffic factors that can be read in isolation but rather as a means of drawing together, and referring back to, the comments that have been made earlier in the Report.

Road and traffic factors relevant to the causation of pedestrian accidents are included in Table 8.1 but are discussed in Chapter 6 of Report No.1 (McLean, Brewer and Sandow, 1979a).

8.2 TRAFFIC RULES

Traffic rules, or the infringement of a traffic rule, remain the most commonly-occurring traffic factor in the causation of the accidents. This does not necessarily mean that 69 per cent (see Table 8.1) of these accidents would have been prevented if all of the erring drivers were to learn the road rules and be encouraged to obey them. The record of infringement of a priority rule, for example, often is a description of what happened rather than an explanation. As is emphasised in Chapter 5, most of the collisions at uncontrolled intersections were a consequence of the failure of one of the drivers to yield but by the time that he was able to see the other vehicle it was already too late to do so and a collision was inevitable. The discussion of this topic is continued in Section 8.4.5.

At sign-controlled intersections collisions more often resulted from a driver, having stopped at the STOP sign, then moving off into the path of an approaching vehicle even though the driver was aware of the presence of that vehicle. It seems likely that, in many cases, the approaching vehicle was speeding (see Section 6.7). The driver at the STOP sign may be aware of the requirement to yield to the approaching vehicle but if he greatly underestimates its speed a collision can result.

For reasons such as these travelling at a speed in excess of the legal limit or, possibly of more consequence, greater than that which is customary, can be particularly hazardous (much lower, legal speeds can also be hazardous, as noted in Section 5.3). The risks involved relate not simply to the driver's ability to control his vehicle, although there were some accidents that derived from that, but from the mistakes made by other road users when they fail to see the speeding vehicle or, seeing it approaching, misjudge its speed. The

enforcement of the legal speed limit can be supported as an activity of considerable potential value, the potential being dependent on the effectiveness of the procedures used.

8.3 TRAFFIC FLOW CHARACTERISTICS

Traffic banked up at traffic signals, behind a bus at a bus stop or a car waiting to complete a right turn was a major factor in the causation of 20 accidents (or about seven per cent). Most of these accidents occurred at sign-controlled T-junctions (see Sections 6.2.1 and 6.6.1) with some at uncontrolled intersections (Section 5.2.1) and others involving pedestrians at midblock locations (Report No.2, McLean, Brewer and Sandow, 1979a). In many instances a driver had deliberately left a gap in the queue so that another vehicle could enter, or exit from the side road. Having left the gap it was then common for that driver to wave the waiting driver across, without realizing that a third vehicle was about to overtake.

This situation has several implications for traffic engineering and road design. At locations where it can be predicted that queues of stationary vehicles are likely to form, such as at traffic signals on busy roads, steps should be taken to prevent turning movements across the queue. This may be able to be achieved by the installation of a raised median strip, by closing the stem of a T-junction, or, less effectively, by prohibiting turning movements. If none of these countermeasures can be adopted then there are good reasons not to attempt to keep the junction open for turning traffic by means of pavement messages saying KEEP CLEAR. Encouraging drivers to create gaps in a queue of traffic is one way to set up the conditions for accidents of the type referred to here.

The regulation of pedestrian movements through queues of stationary traffic may be very difficult because the pedestrians who do so may be in a hurry and careless, based on the relatively few accidents of this type in the study. There may be some locations where physical barriers can be used, such as along a median strip, to direct pedestrians to controlled crosswalks.

Accidents involving gaps in queues of stationary traffic are unusual in that, even though they may involve careless pedestrians, none of the drivers involved in vehicular collisions of this type was intoxicated. This suggests that the possibilities for success in reducing the frequency of such collisions may be greater than for, say, collisions with utility poles which frequently are a consequence of impaired driving due to alcohol intoxication.

8.4 TRAFFIC CONTROL DEVICES

8.4.1 TRAFFIC SIGNALS

Fail-to-Stand Accidents

The most common type of accident at traffic signals was a collision between an oncoming vehicle and one turning right. The various factors that appear to be important in the causation of these collisions are discussed in Section 7.3. Despite the relatively high frequency of collisions of this type in the study there were not enough accidents to enable us to investigate, on a statistical basis, the role of measures such as offset right turn lanes. Nevertheless, the impressions gained in the investigation of these accidents and in repeated visits to many of the accident sites to observe driver behaviour do suggest that measures that improve the view that the turning driver has of oncoming traffic are likely to reduce the frequency of this type of collision. Simpson (1973) in his thorough analysis of police reports of these accidents, was unable to show any benefit from offset right turn lanes. This may have been a consequence of incomplete reporting of the presence of opposing right-turning vehicles. He did note that the greater the number of through lanes the greater the risk of these collisions. This is consistent with our observation of the hazards associated with auxiliary through lanes at signalised intersections (see below under Section 8.5.2). The seriousness of this problem of fail-to-stand accidents at traffic signals is indicated by the severity of their consequences, described in Section 7.3.8. Right turn phases or prohibition of right turns both have undesirable consequences in terms of delays and rerouting of traffic but there is much that should be unacceptable in the existing situation at many signalised intersections.

Duration of the All-Red Phase

Accidents 107 and 127 (Section 7.2.4) indicate that the phasing of traffic signals may not be adequate for the geometry of the intersection. Calculation of adequate phasing is a relatively straightforward matter but the consequences of under-estimation of the necessary duration of the all-red phase can be considerable.

Inoperative and Flashing Yellow Signals

Two accidents were largely a consequence of an inoperative signal installation in one instance and flashing yellow operation in the other. They are discussed in Section 7.2.1 where it is suggested that changes and additions be made to the relevant sections of the Australian Standard Manual of Uniform Traffic Control Devices. The lack of any reference to procedures to be followed to ensure the safety of traffic negotiating an inoperative signal installation is a serious deficiency in the Manual.

8.4.2 TRAFFIC SIGNS

The STOP sign was the regulatory sign in 15 of the 29 accidents studied in which such a sign was relevant but there were only two accidents in which a driver failed to stop. These two accidents are described in Section 6.3.2. In one (Accident 053) we were unable to interview the driver and so we do not know whether or not he was familiar with the area and knew that the STOP sign was there. In the other accident the driver's familiarity with the area as it had been some time previously contributed to his failure to observe the sign, which had been recently installed.

Two other accidents were at least partially a consequence of a driver turning right suddenly on reading the name of a street on a street sign that was difficult to read in one accident (105, Section 5.2.1) and difficult to detect in another (Accident 232, Section 6.6.3). The signs involved were of customary design which suggests that there may be value in an investigation of ways in which the legibility of street name signs can be improved.

8.4.3 GEOMETRIC TRAFFIC CONTROL DEVICES

In Accident 254 a driver was able to approach a roundabout, with the expectation of negotiating it, at a speed that gave him insufficient time to avoid a collision with a cyclist who entered the intersection on his right. As noted in Section 6.5, a change in the dimensions of the roundabout may have reduced the severity of this collision, if not prevented it, by reducing the approach speed of the car.

Two other accidents (066, 167) occurred at intersections where the driver's view of the other vehicle was restricted by bushes on the median in one accident (167, Section 6.3.2), and by a chain-wire fence and bushes on the median in the other (Accident 066, Section 7.3.6). Both intersections and the divided roads were well lit and so the need for a glare screen was not great. The restricted visibility was a major factor in the causation of these two accidents.

8.4.4 ROAD MARKINGS

Although very few of the accidents occurred on wet roads there were two in which the driver commented on the fact that they had not been able to see the painted lane markings on the wet road. One driver allowed her car to veer to the left and crash into a parked car (Accident 179, Sections 3.2.3 and 3.2.8), the other drove off from a signalised intersection on the wrong side of the centreline and hit a pedestrian who was standing in the centre of the road (Accident 144, Report No.2, Section 6.1; McLean, Brewer and Sandow, 1979a)

The skid resistance of painted road markings may possibly have been a factor in Accident 010, in which a motorcyclist fell from his machine on the approach to a signalised intersection, the skid starting on a painted arrow on a dry road. However, as mentioned in Section 3.6.3 the reasons for the rider losing control are not known.

8.4.5 ABSENCE OF A TRAFFIC CONTROL DEVICE

The absence of some form of traffic control at uncontrolled intersections was one of the major factors in the causation of the accidents in the study. This topic is discussed in Chapter 5 (in detail in Section 5.3) and all that will be repeated here is the conclusion that the basic philosophy underlying the warrants for the provision of controls at intersections is undesirable and that, in a metropolitan area, intersections should not be uncontrolled.

8.5 ROAD LAYOUT

8.5.1 ROAD LAYOUT IN THE GENERAL AREA

At one location a driver said that he thought that the intersecting road was controlled by a STOP sign because an earlier intersection had been (Accident 009). Two other uncontrolled intersections appeared to two drivers to be of minor importance because they were not marked with cross road warning signs whereas the preceding intersection had been in each case (207 and 220). These examples relate as much to signing practices as to the general area road layout but they do draw attention to the desirability of viewing an area as a whole when considering the adoption of any traffic control measure, no matter how isolated the particular problem might be.

8.5.2 ROAD LAYOUT AT THE ACCIDENT SITE

Auxiliary kerb lanes or lanes that were not continuous on the far side of signalised intersections played an important role in six fail-to-stand accidents, as described in Section 7.3, and in one rear-end collision (Section 4.2.1). These accidents showed that the auxiliary lane is used as a passing lane. As such, a driver attempting to turn right from the opposing traffic stream has the doubly-difficult task of detecting the presence of a rapidly-moving (because it is overtaking) vehicle that is concealed behind two or more lanes of stationary or slowly-moving vehicles. This increases the risk of a collision occurring and, because of the speed of the through vehicle, it also tends to increase the severity of the crash. Fail-to-stand accidents are the major accident problem at signalised intersections, a problem that to some extent is exacerbated by signalisation (see Simpson, 1973). It therefore seems to be reasonable to

suggest that safety should not be degraded by introducing auxiliary lanes to increase the capacity of an intersection.

The road layout played a role in the causation of two pedestrian accidents (144 and 166). These accidents are described in Section 2.1 of Report No.2 (see Figures 4 and 6) in this series (McLean, Brewer and Sandow, 1979a). In Accident 144 the road layout, as defined by the lane markings at a signalised intersection, led a driver to depart from the intersection on the wrong side of the centreline (as noted in Section 8.4.4 above). In Accident 166 a four-lane one-way road around a city square has a sight-distance such that a pedestrian can step off the footpath when no vehicles are in sight and yet not be able to walk to the other side of the road before a car reaches him.

In several other accidents some aspect of the road layout at the accident site played a role but rarely in such a way as to be of certain or even probable significance in the causation of the accident.

8.6 ROAD SURFACE

The characteristics of the road surface contributed to the rider or driver losing control of his vehicle in five accidents and distracted a pedal cyclist in one other. Again it should be noted that this study was based almost entirely on dry-road accidents by virtue of the weather conditions in Adelaide. Only 13 of the 304 accidents occurred when it was raining and the road surface was damp in only a further nine cases.

A motorcyclist fell from his machine when the stand caught on a manhole cover in Accident 113 (Section 3.5.1). The stand was lower than usual because of the weight of a pillion passenger but the major contributing factor was the zeal with which the rider attempted to negotiate a curve.

A motor scooter rider fell off when, on a test ride, his machine hit a pot hole in a residential street (Accident 203, Section 3.7.2) and two car drivers lost control when, in one accident (163, Section 3.3.2) swerving to pass a car on the irregular surface of a level crossing and in another (Accident 168, Section 3.6.2) encountering loose sand on an S-bend in a 25 km/h zone.

An intoxicated driver veered off a straight road into a tree at a point where camber changes due to a junction with a side road will lead a vehicle onto that collision path if the steering is not corrected (Accident 019, Section 3.4.1 and Figure 3.29).

The cyclist who paid more attention to the rough edge of the pavement adjacent to a concrete gutter than to the traffic ahead of him was involved in a collision with a car in Accident 284

(Section 4.2.4).

Spoon drains affected the speeds with which a vehicle approached an uncontrolled intersection (Sections 5.3.5 and 5.4.2) and also may have distracted the driver (Section 5.4.3). Accident 267 occurred when the tailgate of a station wagon came open as the car crossed a spoon drain (Section 3.7.5).

In summary, even allowing for the dry weather in which the study was conducted, the characteristics of the road surface were rarely relevant to the causation of any of the accidents. This is an indication more of the generally high quality of the road surfaces in the Adelaide metropolitan area than of the potential contribution of this factor to accident causation.

8.7 ROAD WORKS

Apart from the work being performed at the inoperative signal installation in Accident 210 (see Section 8.4.1) there was only one accident (155, Section 3.6.5) in which road works played a role. In that accident an intoxicated motorcyclist rode through a warning barrier at a road closure. This one case is not, of course, statistical evidence of any association between intoxicated road users and this type of accident but it is similar in some respects to other alcohol-related crashes. This suggests that the likely effectiveness of road works warning barriers should be assessed on the basis of knowledge of the relevant effects of alcohol on the perception of and reaction to such warning devices.

8.8 PARKED VEHICLES

The 19 accidents that were collisions with parked vehicles are the most direct example of the relevance of these vehicles to accident causation. In other respects parked vehicles played a role as obstructions to vision, particularly in pedestrian accidents involving children. Two accidents at sign-controlled intersections (063, Section 6.2.1 and 089, Section 6.3.1) and one at an exit from a shopping centre parking lot (092, Section 4.2.6) may not have happened had parked vehicles not obstructed the operators' view of the approaching vehicle. The importance of the visual restriction associated with vehicles parked near uncontrolled intersections was more difficult to assess because it is possible that the collisions would still have occurred had they not been there.

8.9 ROADSIDE : BETWEEN PROPERTY BOUNDARIES

In Table 14 of Report No.1 (McLean and Robinson, 1979) in this series (see note ¹ to Table 8.1) the likely role of the roadside on or beyond property boundaries was listed. This item is not included here because it is essentially descriptive unless we are to argue that our metropolitan

environment should be adapted to the needs of the road system rather than vice versa. The characteristics of the roadside between property boundaries, while fulfilling many roles, can justifiably be changed to reduce certain traffic hazards should the need be demonstrated.

In the accidents studied, objects as diverse as telephone booths, a verandah (that obscured a street name sign) and trees and shrubs were each thought to have played a causal role on one or more occasions. Overall there were eleven accidents in which the restricted visibility probably contributed to the occurrence of the accident and just over three times that number in which the visual restriction possibly could have been a factor. Of the eleven probable cases, removal of the object may have prevented perhaps four or five accidents, there being other factors operating in all eleven accidents. In many locations realignment of the kerb to narrow the carriageway may be as effective as removal of the object that restricts a driver's field of view.

8.10 ARTIFICIAL LIGHTING

The quality of the illumination provided by the artificial lighting was a certain or probable factor in the causation of 15 accidents and possibly a factor in a further eleven.

The ways in which the street lighting was important ranged from a virtual absence of any illumination of a parked car, either direct or in silhouette, on a street lit by tubular fluorescent lamps (eg: Accident 008, Section 3.2.8) to the same type of lamp giving a misleading indication of the alignment of the through road at a Y-junction in which one of the exists was a no through road (Accident 293, Section 3.6.1). Even roads lit by sodium vapour lamps were not always well illuminated because of the large distances between the lamps (more than 70 metres in some installations). This wide spacing of the lamps results in brightly lit sections of roadway alternating with sections that are, by comparison, poorly lit (although often better illuminated than adjoining side streets). Accident 097, in which a driver did not see a stationary car in his path and Accident 188, in which a car reversed onto a road into the path of an approaching car, both occurred midway between widely-spaced sodium vapour lamps. These two accidents are discussed in Sections 4.2.1 and 4.2.6.

Compared to most of the other factors discussed in this Section, artificial lighting is particularly closely associated with intoxicated drivers. Six of the 15 drivers whose performance was affected by poor quality artificial illumination were intoxicated as were five of the eleven drivers whose performance may have been affected. This suggests that the assessment of the likely hazards associated with

poor quality artificial lighting should be made on the assumption that the drivers involved are likely to be intoxicated.

8.11 RELEVANCE OF ROAD AND TRAFFIC FACTORS TO THE CONSEQUENCES OF THE ACCIDENT

Table 8.2 shows the frequency with which the listed items were relevant to the consequences of the accident.

Objects at the roadside were the category most often relevant to the consequences of the accident and of those objects collisions with utility poles were both the most frequent and the most damaging. Eleven per cent of the accidents involved a collision with a utility pole as either the initial or as a secondary event. The probability of a secondary collision of this type occurring was related to the impact geometry, with secondary collisions being more likely to occur following an intersection collision than one midblock, and to the speeds of the vehicles in the initial collision. Collisions with utility poles as the initial impact were strongly alcohol-related as were initial collisions with parked cars. Possible ways to minimize the frequency of occurrence of collisions with roadside objects and with parked cars are discussed in Section 3.

Geometric traffic control devices affected the consequences of the accident when a motorcyclist fell from his machine on the approach to a roundabout and then struck the kerb of the roundabout while sliding along the road. The other accidents in this category were of a similar nature.

8.12 SUMMARY : RELEVANCE OF ROAD AND TRAFFIC FACTORS

One or more factors related to the road and traffic characteristics were relevant to the causation of approximately 40 per cent of the accidents studied. These are the accidents in which the contribution of the road or traffic factor to the causation of the accident was certain or probable. As shown in Table 8.1, these factors may possibly have played a role in about one third of the accidents (this third overlapping the above-noted 40 per cent to some extent). It is important to realize, however, that it was most exceptional for an accident to be attributed to one causal factor. Other factors, such as alcohol intoxication and inexperience in driving, were almost always present.

The figure of 40 per cent does not include accidents at uncontrolled intersections for which the absence of a traffic control device was listed as a causal factor in 17 per cent of all of the 304 accidents. This means that, with this wider definition of road and traffic factors, they played a causal role in at least half of the accidents.

TABLE 8.2: ROAD AND TRAFFIC FACTORS IN THE CONSEQUENCES OF THESE ACCIDENTS

<u>Road or Traffic Factor</u>	<u>Relevant to Accident Consequences</u>	
	<u>Yes or Probably</u>	<u>Possibly</u>
Roadside : on or beyond property boundaries	9% ¹	-
Between property boundaries	20	0 ²
(utility pole)	(11)	-
(road sign)	(5)	(0) ²
(signal installation)	(1)	-
Road layout at accident site	3	1
Geometric traffic control	2	0 ²
Road surface	1	1
Road works	0 ²	-
Parked vehicles	8	-

Notes: ¹ Percentage of 304 accidents.

² Percentage is greater than zero but less than 0.5.
(More than one of the listed factors may have been relevant in a given accident.)

As shown in Table 8.2, a road or traffic factor other than an object on or beyond property boundaries was relevant to the

consequences of about one-third of the accidents in the study.

APPENDIX 8:

ADELAIDE IN-DEPTH ACCIDENT STUDY, 1975-1979

PART 9: ACCIDENT DESCRIPTIONS AND SCALE PLANS

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ABSTRACT

This report contains written and diagrammatic descriptions of accidents reported in an in-depth study of road accidents to which an ambulance was called in the

metropolitan area of Adelaide, South Australia. A representative 8% sample, comprising 304 accidents, was investigated in the 12 month period commencing March 1976.

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INTRODUCTION

A sample of road accidents to which an ambulance was called in the Adelaide metropolitan area was investigated at the scene by multi-disciplinary teams from the Road Accident Research Unit of the University of Adelaide. This survey, which ran for twelve months from 23 March 1976, was sponsored by the Office of Road Safety of the Commonwealth Department of Transport and the Australian Road Research Board. Each accident was studied by an engineer, a psychologist and a medical officer. Their observations at the scene started an average of ten minutes after the ambulance was called and were supplemented by further investigations including interviews with the drivers and other active participants (pedestrians and cyclists), detailed observation of traffic behaviour at the accident site and examination of the injured persons in hospital and the vehicles in towing service depots and elsewhere.

An eight per cent sample, totalling 304 accidents, was obtained of all road accidents as defined above. The sample was representative of this accident population by time of day and day of week. The purpose of this survey, the sampling technique and the method of investigation are described in detail in another report in this series together with a review of the types of accidents investigated and an outline of the general conclusions. This report contains a summary and scale plan for each of the 304 accidents. An attempt has been made to ensure that this information is self-explanatory although the following comments may be of value.

The appendix contains a legend which explains the symbols used on the plans. Each traffic unit (vehicle or pedestrian) that was physically involved in the

accident has been assigned a unit number, which matches the unit number in the coded data. On the scale plan the sequence of events is indicated by the subscripts to the unit numbers. Whenever the final rest position of a traffic unit was not known it is not shown on the plan. Unless there is a note to the contrary on a plan (e.g. Accident 25) the speed limit was 60 km/h.

The traffic signal arrows indicate the direction of the traffic light installations relevant to the accident. They do not all indicate the direction of the green signal (e.g. Accident 4).

Blood alcohol (BAC) readings are listed in the summary for each of the active participants (driver, rider, pedestrian) for whom a reading was available. Those for whom no BAC reading is listed were generally thought not to have been drinking but there was evidence that at least nine of these drivers were intoxicated and they are mentioned in the summaries of accidents 29, 33, 36, 120, 233 (2 drivers), 252, 272 and 303. The Road Accident Research Unit Vehicle Damage Index, 'RARU-VDI' (McLean 1975) is given for all cars which sustained measurable damage from first and subsequent impacts. This index is not the commonly used Society of Automotive Engineers Vehicle Damage Index, 'SAE-VDI' (-, 1972), but rather, a modified version which is described in the introduction to the Data and Data Codes Report, a companion volume in this series. The SAE-VDI is used to describe damage to trucks. A VDI is not given for motorcycles since its relationship to injury levels is unclear.

The 304 accidents are numbered from 1 to 305, with the number 141 not being assigned to any accident.

APPENDIX 9:

ADELAIDE IN-DEPTH ACCIDENT STUDY, 1975-1979

PART 10: DATA AND DATA CODES

ABSTRACT

This report contains the coded data collected during an in-depth study of road accidents to which an ambulance was called in the metropolitan area of Adelaide, South Australia, along with a list of the codes used to classify the data. The

coded data is in the form of microfiche attached to the report. A representative 8% sample, comprising 304 accidents, was investigated in the 12 month period commencing 23rd March 1976.

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INTRODUCTION

A sample of road accidents to which an ambulance was called in the Adelaide metropolitan area was investigated at the scene by multi-disciplinary teams from the Road Accident Research Unit of the University of Adelaide. This survey, which ran for twelve months from 23 March 1976, was sponsored by the Office of Road Safety of the Commonwealth Department of Transport and the Australian Road Research Board. Each accident was studied by an engineer, a psychologist and a medical officer. Their observations at the scene started an average of ten minutes after the ambulance was called and were supplemented by further investigations including interviews with the drivers and other active participants (pedestrians and cyclists), detailed observation of traffic behaviour at the accident site and examination of the injured persons in hospital and of the vehicles in towing service depots and elsewhere.

An eight per cent sample, totalling 304 accidents, was obtained of all road accidents as defined above. The sample

was representative of this accident population by time of day and day of week. The purpose of this survey, the sampling technique and the method of investigation are described in detail in another report in this series together with a review of the types of accidents investigated and an outline of the general conclusions. This report contains a list of the codes used to classify the data collected during this study. Seven data codes were developed and these are described in the following section. The data was collected on field coding forms and transferred to computer using the codes listed in this report.

This report also contains diagrams of the traffic unit movement codes used and an explanation of the Modified Vehicle Damage Index (McLean, 1975).

The coded data is presented in the form of microfiche attached to this report.

