Development of techniques for studying unsafe driving actions

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The abstracts and keywords on this page are provided in the interests of improved information retrieval. Each reference card is designed so that it can be cut out and incorporated in the reader's own file.

Keywords, unless carrying an asterisk, are from the 'International Road Research Documentation [IRRD] Thesaurus, 1985'.

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ABSTRACT : This study investigates techniques for studying the incidence of unsafe driving actions (UDAs) in both the accident and normal driving population in an attempt to develop an overall plan for measuring relative crash risks of UDAs. Stage 1 re-analysed the Adelaide in-depth study (McLean et al. 1979) coding driver behaviour with definitions from previous studies. During this procedure it became apparent that an improved system for assigning UDAs was required. This led to the development of a flow chart technique which was found to be both reliable and sufficiently detailed. Stage 2 applied the flow chart technique to police crash report forms. This resulted in too many 'unknown' responses to flow chart decisions. A pilot study suggests that additional information held at Police Headquarters may be the most successful way to re-attempt Stage 2. Stage 3 piloted several techniques for observing UDAs in the normal driving population.

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EXECUTIVE SUMMARY

The aim of the study was to identify the driving behaviours most frequently associated with road crashes, and to assess the feasibility of observing how frequently they occurred in the course of normal driving. This would provide a list of unsafe driving behaviours which would need to be considered for enforcement countermeasures, and would determine whether it would be possible to determine relative crash risks of the most frequent unsafe behaviours.

Stage 1 involved gaining information on unsafe behaviour from previous studies. This consisted of a re-examination of the Adelaide in-depth study (McLean *et al.* 1979), using the behavioural definitions from earlier studies. By applying the definitions used in previous studies in parallel, it was hoped to gain insight into any difference in the methods of these investigations. During this procedure it became apparent that an improved system for assigning unsafe driving actions could be developed.

A flow chart was designed which required much less cognitive processing by the coder, because it presented simple questions in a systematic order. This led to high reliability between coders. In addition, grouping of flow chart decisions allowed a useful comparison with error categories used in other studies and revealed consistent results.

The objective of Stage 2 was to determine the frequency of unsafe driving actions in a representative sample of crashes from Victoria and South Australia. Two independent coders coded a sample of crash reports using the flow chart technique. This resulted in too many 'unknown' responses to flow chart decisions.

It was not clear whether the high proportion of 'unknown' responses was due to the coders being too cautious or whether there was insuffcient information on the crash forms. After completion of Stage 2 it was discovered that extra statements held at Police Headquarters might be suitable for further investigation. Two pilot studies were undertaken to determine whether this information would be useful and whether it would be superior to using a more lenient approach with the original crash forms. The additional Police statements were found to have much greater detail, and analysis of these was far superior to the other methods. It is recommended that future work in this area include a second attempt at Stage 2 using this extra information.

In Stage 3, techniques for observing the incidence of unsafe behaviours were piloted. An efficient coding system for recording conflicts at intersections was developed through pilot work, and observations were backed up by video recording of events. Video records proved to be useful for analysing traffic parameters such as speed and headway. No reliable relationship between events observed in the field and events observed on the video record could be discerned. A technique involving observation of incidents from a moving vehicle was also piloted.

Several options for future work have been outlined. These are: (a) to complete the process of applying the flow chart analysis to existing data, supplementing it with information from police statements; (b) to extend this process by comparing crash records with detailed information about traffic movements available from co-ordinated signal systems; (c) to conduct an enforcement-oriented study, using stationary observation of traffic; (d) to conduct an education-orientated study, using the car-following technique; and (e) some combination of these.

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CHAPTER 1:
INTRODUCTION

P.T. Cairney & K.D. Charlesworth

1.1 THE ROLE OF ROAD USER FACTORS IN CRASHES

For a long time now, there has been evidence to suggest that most traffic crashes are brought about by deficiencies in the conduct or abilities of road users, rather than deficiencies in vehicles or road infrastructure. In one of the earliest studies of this type, an analysis of the 'causes' of crashes in London in 1935 by the Metropolitan Police attributed 88 per cent of crashes to 'human failure', 4.9 per cent to vehicle defects and other vehicle causes, and a mere 1.6 per cent to defective roads (Tripp 1938). Despite radical changes to traffic composition, road systems and vehicle characteristics, more recent studies have produced remarkably similar estimates of the involvement of human factors in crash causation. Sabey and Staughton (1975) estimated that approximately 65 per cent of the crahes they studied were attributable to human factors alone, while a further 30 per cent involved human factors in combination with vehicle or road factors. Thus 95 per cent of the total involved driver factors in some way. A contemporaneous study carried out in the U.S. (Treat *et al.* 1979) produced very similar estimates. The corresponding figures were: crashes involving driver factors alone, 57 per cent, and those involving driver factors in combination with road and vehicle factors, 36 per cent, making a total of 93 per cent involving road user factors.

What are the implications of findings such as these for road safety? One approach which received a lot of early attention was to identify drivers with a particularly high crash involvement with a view to removing them from the driving population or directing them towards remedial programs. Thus began the tradition of studies of the 'accident prone' driver. Studies recently reviewed by McKenna (1983) have shown that it is very difficult to characterise individuals as 'accident prone', although it is possible to identify particular groups in the community as having high crash involvement. Tripp (1938) accepted that drivers particularly likely to be involved in crashes were unlikely to be identified with any certainty by means of psychological tests : this view has been confirmed over the intervening half century. Multiple crash involvement does not vary greatly from what statistical theory would predict, given that all individuals have an equal chance of crashing in a given time period. While a few individuals may account for a disproportionate number of crashes, the total proportion of crashes they account for is small. Thus the potential gains from exclusion or remediation of 'accident-prone' drivers are small.

A general consensus has emerged that the most appropriate way to reduce crash losses is to create a road and traffic system which takes better account of the characteristics and limitations of the human participants in the system, and whose mobility needs the system serves. Three approaches to system modification are generally considered: engineering, enforcement and education.

Past successful interventions to promote safety have been rather specific, and have dealt with obvious problems. For example, drink-driving countermeasures have been effective in reducing the number of impaired drivers on the road, and the development and mandatory use of occupant restraints has greatly enhanced occupant protection during crashes. Future gains are likely to be more difficult to achieve.

Effective intervention by any of these three approaches depends on a thorough understanding of the problems which lead to a lack of safety. Just to state that approximately 95 per cent of crashes are related to road user factors is not in itself particularly helpful. Information is required about the nature of the failures and the relative frequency of their occurrence. Although system failures may be attributed to 'human' factors, it is entirely possible that many of these failures may be eliminated by improvements to the road and its immediate environment, by such means as improving sight distances or delineation, for example. Failures which are not amenable to engineering may be addressed either through a change to enforcement practices, which changes the consequences of undesirable behaviour, or through changes to the system of driver training or continuing driver education, providing information which will motivate changes in driving behaviour.

A rational program of interventions would depend on two types of information: how often a particular behaviour is associated with a crash, and how often that particular behaviour occurs in the course of normal driving. Knowing how often a particular behaviour is associated with a crash provides a list of priority behaviours which must be addressed, and answers the question, 'Which behaviours are worth doing something about ?'

Knowledge of how often these behaviours occur in the course of normal driving allows estimates to be made of the risk associated with manoeuvres. Behaviours which are associated with crashes and which occur frequently in the course of normal driving are low-risk behaviours, in that the probability of that behaviour resulting in a crash on any particular occasion is low. On the other hand, behaviours which are associated with crashes but which occur rarely in the course of normal driving are high-risk behaviours, since the probability of a crash resulting from that behaviour is high on any particular occasion when it occurs. Such information is important when it comes to deciding what to do about crash-associated behaviours. For example, if high-risk behaviours occur very infrequently in the course of normal driving, then it is probably not feasible to address the problem through enforcement, unless specific detection techniques can be devised. On the other hand, it would seem that such situations would be worth emphasising in the course of driver education. If the risk associated with common traffic violations is sufficiently low, then they are probably not worth emphasising as an enforcement priority. High- and moderate-risk behaviors which occur frequently ought to be given priority for enforcement activity.

The aims of the present project were to provide a definite answer to the first of these questions, 'Which behaviours should we be doing something about ?', and to examine the feasibility of conducting the observational studies which would allow the computation of the risk associated with these different behaviours. When compiled, these risk estimates would help answer the second question,'What should we be doing to eliminate these undesirable behaviours ?'

1.2 METHODS FOR IDENTIFYING CRASH-RELATED BEHAVIOURS

There are a number of different methods for identifying which driver behaviours are crash-related.

Most jurisdictions maintain systematic records of traffic crashes which are easily accessible. These records differ between jurisdictions with respect to reporting criteria (e.g. injury only v. a specified property damage threshold), and the amount of data they contain about pre-crash manoeuvres. In general, Australian jurisdictions have very detailed information available concerning pre-crash manoeuvres. The data from Victoria analysed in the present study are particularly useful in that crash patterns are described by a code for road user movements (RUMs). Mass crash data bases are useful because they contain readily-retrievable information about a great number of crashes. They do, however, have the disadvantages that the information may be sparse, some data may comprise judgments made by non-specialist personnel, and the data may be subject to sytematic biases as well as random error (Cairney 1986). Such data are nevertheless invaluable for providing an overall view of the relative frequency with which particular driving manoeuvres are involved in crashes in different circumstances.

A second source of information about crash-related behaviours is the various in-depth studies which have been carried out over the years. These studies involve detailed reconstruction of the events leading up to a sample of crashes, based on data gathered by the research team on-site soon after the crash occurred. Although the number of crashes systematically examined in such studies is necessarily limited, the data are very detailed and of high reliability, and so are exceptionally useful.

These two approaches rely on identifying crash-related behaviours retrospectively. While they have the advantage of dealing with behaviours which contributed to an actual crash situation, these behaviours are reconstructed after the event. Even with careful reconstruction, some critical aspects of the situation may be missed, or may not be amenable to analysis. For example, Plowden and Hillman (1984) criticised the U.K. in-depth studies on the basis that they underestimated the role of speed in crash causation because no systematic assessment of vehicle speeds was carried out. Alternatively, it may not be possible to reconstruct some events. Some single-vehicle crashes may have been precipitated by another vehicle's position or manoeuvres. If the crashed vehicle's driver does not survive, this would not be known. Finally, events which rely on recall by participants may be consciously or unconsciously distorted, although careful reconciliation of conflicting accounts with known events should minimise this factor.

Both the in-depth studies and the mass crash studies are capable of yielding estimates of how frequently particular behaviours precede a crash, and to this extent they are capable of generating a list of behaviours which should be given priority in countermeasure development. To the extent that crashes studied are representative of all crashes, similar types of behaviours should emerge as priorities from different studies. However, it may be anticipated that accounts in crash reports will deal only with fairly gross behaviour as one of their main functions is to serve as an objective record of events which may be contentious. In-depth studies, on the other hand, are more likely to yield useful information about driver state, about what participants in the situation could and could not see, and about the speed of the vehicles involved.

Crashes are very rare events, so it is not feasible to study them directly. An alternative approach has been to study crash-like situations, either in the car with the driver or unobtrusively from the roadside. These behaviours are more frequent than crashes, so their direct observation is feasible. Two main approaches have been developed: unobtrusive observation of traffic, and in-car observation of driver behaviours. In the first case, drivers are unaware that their behaviour is being monitored and hence may be presumed to be driving normally. When behaviour is studied in-car, the driver is obviously aware that his behaviour is being studied. However, errors characteristic of sites and characteristic of individuals emerge frequently enough for this approach to have considerable face validity (Risk and Shaoul 1979; Quimby and Watts 1981).

The validity of both these techniques assumes that the critical situations being observed are similar to crash situations, except that the crash did not take place. Perhaps the most highly developed rationale for unobtrusive observations of traffic behaviour is associated with the 'traffic conflicts technique'. This emphasises traffic conflicts, or situations where the behaviour of one road user provokes evasive action by another, as the key element in predicting and understanding a large sub-set of crashes. This approach has been thoroughly appraised by Williams (1981), and found wanting. As he points out, conflicts are poor predictors of crashes: even crashes of lesser severity are poor predictors of severe crashes, as they tend to happen at different times and places and to be the outcomes of different manoeuvres. More recent work has demonstrated that disaggregating both conflicts and crashes by movement patterns provides reasonably good prediction (Erke 1984). However, it is true to say that there is as yet no general agreement about the nature of conflicts and crashes (Cairney 1985).

The value of these approaches is that they are capable of yielding estimates of how frequently the behaviours in question occur in the course of normal driving. This information is required before any computation of the relative risk of different driving behaviours can be made. The point was made earlier that this information is necessary before it can be decided how the various priority behaviours should be addressed.

These two methods also differ in terms of the types of data they can offer. In the case of unobtrusive observations, only gross manoeuvres can be observed although, if film or video records are made, it is possible to develop relatively sophisticated indices of this behaviour, such as the margin in space or time by which a collision was avoided. Alternatively, it is possible to train observers to make reliable judgments about the type or severity of conflict observed.

With in-car studies, it is more difficult to obtain objective measures of this type. The advantage of in-car studies is that detailed aspects of driver behaviour may be observed which could not be observed from outside the vehicle, such as search behaviours at critical points or anticipatory gear changes.

The two types of study are therefore suited to producing estimates about how frequently different types of behaviour occur during the course of normal driving. Behaviour recorded in-car is more likely to have implications for driver training, as the behaviour in question usually concerns best practice or recommended procedure. Failure to carry out these procedures can lead to a situation which is unsafe or leads to an offence being committed, or both. On the other hand, unobtrusive observation is likely to detect only fairly gross behaviour, similar to the evidence obtainable for enforcement purposes except that it is collected in a systematic manner. Since only overt behaviour is the subject of most traffic regulations, this type of study is more suited to producing information which is of relevance for enforcement. This situation is complicated further by there being two possible modes of unobtrusive observation, i.e. observation from a stationary position, say at an intersection, or by an observer in a moving vehicle travelling with the traffic stream. The different techniques are likely to detect different behaviours, or to detect similar behaviours with different frequencies.

All these investigation strategies should be capable of yielding information which is useful in identifying traffic engineering deficiencies, although it seems inevitable that the type of deficiency identified will depend upon the technique used.

The present study attempted to integrate in-depth and mass crash studies, and to explore the possibilities of using unobtrusive techniques to estimate the frequency with which these behaviours occur in normal driving. No attempt was made to explore the possibility of using in-car techniques; such a study is currently being carried out as another ARRB project. Previous studies which are especially relevant are reviewed in Section 1.4, with attention to their substantive findings rather than their general principles.

1.3 DEFINITIONS

Some clarification of terminology is necessary at this stage. In particular, it is necessary to distinguish among three terms extensively used in the literature : unsafe driving actions (UDAs), traffic conflicts, and driver error. Lohman *et al.* (1976) refer to UDAs as acts committed with the full intent of the driver. Although they are not explicit about this, they seem to be excluding acts which involve accidental factors such as unexpected loss of control. One difficulty is that many of the acts they accept as UDAs may be committed without the driver being aware of it. Many drivers are unaware of the speed limit which applies (e.g. Cameron 1978), and many of the situations which Lohman *et al.* describe as 'pulling in front' are the results of situations where the driver 'looked but failed to see' (Sabey and Staughton 1975). Intent in many of the UDAs is therefore questionable.

Another way of conceptualising an important class of unsafe behaviours is as traffic conflicts, i.e. situations where the behaviour of one road user requires evasive action on the part of another road user. Situations at intersections, or where lane changing is frequent, typically generate conflicts.

The third term is driver error : errors, such as failure to signal a turn, may not be conscious and may or may not contribute to the development of conflict situations.

The terminology adopted in the present paper, while admittedly still rather loose at this early stage of formulating an approach, has been to use the terms conflict and error as defined above, and to refer to errors with safety implications as UDAs. This deviates from the Lohman *et al.* usage as it does not distinguish between conscious and unconscious actions. The less specific term 'incident' has been used as a synonym for conflict, error, and UDA where more than one term might apply, or it is not possible to decide which term should be used.

1.4 PREVIOUS STUDIES

Much previous work aimed at identifying unsafe driving actions has been carried out overseas, and only one study has been carried out in Australia. These studies are briefly reviewed.

1.4.1 Mass Crash Studies

Despite the fact that a wealth of detail about road user behaviours leading up to crash situations is routinely available in mass crash data bases, this generally seems not to have been analysed from the point of view of identifying the most common unsafe driving actions. The traditional uses of such data bases have been the identification and diagnosis of high-crash locations, the evaluation of legislative and policy changes, and the identification of driver groups with particularly high crash risk. With the linking of crash information to road class (and eventually to road inventory) data bases, and the inclusion of additional information, e.g. relating to driver blood alcohol concentration, new possibilities have been opened up for the analysis of a large number of crash-related variables using large samples of crashes. For example, careful analysis has allowed insights into the extent to which age, driving experience and alcohol are related as crash factors (Charlesworth and South, 1984), and into the components of the driving task which are most affected by alcohol (Johnston 1980). Linking crash and road class data bases has identified the class of road where particular types of crash are most likely to occur (Brindle and Andreassend 1984; Andreassend, Hoque and Young 1984), and identified types of locations, especially junctions and intersections where local roads meet arterial roads, where large proportions of crashes occur (Cairney 1986).

1.4.2 In-Depth Studies

In-depth studies are generally interested in much more than the road user behaviour preceding a crash. Typically, they take into account in-crash factors, such as the role of vehicle and road furniture design in minimising occupant injuries, and post-crash factors such as the availability of medical services. The discussion of in-depth studies which follows will concentrate only on driver factors in the pre-crash and in-crash phases.

There have been several major in-depth studies. These include the TRRL study (Sabey and Staughton 1975), the Indiana tri-level study (Treat *et al.* 1979) and the Adelaide in-depth study (McLean *et al* 1979). The TRRL investigation was the largest in-depth study with a total of 2130 crashes which included 60 per cent of all injury crashes and 20 per cent of reported damage crashes in the south-east Berkshire area between 1970 and 1974. While this study was primarily rural, the Adelaide study included in-depth investigations of 304 crashes from the metropolitan area. The third study was known as the Indiana tri-level study because it included three levels of investigation. Studied were 13 568 police-reported crashes, a subset of 2 258 of them investigated on-scene by technicians, and a subset of 420 investigated in depth by a multidisciplinary team.

The tri-level study assessed causal factors as definite, probable, or possible. For comparison with the other studies it is the definite causal factors from the in-depth analysis which are most appropriate. The three most frequent causal factors from this category were: 'improper lookout', 'inattention' and 'excessive speed'. The highest ranking causal factor in the TRRL study was 'lack of care'. This is a very general category which probably includes factors further down the list in the tri-level study, such as 'false assumption', 'improper driving technique' and 'inadequate defensive driving'. The next three errors in the TRRL study were: 'too fast', 'looked but failed to see' and 'distraction'. These appear to compare favourably with the tri-level study. The Adelaide in-depth study has used very different driver errors and its highest ranking errors are 'failure to accomodate to a visual restriction', 'secondary activity' and 'inadequate monitoring of the environment'. The most noticeable difference from the other studies is the lack of 'excessive speed' as one of the most frequent errors. This could be due to the other studies including more rural areas.

1.4.3 Observational Studies

Harvey, Jenkins and Sumner (1975) unobtrusively observed driver behaviour using three different methods. The first method, the in-car method, involved 108 drivers driving their own car around a pre-determined route of 45 km, accompanied by an observer in the front passenger seat who recorded the driver errors as they occurred. For the observed car method, five routes were selected all of which were included in the 28 km route used in the above method. Behaviour was recorded from a following car: (a) visually, using a video camera and recorder, and (b) using a sound commentary recorded on the audio channel of the recorder. The third method involved time-lapse photographing of particular sites on the five routes chosen for the observed car method. The reliability of error classification was high for each method. A high level of correlation was found between: (a) the observed errors together with their level of danger and the errors which led to injury accidents, and (b) the locations of observed errors, and the locations at which injury accidents had occurred.

Possibly the most widely used approach to unobtrusive observation of traffic is that of traffic conflicts technique, first advocated by Perkins and Harris (1967), and much modified since (e.g. Asmussen 1984). A conflict is a situation where the actions of one road user precipitate evasive action on the part of another, although the precise definition varies from investigator to investigator, as does the observational technique. The original intent of conflict studies was to use conflict measures as a proxy measure for crashes, since they are crash-like situations. However, conflicts have not so far proved to be useful predictors of crashes. The much weaker view now prevails that conflicts are a potentially useful tool for diagnosing operational problems and evaluating treatments, without having to wait for crashes to occur.

Lack of a theoretical link between conflicts and crashes was identified by Williams (1981) as a major weakness of conflict studies. As he pointed out, less severe crashes are not good predictors of more severe crashes, as they tend to be different types of crash, and they happen at different times and at different places. Why then should near crashes be expected to be good predictors of actual crashes? This theoretical issue remains unresolved. Investigators differ in their claims about the nature of the empirical relationship between conflicts and crashes, U.K. work positing a relationship between severe conflicts and all crashes, while Austrian work points to a relationship between all conflicts and severe crashes (Asmussen 1984). Recent moves to carry out systematic comparisons between different techniques hold out the promise of a better understanding of the differences between investigators. Disaggregation of conflict types and crash types has suggested that specific types of conflict are reasonable predictors of their corresponding crash types (Erke 1984), although the data base on which this relationship is based is small.

1.4.4 Unsafe Driving Actions

A broader range of behaviours was observed by Lohman *et al.* (1976). As the study was primarily concerned with evaluating the relationship between enforcement strategies, behaviours similar to those observable by Police officers were studied. Lohman *et al.* began with a large sample of traffic crashes in North Carolina, which they classified according to 23 crash types, 16 types of vehicle manouevre, for up to two vehicles, a total of 5888 combinations. Crashes in each cell in the matrix were then classified according to 23 violation categories for each vehicle, a total of 46 in all. Many of the possible combinations did not appear in the data.

Twenty-five combinations of crash and vehicle manouevres accounted for 83 per cent of the crashes. A sample of crash records was selected and the narrative systematically examined for evidence of factors which had contributed to the crash: on this basis, all cases could be accounted for, including two 'miscellaneous' and one 'not stated' categories.

Crashes in 1973 and 1974 were then selected for the three counties in the study area, a total of 26 272 crashes. These were then examined to see which unsafe driving action (UDA), if any, had contributed to the crash. The 20 most frequent UDAs were identified: these UDAs had contributed to 72 per cent of crashes.

This list of 20 UDAs was then reduced to a smaller set to be observed in the field, taking in to account the frequency of each UDA in crashes, the frequency of the UDA in fatal crashes, and its observability in the field. This final list comprised six UDAs, namely pulling in front of traffic, turning in front of on-coming traffic, running a control, following too closely, speeding, and driving too close to or over centrelines. These UDAs were implicated in 40 per cent of the crashes from the three county sample. Little correspondence was observed between the frequency of each UDA in crash causation and the frequency of citations for corresponding offences.

Forty-one crash sites were then selected in the three-county area to provide hourly estimates of each UDA. Each site was observed by three observers for three hours, making a total of 369 person-hours observation. The demands of the observational task were such that one observer concentrated on one UDA for an hour at each site. Thus the frequency estimates of the UDAs are based on one hours' observation by one observer, at each of 41 sites. Observations of the different sites were distributed between weekdays and weekends, and between daytime and night-time. Practical considerations dictated that most observations be made during daytime on weekdays. These data were then used to develop weighting factors from which frequency estimates of UDA occurrence could be calculated from the raw observational data. These weighting factors transformed the raw data to a distribution with its observations in strict proportion to the proportion of hours in each observational period, that is to say, 35.7 per cent on weekday daytime periods, 35.7 per cent on weekday night-time periods, and 14.3 per cent on both the corresponding weekend periods.

The problem with this procedure is that sites are confounded with time of day: the weighting procedure assumes that the relative frequency of a particular UDA across sites is the same at different time periods. Consider the sites observed during daytime: at only half of these was the relatively common 'following too close' UDA observed, and 76 per cent of the 'pulling in front' UDAs occurred at only three of the 29 sites. In view of the large variability in the observations and the possible biases, it is therefore unfortunate that no variability statistics or confidence limits are presented for these estimates.

The next stage in the analysis involved the calculation of the risk associated with each UDA. By defining risk as the ratio of the conditional probability of a crash given UDA_j to the conditional probability of a crash given 'other behaviour', the term for 'probability of a crash' (which is not known on the basis of the available data) cancels out, and the formula for risk reduces to

$$\text{Risk}(UDA_j) = \frac{P(UDA_j/\text{crash})}{P(\text{other behav./crash})} \times \frac{P(UDA_j)}{P(\text{other behav.})}$$

Risks were calculated for each of the six UDAs, for each of the four time periods. Risks associated with each of the UDAs varied considerably among the periods. However, there was a clear rank ordering of the UDAs, with 'speeding' being the lowest risk behaviour, followed by 'driving left of centre', 'running a traffic control' and 'following too closely'. 'Turning in front of on-coming traffic' was the highest risk behaviour observed, followed by 'pulling in front'. Depending on the time of day, the 'turning in front' UDA was estimated to be 20-120 times as risky as 'speeding'.

The authors acknowledge that the results depend critically on the definitions of the UDAs. 'Turning in front' and 'pulling in front' required definite conflict situations to develop before they were counted as UDAs. The definition of 'following too close', i.e. following with a headway of 0.7 s or less, was fairly stringent. The original definition of 'speeding' was travelling 5 mile/h (8 km/h) over the speed limit: this resulted in a very large number of UDAs being observed, and consequently with a very low risk being associated with speeding in general. When the definition of 'speeding' was altered to exceeding the limit by 15 mile/h (24 km/h) or more, the relative risk associated with speeding rose dramatically: speeding by this amount in a 55 mile/h zone resulted in a relative risk some 200 times greater than speeding by 5 mile/h in a zone with a lower limit. With the revised definition of 'speeding', the risk associated with speeding in a 55 mile/h zone was approximately 1/3 that of 'pulling in front', compared with 1/100 of the risk for 'pulling in front' with the original definition.

The sensitivity of the results to precise definitions, and possibly to site factors, is particularly worrying so far as the 'turning in front' UDA is concerned, identified as the highest risk UDA. This was observed at only four of the 41 sites, and practically all the instances were observed at only two sites. A slightly different selection of sites may well have resulted in higher frequency estimates and hence lower relative risk.

Although the Lohman *et al.* study is valuable in drawing attention to the relative risks associated with different UDAs, it has four serious drawbacks. The preceding discussion illustrates how dependent the risk calculations are on the precise definitions of what constitutes a UDA. The UDAs identified as high risk required the development of conflict situations, while those which were of lower risk, such as crossing the centreline or running a control, were classified as UDAs whether or not other vehicles were present. Thus they were classified as 'unsafe' even though there was no possibility of a conflict situation developing. As definitions become more stringent, so the observed behaviours occur less frequently and the degree of risk arrived at through the calculations increases. So long as enforcement is the focus of the study, and so long as the observed actions approximate the behaviours Police officers would consider offences, this is probably not a serious drawback. If the focus of the study goes beyond enforcement, then the sensitivity of the risk calculations to the criterion for unsafe behaviour is an issue which requires careful consideration.

The second problem is the adequacy of the sampling plan for the UDAs. Unless the behaviour sampled is truly representative of driver behaviour within the study area, then risk estimates could be seriously in error. Inspection of the data reveals considerable variation among sites. This is further exacerbated by the confounding of site with time of day in the sampling procedure. Because of this confounding, the accuracy of the time of day weighting factors depend upon the representativeness of the sites at which the night-time observations were made. So few sites were sampled at night-time that it seems unlikely that an adequate representation was obtained.

A third, related, difficulty is that the authors have used none of the usual statistical techniques for indicating the variability or reliability of the risk estimates. Consequently, it is difficult to assess how good the estimates of relative risk are. Since the distributions of UDAs so clearly depart from normality, care is required in interpreting measures of variability. Nevertheless, repeat observations at the same sites at different times would have given a good indication of how stable the results were.

The final problem, as the authors themselves acknowledge, is that it is by no means clear that high-risk behaviours should be the ones targetted for Police enforcement. Final recommendations about enforcement practice are likely to be a compromise between how easily observed the behaviour is, how many crashes it contributes to, and the risk associated with the behaviour. High risk does not in itself mean that a behaviour is an automatic candidate for enforcement. If a high-risk behaviour can only be observed very rarely, then it is not practical to structure enforcement efforts round its detection. While Police may still react to that behaviour when it occurs, they should not commit substantial resources to activities specifically designed to detect that behaviour.

While there may be doubt about the exact relative risks, the actual differences in the risk associated with the six UDAs calculated by Lohman *et al.* are very large. While the picture may be altered by more accurate determinations of frequency, the essentials are likely to remain the same so long as the same definitions of unsafe behaviour are used. The authors demonstrated how sensitive the relative risk associated with speeding was to the precise definition used. The same is likely to apply if different definitions of unsafe following were used, or if the presence of another vehicle or limited sight distance was required before running a control or crossing the centreline was considered unsafe.

Thus it is important in such studies to record as much objective information as possible about the behaviour of interest, in order that the sensitivity of the risk analysis to different definitions may be explored. Much of the practical value of such studies depends on their being able to demonstrate a mis-match between what a Police officer (for enforcement purposes) or an ordinary driver (for driver education purposes) considers to be dangerous behaviour and the objectively determined risk associated with that behaviour. Ideally, any investigation should start with an empirically-derived definition of the behaviours which people in the target audience would consider unsafe. In the absence of such knowledge, objective measurement of the behaviour, information about the circumstances of the behaviour, such as the presence of other traffic or the available sight distance, or some assessment of the severity of resulting conflicts, would seem preferable to a simple indication that a particular behaviour had occurred.

1.4.5 Relationship Between Volumes, Conflicts and Crashes.

Glauz, Bauer and Migletz (1986) systematically examined the relationship between volumes, conflicts and crashes. Although it only deals with a subset of unsafe behaviours, namely those involving interactions with other traffic, this study is particularly significant for the way it tackles the relationship between these three key variables. Rather than try to estimate the incidence of unsafe behaviours for a whole network on the basis of very limited sampling, their analysis was confined to crashes which happened at the intersections observed at the same times and under the same conditions that observations were made. Crash records were compared with conflict and volume data obtained at the same sets of sites, enabling the calculation of crash/conflict and volume/conflict ratios. It is very clear from this study that disaggregation of intersections by type of control and volume is essential, as the crash/conflict ratios differ considerably among different intersection types.

Forty-six intersections, classified as high volume signalised, medium volume signalised, medium volume unsignalised and low volume unsignalised, were selected. Each intersection was observed for 16 25-minute periods over an 11-hour session, for four successive days. In all, the study was based on 576 observer days. On the basis of previous experience, 12 primary conflict types were considered. For each class of intersection, counts for each type of conflict were processed to give mean values and their variance. Other descriptive statistics were calculated on the assumption that conflict data are distributed according to a gamma distribution, which previous work had shown to be a suitable approximation (Hauer 1975).

Not surprisingly, cross-traffic conflicts were more common at unsignalised intersections, and turn-against conflicts more common at signalised intersections. Comparison of the crash-conflict ratios revealed substantial differences. These have been expressed as the average number of conflicts per crash (or conflict/crash ratio) in Table 1.1 in Glauz *et al.* The through-traffic/cross-traffic conflict at unsignalised medium-volume intersections is the riskiest manoeuvre, with approximately one crash per 1400 conflicts, followed closely by the opposing left turn conflict at high volume signalised intersections with one crash per 1500 conflicts (equivalent to the right-against conflict in countries such as Australia which drive on the left). Same-direction conflicts were identified as relatively low-risk situations. The risk of a crash associated with the highest-risk conflicts is approximately 350 times the risk associated with the least risky conflicts. Although not strictly comparable, the results are consistent with those of Lohman *et al.* in that the opposing left turn conflict (equivalent to Lohman *et al.*'s 'turning in front') and the cross-traffic conflict (equivalent to Lohman *et al.*'s 'pulling in front') are identified as the highest-risk situations. While Glauz *et al.* (1986) identify the opposing left turn conflict as approximately 350 times as dangerous as the same-direction conflict (roughly equivalent to Lohman *et al.*'s 'following too close'), Lohman *et al.* found that the 'turning in front' UDA was approximately 13 times as dangerous as their 'following too close' UDA. This highlights how sensitive the observations, and hence the risk calculations, are to the precise definitions of the behaviour used.

The Glauz *et al.* study also emphasises the need to distinguish between the different types of intersection as the risks associated with different conflict types differ considerably. It also has the advantages of dealing with absolute measures of risk, of being able to relate volumes, crashes and conflicts, and of producing estimates of the variance associated with rates and ratios. Against this must be set the disadvantage of dealing only with conflicts and not with other UDAs such as speeding or following too closely. Also, since only crashes at intersections are considered, it is confined to a subset of crashes, and only those in daylight in good weather. Nevertheless, this seems preferable to the tenuous estimation techniques used by Lohman *et al.*

There is no reason why it would not be possible to combine the wider range of unsafe behaviours considered by Lohman *et al.* with a more adequate sampling procedure which did not confound time and place, in order to ensure that adequate data on the variability of the observations were obtained. Such a study could be used both to calculate the crash/conflict ratios based on the crashes at the observed sites, and to estimate the relative risk of the different UDAs in the manner adopted by Lohman *et al.*, taking into account crash data from a whole network.

1.5 STUDY PLAN

The aim of the present study was to identify the driving behaviours most frequently associated with crashes, and to assess the feasibility of observing how frequently they occurred in the course of normal driving. These tasks resolved into three stages.

The aim of Stage 1 was to find out as much as possible about crash-related behaviours from previous studies. This stage consisted of a detailed re-examination of the case reports from the Adelaide in-depth study (McLean *et al.* 1979), using the behavioural definitions from earlier in-depth studies. By applying the definitions used in previous studies in parallel, it was hoped to gain insights into the difference in method in these investigations. In the course of this work, difficulties became evident, and so a flow chart was developed which changed the nature of the classification task from the assignment of several global categories to answering specific questions with very few possible outcomes.

Stage 2 attempted to find out the relative incidence of unsafe driving actions in a representative sample of these crashes. A sample of crash report forms from Victoria and South Australia was selected, stratified by severity and location. Two independent coders were employed to classify the report forms with the flow chart technique developed in Stage 1.

In Stage 3, techniques for observing the incidence of unsafe behaviours were piloted. An efficient coding system for recording conflicts at intersections was developed through pilot work, and observations were backed up by video recording of events. A technique involving observation of incidents from a moving vehicle was also piloted.

CHAPTER 2:
DEVELOPMENT OF FLOW CHART TECHNIQUE

K.D. Charlesworth

2.1. BACKGROUND

Lohman *et al* (1976) investigated relative crash risks of unsafe driving actions by analysing crash data to identify leading unsafe driving acts and observing the frequency of these actions on the road. Behaviours observed on the road were selected on their ease of observation as well as the frequency of the behaviours in the sample of crashes because they were primarily concerned with implications for enforcement countermeasures. They included such broad categories as 'pulled out in front of traffic', 'turned in front of traffic' and 'backing unsafely'. While such categories should have ensured high reliability, they were not very informative. There was no information on the conditions of the driver or environment which led to such an error being performed. For example, in the case where it was determined that a driver pulled out in front of traffic, it is not known whether there was an obstruction which restricted the driver's view, whether the driver did not look, or whether he misjudged the other driver's speed.

Several other studies, while not having measured the exposure of different driving actions, have investigated the frequency of driver errors in road crashes. These studies have more descriptive types of errors because they involved interviewing participants after a crash rather than being limited to examining report forms. These include the Indiana Tri-Level study (Treat *et al* 1979), the TRRL study (Sabey and Staughton 1975) and the Adelaide in-depth study (McLean *et al.* 1979).

While the errors recorded in these studies are more informative than those used in the Lohman *et al.* (1976) study, the data has often not been tabulated in relation to the type of crash. For example, McLean *et al.* (1979) list errors such as 'failure to accomodate for a visual obstruction' but do not give any information about whether the vehicle was turning in front of another vehicle at an intersection or was pulling out of a driveway. *Table I* presents the distribution of driver errors identified in the four studies.

2.2. AIM OF STAGE 1

The aim of Stage 1 of this investigation was to use these previous studies to gain an understanding of the most frequent unsafe driving actions occurring in road crashes. It is difficult, however, to select the most frequent UDAs when the definitions used in each study are so diverse, leading to very different lists of errors. In addition, given that the overall aim of the project is to be able to provide a list of the most risky driver behaviours so that appropriate countermeasures may be designed, it is desirable to also determine the situations in which these behaviours occur.

It was decided that the most effective method of comparing the different definitions was to reanalyse a study using several of the driver error definitions used in these previous studies and to code the crashes according to different driving situations. This would allow assessment of the different definitions in relation to their reliability and ability to provide detailed information.

TABLE I
Unsafe Driving Actions Identified in the North Carolina, Adelaide In-depth, TRRL and Indiana Tri-Level Studies.

North Carolina Study (Lohman et al. 1976)	*% Crashes*	*Adelaide in-depth (McLean et al. 1979)*	*% Crashes*
Following too closely	16.0	Failure to accomodate to a visual restriction	20.3
Pulling in front of traffic	9.0	No apparent error	15.3
Backing when unsafe	8.7	Secondary activity	13.9
Turning in front of traffic	4.7	Inadequate monitoring of environment	11.3
Speeding too fast for conditions	4.5	Insufficient information available	5.3
Running a traffic control	4.4	Travelling too fast to respond	4.2
Changing lanes or merging	4.3	Fail to respond appropriately in emergency	2.9
Speeding (above limit)	3.7	Response of uninvolved participant	2.3
Turning too wide or sharp	3.4	Failure to obey traffic signal or rule	1.5
Driving left of centre	2.8	Vehicle defect	1.3
Turning from wrong lane	2.0	Visual distraction	0.8
Driving under influence of alcohol	1.2	Failure to respond in emergency	0.5
Driving too close to kerb side	1.2	Failure to operate appropriate controls	0.3
Passing a turning vehicle	1.2		
Improper parked/stopped vehicle	1.1		
Pulling from parked position	1.1		
Hit parked vehicle while leaving	0.8		
No signal or inadequate signal	0.5		
Going straight in turning lane	0.3		
Crossing the line of a lane	0.3		
Indiana Tri-level (Treat et al. 1979)		*TRRL (Sabey and Staughton1975)*	
Improper lookout	17.6	Lack of care	24.1
Excessive speed	7.9	Too fast	12.0
Inattention	9.8	Looked, failed to see	9.8
Improper evasive action	4.8	Distraction	9.0
Internal distraction	5.7	Inexperience	5.7
Improper driving technique	6.1	Failed to look	4.9
Inadeq. defensive driv. technique	6.1	Wrong path	4.7
False assumption	4.5	Lack of attention	4.1
Improper maneuver	5.0	Improper overtaking	3.9
Overcompensation	3.3	Incorrect interpretation	3.3
		Lack of judgement	3.1
		Misjudged speed and distance	2.9
		Following too close	2.0
		Difficult manoeuvre	1.9
		Irresponsible or reckless	1.6
		Wrong decision or action	1.3
		Lack of education or roadcraft	1.3

The Adelaide in-depth study was selected for this procedure because the raw data, including illustrations, descriptions and responses to interviews, were easily accessible. A copy of the data tape is held at ARRB. The fact that the study was carried out in Australia was a further advantage. The Victorian Road Traffic Authority's road user movement (RUM) code was used to provide situational information.

2.3 DEVELOPMENT OF CODING PROCEDURE

2.3.1 Selection of Information to be Coded

There are 99 RUMs used to code the Victorian mass crash data. It was decided to use this system to code the Adelaide in-depth data because it provided the required situational data, it had well documented definitions and it would enable the results to be compatible with the Victorian mass data. The RUM definitions, used by the Road Traffic Authority since 1983, were employed. Appendix A gives a copy of the RUM chart.

The driver errors assigned by the Adelaide in-depth study were available on the Adelaide data tape, so no extra coding was required to use this information. Use of the errors from the TRRL study was considered but since the definitions were not included in their published material it was decided to exclude them from the reanalysis of the Adelaide data. The North Carolina and Indiana tri-level studies had both included definitions of their UDAs in the publications and so these definitions were included at this stage of the procedure.

2.3.2 Storage of Data

Variables on the Adelaide data tape which appeared relevant to the study were stored in a Scientific Information Retrieval (SIR) database (Robinson *et al.* 1980) on the ARRB computer. This allowed easy addition of extra variables, i.e. the new codes to be added. The SQL language associated with SIR also enabled easy searching of data.

2.3.3 Trial Method

Based primarily on the availability of definitions the RUM code, Lohman *et al*'s definitions of unsafe driving actions and Treat *et al*'s definitions of causal factors were selected for the reanalysis of the Adelaide in-depth data. It was then necessary to begin coding and to determine which codes could be used easily.

For the RUM codes, a RUM chart and set of definitions were used. The definitions used for the two sets of errors can be found in Appendix A of Lohman *et al.* (1976) and the causal factors glossary in Treat *et al.* (1979). The Treat *et al.* approach has both major and minor codes; at this stage the major codes were used.

The first ten crashes were coded by one coder to determine the information required in the coding procedure. Thereafter the crashes were coded by two independent coders. A diagram and illustration was available for each crash in the Adelaide study (University of Adelaide Road Accident Research Unit 1979). This information was sufficient to allocate the RUM and Lohman *et al.* codes. Because the Treat *et al.* definitions included more details on the driver, it was clear that further information was required before these definitions could be allocated. It was decided to use the Adelaide in-depth errors and information on any secondary activity and any visual obstruction to aid in the allocation of the Treat *et al.* definition. A print of this information was made available for each crash as it was being coded.

After the first ten crashes had been assigned a RUM, 'Lohman' and 'Treat' code by one coder, the procedure was discussed and the next 40 crashes were coded by both coders. At the completion of this round, responses were compared and in the cases where codings were different, further discussion led to agreement on a code which then was recorded. The same procedure was carried out for the next 50 crashes and following recording of agreed responses, the next 100 crashes were coded and recorded.

At this stage, it was apparent that there was little difficulty with the RUMs and Lohman UDAs. However, the Treat codes were very difficult. It was then decided to try using the minor codes, hoping that by having even more detailed codes the procedure would become easier. However, the converse applied. With more options from which to choose, the number of disagreements increased even further.

The Treat causal factors were so difficult to assign because there were too many complex decisions to be made simultaneously. The Treat system requires the coder to choose the most important causal factor from a large range. This requires much cognitive processing because the coder has to remember all of the options or continually search all the causal factors so that he could mentally place the them in a hierarchy. In addition, there were several categories such as 'inadequate defensive driving' and 'false assumption' which were difficult to distinguish from each other.

Since the information which the Treat definitions provided was considered valuable, it was decided that a new set of UDAs would be drawn up with an equivalent amount of detail but with improved reliability. It was decided that the most effective way to reduce the amount of processing by the coder would be to present a flow chart of decisions. By presenting a set of simple decisions in a systematic way, the coder has less to process. There is no need for the coder to decide which UDA is most important; instead, questions relating to individual aspects of driver's performance are asked and the coder is required to answer 'yes', 'no', 'irrelevant' or 'unknown'.

A further advantage of the flow chart was the inclusion of a set of UDAs for pedestrians. The exclusion of causal factors for pedestrians had meant that pedestrian crashes had not been coded in the Treat study.

The flow chart, along with the criteria for making each decision, are presented in Appendix B. Brief descriptions of the flow chart decisions are presented below. The coder codes each driver and pedestrian separately. The flow chart consists of seven different sections. At the end of each section the coder is directed to the next appropriate section. Which particular sections are coded depends on whether the unit being coded is a driver or pedestrian and whether it is a single or multi-vehicle crash. Appendix B illustrates these details.

A BRIEF DESCRIPTION OF FLOW CHART DECISIONS

<u>1. How did participant approach situation?</u>

(a) Attempted suicide	Is there evidence that the driver attempted suicide?
(b) Not conscious	Was the driver unconscious before the crash occurred? This includes those who have fallen asleep and those who have had a heart attack.
(c) No headlights	Did the driver fail to have headlights on when it was too dark to be driving without them?
(d) Inadequate signal	Were the vehicle's signals used inappropriately or not at all when they were required? This includes faulty signals.
(e) Excessive speed	Was the driver travelling too fast for conditions?
(f) Distraction	Was the driver distracted while he was driving? This includes drivers talking to passengers, picking up something, or looking at something.
(g) Outside vehicle	Was the distraction located outside the vehicle?
(h) Single-vehicle	Was it a single-vehicle or hit parked vehicle crash?

<u>2.Single-vehicle crash - what did driver do?</u>

(a) Fail to detect	Did the driver fail to detect a parked vehicle or other obstruction?
(b) Inadequate control	Did the driver change the direction he was travelling as a result of losing control?

(a) Visual obstruction	Was there a visual obstruction which blocked the view of another unit involved in the crash?
(b) Saw other unit	Did this pedestrian or driver see the other unit before it was too late to avoid the crash?
(c) Look	Did the driver or pedestrian look in the direction of the other unit?
(d) Pedestrian	Was a pedestrian involved in the crash?
(e) Driver	Is it the driver being coded?

?

(a) Priority	Did the driver have priority?
(b) Inadequate control.	Was the vehicle poorly controlled or positioned?
(c) Following	Was the vehicle following too close?
(d) Ran through a control	Did the driver fail to stop at a Stop sign or fail to obey a red traffic signal?
(e) Assumed priority	Did the driver who did not have priority believe that he had priority?
(f) No conflict	Did the driver assume that there were no conflicting traffic movements? This includes cases where the driver saw a vehicle and assumed that it would not be driven into his path and also cases where the driver didn't see another unit and assumed that either nothing was coming or if something was coming that it would stop.
(g) Misjudge	Did the driver misjudge the other vehicle's speed or position?

5. Was effective evasive action taken?

(a) Action	Was evasive action taken in time to avoid the crash?
(b) Obvious	Was there obvious action that could have been taken but was not?
(c) Appropriate	If evasive action was taken, was it appropriate?

6. Pedestrian crash - what did driver do?

(a) Driver priority	Did the driver have priority?
(b) Disobey	Did the driver disobey a traffic rule, e.g. fail to stop at pedestrian crossing?
(c) Assume pedestrian	Did the driver see the pedestrian and assume the pedestrian would stop?

7. Pedestrian crash - what did pedestrian do?

(a) Pedestian priority	Did the pedestrian have priority?
(b) Misjudge	Did the pedestrian misjudge the driver's speed or position?
(c) Ran	Did the pedestrian run onto the road?
(d) Assume	Did the pedestrian assume that the driver would stop?

2.3.4 Final Method

Before going onto the last 100 crashes, the first 200 were recoded using the flow chart. Again discussion and agreement was made after crash 50, 100 and 200. After crash 50 a further decision was included in the flow chart (4(g)-misjudgement of speed or distance). Any case which could not be fitted within the flow chart was termed 'uncodable'. The last 104 crashes were coded with RUM, Lohman, and the flow chart after the first 200 were coded with the flow chart.

The RUM, Lohman and flow chart codes were then recorded in SIR and a binary variable was allocated regarding whether there was original agreement or not on each particular decision.

2.4 RESULTS

2.4.1 Reliability

Tables II, III and *IV* compare the amount of agreement between coders for RUMs, Lohman errors and the flow chart decisions respectively.

The overall agreement for RUMs was 74 per cent. An examination of individual RUMs reveals that the two most frequent RUMs, 21 and 31, both have an agreement of 100 per cent. Some of the less frequent RUMs do have quite low reliability, e.g. RUM 76 has only one agreement over four crashes. This probably reflects the fact that learning the criteria for attributing each RUM occurred with practice and the fewer the crashes in a category, the less opportunity for learning the criteria.

The overall agreement for Lohman unsafe driving actions was 82 per cent. Again, there was high agreement for the most frequent categories. During each stage where individual codes were compared and a code agreed upon where there was disagreement, it was found that problems for Lohman UDAs were due to some confusion about the criteria for assigning the UDAs. For example, Lohman *et al.* (1976) state, 'If a driver committed two UDA's in the same accident, the action most directly related to the crash was counted' (p. 15). This type of statement led to some difficulties in the coding procedure.

Reliability for the flow chart decisions was 91 per cent. This figure is higher than that for RUMs and Lohman UDAs. The high reliability indicates clear criteria for making the decisions. The lowest individual reliability was for 'obvious action' indicating either poor criteria for this decision or too little available information for making the decision or an interaction of these two suggestions.

TABLE II
Amount of Agreement between Individual Coders when Coding RUMs for Adelaide In-depth Crashes

RUM	Total Crashes	Agree	Not Agree	Unknown	RUM	Total Crashes	Agree	Not Agree	Unknown
1	16	10 (67)*	5	1	44	11	7 (64)	4	0
2	11	8 (80)	2	1	51	7	6 (86)	1	0
3	10	7 (70)	3	0	52	16	1 (93)	1	2
4	2	2 (100)	0	0	54	1	1 (100)	0	0
7	1	1 (100)	0	0	55	1	0 (0)	0	1
11	5	3 (60)	2	0	56	2	0 (0)	2	0
12	5	3 (60)	2	0	57	2	1 (50)	1	0
13	4	1 (33)	2	1	62	3	0 (0)	3	0
14	1	1 (100)	0	0	63	1	0 (0)	1	0
15	4	1 (25)	3	0	64	1	0 (0)	1	0
21	64	62 (100)	0	2	65	1	0 (0)	1	0
24	22	19 (90)	2	1	72	6	1 (17)	5	0
25	1	0 (0)	1	0	73	1	0 (0)	1	0
27	1	1 (100)	0	0	74	6	3 (50)	3	0
28	1	0 (0)	1	0	76	4	1 (25)	3	0
31	41	40 (100)	0	1	81	1	0 (0)	1	0
33	7	4 (57)	3	0	82	16	12 (75)	4	0
34	1	1 (100)	0	0	84	4	2 (50)	2	0
37	4	2 (50)	2	0	85	3	3 (100)	0	0
41	4	4 (100)	0	0	86	5	0 (0)	5	0
42	4	2 (50)	2	0	91	1	1 (100)	0	0
43	1	0 (0)	1	0	94	1	1 (100)	0	0
					Total	304	224 (74)	70	10

* per cent agreement between coders when coding particular RUMs. RUM Nos. defined in Appendix A

TABLE III
Amount of Agreement between Individual Coders when Coding Lohman et al's UDAs for Adelaide In-Depth Crashes

LOHMAN UDAS	AGREEMENT Number	AGREEMENT %	Not Agree	Unknown	Total
No UDA	187	92	16	7	210
Following too close	7	50	7	0	14
Pulling in front	72	84	14	2	88
Backing unsafely	1	50	1	0	2
Turning in front	41	93	3	2	46
Speeding for conditions	6	46	7	0	13
Running stop sign	8	80	2	1	11
Changing lanes	0	0	2	0	2
Speeding for limit	11	65	6	0	17
Turning too wide	4	50	4	0	8
Driving right of centre	1	100	0	0	1
Turn, wrong lane	4	67	2	0	6
Driving under influence	12	63	7	1	20
Passing turning vehicle	2	67	1	0	3
Driving too close	14	70	6	1	21
Improper parked vehicle	0	0	2	0	2
Pulling from parked position	3	43	4	0	7
No signal	0	0	2	0	2
No appropriate code	52	85	9	4	65
TOTAL	425	82	95	18	538

UDA: Unsafe Driving Action

TABLE IV
Amount of Agreement between Individual Coders when Coding Flow Chart Decisions for Adelaide In-depth Crashes

		AGREEMENT				
FLOW CHART UDAs	*Decision*	*Number*	*%*	*Not Agree*	*Unknown*	*Total*
1 a Suicide	yes	4	100	0	0	4
	no	534	100	0	0	534
1 b Unconscious	yes	4	100	0	0	4
	no	533	100	0	0	533
	unk	0	0	1	0	1
1 c No headlights	yes	2	100	0	0	2
	no	493	100	0	0	493
1 d Inadequate signal	yes	4	57	3	0	7
	no	484	100	0	0	484
	unk	0	0	4	0	4
1 e Excessive speed	yes	48	81	11	0	59
	no	434	100	1	0	435
	unk	0	0	1	0	1
1 f Distraction	yes	73	79	19	0	92
	no	0	0	6	0	6
1 g Outside vehicle	yes	29	81	7	8	44
	no	32	73	12	9	53
1 h Single-vehicle						
2 a Fail to detect	yes	11	65	6	0	17
	no	43	96	2	0	45
2 b Inadequate control	yes	43	93	3	0	46
	no	2	100	0	0	2
3 a Visual obstruction	yes	178	91	18	0	196
	no	226	94	14	1	241
3 b Saw other unit	yes	73	82	16	0	89
	no	189	87	28	0	217
	irr	1	100	0	0	1
	unk	87	67	43	1	131
3 c Looked	yes	15	48	16	1	32
	no	25	66	13	0	38
	irr	17	100	0	0	17
	unk	227	85	39	0	266
3 d Pedestrian involved						
3 e Driver being coded						
4 a Priority	yes	146	92	12	1	159
	no	145	92	12	0	157
	irr	43	83	9	1	53
	unk	0	0	2	0	2

TABLE IV cont.

FLOW CHART UDAs	*Decisio*	*AGREEMENT*		*Not Agree*	*Unknown*	*Total*
		Number	*%*			
4 b Inadequate control/position	yes	3	38	-	-	9
	no	35	92	3	5	43
	unk	0	0	1	0	1
4 c Follow too close	yes	4	80	1	0	5
	no	34	87	5	6	45
	unk	0	0	1	0	1
4 d Ran control	yes	7	70	3	0	10
	no	136	96	5	8	149
	unk	0	0	0	1	1
4 e Assumed priority	yes	9	69	4	0	13
	no	129	96	6	9	144
	unk	0	0	3	0	3
4 f Assumed no conflict		202	80	51	12	265
		14	82	3	4	21
	unk	8	31	18	1	27
4 g Misjudge speed	yes	17	81	4	3	24
	no	217	87	33	57	307
	unk	9	33	18	1	28
5 a Evasive action	yes	190	85	33	0	223
	no	173	94	11	1	185
	unk	29	74	10	0	39
5 b Obvious action	yes	5	28	13	0	18
	no	155	90	17	1	173
	unk	20	51	19	0	39
5 c Appropriate action	yes	137	85	25	0	162
	no	12	43	16	0	28
	unk	10	42	14	0	24
6 a Driver priority	yes	24	89	3	0	27
	no	2	100	0	0	2
	irr	5	100	0	0	5
6 b Disobey rule	yes	1	50	1	0	2
6 c Assume pedestrian	yes	5	83	1	0	6
	no	3	75	1	0	4
	irr	17	89	2	0	19
	unk	1	33	2	0	3
7 a Pedestrian priority	yes	2	100	0	0	2
	no	24	89	3	0	27
	unk	6	100	0	0	6
7 b Misjudged speed	yes	3	100	0	0	3
	no	27	96	1	0	28
	unk	0	0	2	0	2
7 c Ped ran onto road	yes	18	75	6	0	24
	no	6	100	0	0	6
	unk	0	0	1	0	1
7 d Assumed driver	yes	0	0	1	0	1
	no	12	100	0	0	12
TOTAL		856	90	644	132	632

2.4.2 Analysis of Unsafe Driving Actions

In order to analyse the crashes in terms of UDAs, they have been divided into four categories: pedestrian, bicycle, single-vehicle and multi-vehicle crashes.

Pedestrian crashes

There were 40 pedestrian crashes involving 40 drivers and 43 pedestrians. *Table V* gives a distribution of road user movements and flow chart decisions.

FLOW CHART UDA			Decision	RUM 1	RUM 2	RUM 3	RUM 4	RUM 7	Total
1	a	Suicide	yes	2	0	0	0	0	2
	f	Distraction	yes	2	0	2	0	1	5
3	a	Obstruction	yes	2	11	2	0	0	15
	b	Saw other unit	no	9	8	2	0	1	20
			unk	3	3	5	1	0	12
	c	Look	no	2	5	0	0	0	7
			unk	7	6	6	1	1	21
7	a	Priority	no	8	11	7	0	1	27
			irr	3	0	1	2	0	6
	b	Misjudged vehicle	yes	1	0	1	1	0	3
			unk	0	0	1	1	1	3
	c	Ran onto road	yes	7	11	5	0	1	24
			unk	0	0	1	0	0	1
		Total coded		15	11	8	2	1	35

The Table shows that the most frequent RUMs were RUM 1 (near side), RUM 2 (emerging), and RUM 3 (far side), accounting for 37, 28 and 23 per cent of pedestrian crashes respectively.

Fifty-seven per cent of the 35 coded pedestrians had stepped onto the road without seeing the vehicle. The high number of unknowns for the 'Look' category shows that in a large proportion of cases it was unclear whether the pedestrian had looked in the direction of the vehicle before stepping onto the road. Forty-six per cent of pedestrians in this category had emerged from behind a parked vehicle and so a visual obstruction had been recorded in each of these cases, and there were four other cases where an obstruction had been involved. For 8 per cent of pedestrians it was known that the vehicle was seen and in each of these cases the pedestrian had misjudged the vehicle.

Two pedestrians attempted suicide, and so no further information was recorded for these individuals. Two pedestrians had priority and no error is apparent for these (neither of them had assumed the driver would stop).

There were six cases where priority was irrelevant because the pedestrian was standing in the middle of the road. Of these, one misjudged the vehicle, for another it was unknown whether the vehicle was misjudged and for the balance of these pedestrians it was unclear why the pedestrian was hit.

Table VI presents the most frequent error attributed to pedestrians in the McLean *et al.* study for each RUM as well as some relevant additional information which was available on the Adelaide data tape. Sixty-one per cent of the pedestrians were male. The most frequently involved age group was 'under 15 years' and these pedestrians appeared particularly over-represented in the 'emerging' crashes. Thirty-five per cent of pedestrians were wearing dark clothes, and this category of pedestrians was most frequent in the 'near-side' crashes.

TABLE VI
Comparison of Major Pedestrian Variables Collected by McLean et al. and RUM Code

PEDESTRIAN INFORMATION		RUM 1	2	3	4	7	otal
Sex	Male						26
	Female						17
Age (yrs)	<15	4	7	2	0	0	13
	15-25	2	2	2	2	2	10
	26-50	4	2	2	0	0	8
	>50	6	1	5	0	0	12
Clothing	Light	4	3	5	1	1	14
	Bright	1	3	1	1	1	7
	Dull	2	3	0	0	0	5
	Dark	8	1	5	0	0	14
	Unknown	1	2	0	0	0	3
Trip Purpose	Commuter	3	2	0	1	1	7
	Business	3	0	1	0	0	4
	Recreationa	1	1	0	1	0	3
	Social	2	1	4	0	1	8
	Shopping	3	4	0	0	0	7
	Other	1	4	2	0	0	7
	Unknown	3	0	4	0	0	7
Total		16	12	11	2	2	43
Major Driver Error (percent of RUM category)		Inadequate Monitoring (56)	Inadequate Information (11)	Inattention & Influence of alcohol (27,27)	No major error	Inadequate Monitoring (100)	

Table VII summarises the results of the flow chart method for each driver involved in pedestrian crashes. In the two cases in which drivers did not have priority, the drivers had disobeyed traffic rules. In 60 per cent of cases in which priority was irrelevant the driver did not see the pedestrian, in another case it is not known whether the pedestrian was seen and in the other case the driver saw the pedestrian and assumed the pedestrian would stop.

TABLE VII
Distribution of Flow Chart Decisions Coded for Drivers Involved in Pedestrian Crashes
(Adelaide in-depth data)

FLOW CHART UDA			DECISION	RUM 1	2	3	4	7	Total
1	f/g	Distraction	in	0	0	0	1	0	1
			out	3	0	1	0	0	4
3	a	Obstruction	yes	3	11	2	0	0	16
	b	Saw other unit	no	7	11	4	0	0	22
			unk	2	0	1	0	1	4
	c	Look	no	1	0	0	0	0	
			unk	5	5	2	0	7	
6	a	Priority	no	2	0	0	0	0	
			irr	2	0	1	2	0	
	b	Disobey	yes	2	0	0	0	0	
	c	Assumed ped	yes	2	0	3	1	0	
			unk	1	0	1	0	1	
5	a	Action	no	4	1	1	2	0	
			unk	0	0	0	0	1	
	b	Obvious	yes	0	0	0	0	0	0
			unk	0	0	0	1	1	2
	c	Appropriate	no	0	0	0	0	1	1
			unk	0	1	0	0	0	1
		Total coded		12	11	8	2	1	34

Sixty-eight per cent of drivers had priority. In 19 per cent of these cases the pedestrian was seen, in 70 per cent of the cases the pedestrian was not seen and it was unknown in 11 per cent of cases whether the pedestrian was seen or not. In each of the cases in which the pedestrian was seen it was assumed that the pedestrian would not move into the traffic stream. In a large proportion of the cases where a pedestrian was not seen, an obstruction was hiding the pedestrian.

In summary, except for a few cases where a pedestrian had misjudged a vehicle, most of the crashes involving vehicles and pedestrians resulted from pedestrians stepping out into traffic without a clear view of the road.

Bicycle crashes

There were 22 bicycle crashes in the Adelaide in-depth study. Figure 1 gives the distribution of RUMs. The two most frequent RUMs were RUM 12 and 11 ('entering' and 'struck from behind') respectively. There were 17 multi-vehicle crashes and five single-vehicle.

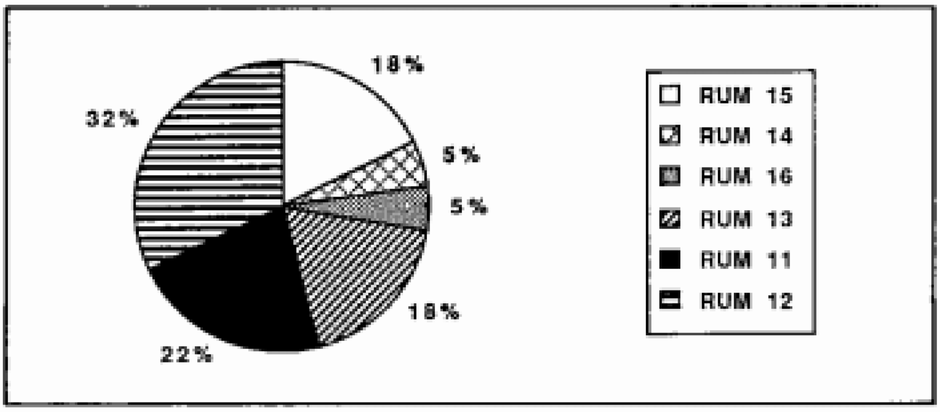


Figure 1 - Distribution of RUMS for Bicyle Crashes

Table VIII shows the flow chart decisions for both cyclists and drivers involved in bicycle crashes. Of the five single-vehicles, one was unconscious prior to the crash, one failed to detect an obstruction and three lost control of their vehicle.

TABLE VIII
Distribution of Flow Chart Decisions for Cyclists and Drivers Involved in Bicycle Crashes
(Adelaide in-depth data)

FLOW CHART UDA	*DECISION*					
	CYCLIST			*DRIVER*		
	Yes	*No*	*Unknown*	*Yes*	*No*	*Unknown*
1 b Unconscious	1	19	0	0	15	0
c No headlights	2	18	0	0	15	0
d No signal	2	18	0	0	15	0
e Excessive speed	1	19	0	3	12	0
f Distraction -in	0	0	0	1	0	0
-out	1	0	0	2	0	0
2 a Fail to detect	2	3	0	-	-	-
b Out of control	3	2	0	-	-	-
3 a Obstruction	6	9	0	6	9	0
b Saw other unit	2	6	7	1	9	5
c Look	0	4	9	0	0	14
4 d Ran traffic control	0	10	0	0	5	0
e Assumed priority	1	8	1	0	5	0
f Assumed no conflict	9	2	4	14	1	0
g Misjudged	2	9	4	1	14	0
5 b Obvious action	2	5	3	0	4	0
c Appropriate	4	1	1	10	1	0

Two of the cyclists involved in multi-vehicle crashes could not be coded, leaving 15 coded multi-vehicle bicycle crashes. In five of these the cyclist had priority and in ten they did not. Of the five cyclists who had priority, four assumed no conflicting traffic movements and for one it was unknown. Two of those cyclists who had priority did not see the other vehicle and for three it was not possible to determine whether the vehicle was seen or not.

For those cyclists without priority, half (five) assumed no conflicting traffic movements. Of these, four did not see the vehicle and it was unknown for one. For the other five, one assumed priority, two misjudged the speed of the other vehicle and in two cases it was not possible to determine what happened.

There were 17 drivers involved in crashes with cyclists. All of those without priority assumed no conflicting traffic movement because the driver did not see the cyclist. The cyclist was not detected due to an obstruction in only one case.

For those with priority only one driver saw the cyclist and misjudged its speed or position. The other drivers assumed no conflicting traffic movement. Five drivers did not see the bicycle and four of these had a visual obstruction. For four other drivers it was unknown whether the cyclist had been seen and there was an obstruction in only one of these cases.

Single-Vehicle Crashes

There were 68 single-vehicle crashes, 60 of which could be coded by the flow chart. *Table IX* shows the distribution of RUMs and flow chart decisions recorded for each RUM. The two most frequent RUMs were RUM 52 'hit parked vehicle' and RUM 82 'left off carriageway into fixed object'; each accounted for 24 per cent of the single-vehicle crashes.

FLOW CHART UDA		DECISION	RUM																Total
			28	37	52	54	55	56	57	62	72	73	74	76	81	82	84	86	
1 a	Suicide	yes									1						1		2
b	Unconscious	yes			1											1	1		3
		unk			1														1
e	Speed	yes	1			1				2	1	1	4	3		2	1	1	17
f	Distraction	in			4						1				1	5	1		12
		out			1	1						1				1			4
2 b	Fail to detect	yes		1	11	1							1	1					15
c	Inadequate control	yes	1		3		1	2	1	2	3	1	5	3	1	15	3	3	43
3 c	Appropriate action	no			3					1		1	1	1		1			8
	Total drivers coded		1	1	15	1	1	2	1	2	4	1	6	4	1	15	2	3	60

Examination of the flow chart decisions reveals that the most frequent decisions, in descending order, were 'inadequate control', 'excessive speed', and 'fail to detect'. 'Inadequate control' accounted for all RUM 82 crashes 'fail to detect' accounted for 73 per cent of RUM 52 crashes. 'Excessive speed' did not appear to be an important factor in the two most frequent RUMs and was more evenly distributed throughout all single-vehicle crashes.

In order to gain some understanding as to why vehicles lost control or failed to detect an object or vehicle, *Table X* presents these two flow chart decisions cross-tabulated with blood alcohol levels, speed and distraction and divides 'inadequate control' into those which occurred on a curved or straight road. The type of road was based on RUMs and could only be determined accurately for 76 per cent of crashes in which vehicles lost control.

TABLE X
Cross-Tabulation of Drivers Involved in Single-Vehicle Crashes Recorded as Having High BAC, Speeding or Distracted with Whether They have Failed to Detect an Object or Lost Control.

UDA	Vehicle lost control			Fail to detect	Total Single
	On a Curve	On a Straight	Total		
BAC 0.051-0.15 g/100 mL	3	4	11	3	14
>0.15 g/100 mL	3	6	13	7	20
Speed	7	4	14	3	17
Distraction	3	8	11	5	16
Total drivers coded	12	20	43	15	68

Sixty-three per cent of all vehicles which lost control were on a straight road, compared to 29 per cent on a curve. Fifty-seven per cent of drivers who lost control had BACs greater than 0.05g/100mL. There appeared little difference in alcohol level between those drivers who lost control on a curve and those who lost control on a straight road.

Excessive speed was recorded for 36 per cent of vehicles whose drivers lost control. Speeding appeared to be over-represented in those drivers who lost control on a curve since 58 per cent of these were speeding compared to 20 per cent on a straight road.

Twenty-six per cent of drivers who lost control had been distracted. Distractions appear to be over-represented in drivers who lost control on a straight road. Thirty-five per cent of these drivers had been distracted.

Seventy per cent of drivers who failed to detect an object or parked vehicle had BACs greater than 0.05g/100mL. There appears to be an over-representation of drivers with a BAC greater than 0.15g/100mL in the 'fail to detect' category.

Speeding appears to be less frequent in 'fail to detect' than 'loss of control' crashes, accounting for 20 per cent of crashes compared to 36 per cent. In contrast, distractions appear more prevalent in 'fail to detect' crashes.

Multi-Vehicle Crashes

There were a 170 multi-vehicle crashes. Of these, 142 were situations in which one vehicle had priority, in 28 crashes priority was irrelevant, for one crash it was unknown which vehicle had priority and three crashes could not be coded.

Table XI shows the flow chart decisions for vehicles without priority. The three most frequent RUMs were 21, 31 and 24 (cross traffic, right against, and right near respectively). Of the 142 coded, 11 per cent were recorded as speeding and all but one of these vehicles was involved in a RUM 21. Drivers were distracted in 36 per cent of crashes and they appeared to be over-represented in driveway crashes, accounting for 60 per cent of driveway crashes. Since the driver does not have priority this would be the driver entering or leaving the driveway.

Visual obstructions were present for 56 per cent of drivers. The proportion of crashes involving visual obstructions was distributed evenly through RUMs. Sixty-eight per cent of drivers did not see the other vehicle and for a further 19

TABLE XI
Distribution of Flow Chart Decisions for Drivers without Priority in Multi-Vehicle Crashes
(Adelaide in-depth data)

FLOW CHART UDA		DECISION	RUM 21	24	25	27	31	41	42	44	Total
1 d	No signal	yes	0	0	0	0	0	0	1	0	1
		unk	0	0	0	0	0	0	1	1	2
e	Speed	yes	15	0	0	0	1	0	0	0	16
f	Distraction	in	15	4	0	0	11	1	0	4	35
		out	7	3	0	0	4	0	0	2	16
3 a	Obstruction	yes	40	12	1	0	22	0	2	2	79
b	Saw other unit	no	47	12	1	0	25	3	3	6	97
		unk	9	5	0	1	7	0	1	4	27
c	Look	no	7	1	0	0	2	1	0	0	11
		unk	39	13	1	1	25	2	3	9	93
4 d	Ran control	yes	7	2	0	0	1	0	0	0	10
f	Conflict	yes	51	15	1	1	30	4	4	6	112
		unk	7	3	0	0	3	0	0	3	16
g	Misjudge	yes	3	3	0	0	3	0	0	0	9
		unk	7	3	0	0	3	0	0	2	15
5 a	Action taken	no	28	11	1	0	18	4	3	7	72
		unk	8	4	0	0	5	0	1	0	18
b	Obvious	yes	5	2	0	0	3	0	0	0	10
		unk	5	4	0	0	7	0	0	0	16
c	Appropriate	no	3	1	0	0	0	0	0	1	5
		unk	5	1	0	0	6	0	0	0	12
	Total coded		63	21	1	1	38	4	4	10	142

per cent it was not known whether the driver saw the other vehicle. Thus, in only 13 per cent of cases is it known that the other vehicle was seen. Seventy-four per cent of drivers who did not see had a visual obstruction. The high proportion of unknowns for 'look' shows that the data source did not have sufficient information on this. Thus, it is not known whether the high proportion of not seeing was due to lack of looking, although the high proportion of visual obstructions does suggest that this was the primary reason for drivers not seeing.

An examination of the drivers who definitely did not see shows a very high proportion for RUM 21. While there were few cases in RUM 41 and 42, there was also a high proportion of not seeing in these cases. For RUM 41 there were no obstructions and so it appears that vehicles are not monitoring the area well when doing u-turns.

Ten drivers ran a control such as a traffic light or Stop sign. Seventy per cent of these were involved in a RUM 21. Nine drivers misjudged another vehicle. These are distributed evenly between RUMs 21, 24 and 31. Seventy-nine per cent of drivers without priority assumed no conflicting traffic movements. Sixty-two per cent of these drivers did not see the other vehicle and for 78 per cent of these a visual obstruction was present.

Fifty-one per cent of drivers definitely took no evasive action, and for 13 per cent it was unknown. Of the 72 drivers who did not take action, obvious action was available for 14 per cent of drivers. Of the 52 drivers who did take evasive action, it was inappropriate for only 10 per cent of cases.

Table XII shows the flow chart decisions for drivers with priority. Again, only one driver did not give an appropriate signal. Speeding was only recorded for 13 per cent of drivers and as for those without priority, it was RUM 21 in which this was most prevalent. This indicated that both drivers with and without priority were equally likely to have been speeding. Distractions were present in 12 per cent of cases. This figure is lower than for those without priority and does suggest that the highter incidence of distractions for drivers without priority may be responsible for them not giving right of way.

TABLE XII
Distribution of Flow Chart Decisions Coded for Drivers with Priority in Multi-Vehicle Crashes
(Adelaide in-depth data)

FLOW CHART UDA		*DECISIO*	*RUM*								Total
			21	*24*	*25*	*27*	*31*	*41*	*42*	*44*	
1 d	No signal	yes	0	1	0	0	0	0	0	0	1
e	Speed	yes	14	1	1	1	0	0	0	1	18
	Distraction	in	3	0	0	0	3	1	0	1	8
		out	3	1	0	0	2	0	2	1	9
3 a	Obstruction	yes	38	9	1	0	21	0	0	3	72
b	Saw other unit	no	32	6	1	0	11	0	1	3	54
		unk	15	9	0	1	17	1	1	6	49
c	Look	no	9	0	0	0	0	0	0	1	10
		unk	35	14	1	1	26	1	2	7	85
4 f	Conflict	yes	56	16	1	1	36	4	4	10	127
		unk	5	1	0	0	0	0	0	1	7
g	Misjudge	yes	2	2	0	0	0	0	0	0	4
		unk	5	1	0	0	1	0	0	0	7
5 a	Action taken	no	23	5	0	1	13	0	2	1	45
		unk	3	0	0	0	1	0	0	1	5
b	Obvious	yes	2	0	0	0	2	1	0	0	5
		unk	4	0	0	0	1	0	0	1	6
c	Appropriate	no	3	5	0	0	2	0	0	0	10
		unk	2	2	0	0	1	0	0	0	5
	Total coded		63	21	1	1	38	4	4	12	144

Obstructions were present for 50 per cent of cases. Not surprisingly, this did not differ significantly from the drivers without priority because they were at the same locations.

Thirty-eight per cent of drivers definitely did not see the other vehicle and for 34 per cent it was unknown. This leaves 28 per cent who did see, a higher proportion than for the no priority cases. This was consistent because there was a higher proportion of drivers with priority assuming no conflicting traffic movements as they saw the vehicle but assumed it would stop.

Thiry-one per cent of drivers did not take evasive action, a lower proportion than drivers without priority. In 11 per cent of cases there was obvious action that could have been taken. Twenty-two per cent of drivers took inappropriate evasive action.

Table XIII shows the distribution of RUMs for multi-vehicle crashes where priority was irrelevant. The two most frequent RUMs were RUM 33 (right rear) and RUM 51 (rear end-mid block). Since there were only 28 of these crashes, flow chart decisions have not been cross-tabulated with RUMs. Table XIV shows the total frequency of flow chart decisions for these crashes. Given that the most frequent RUMs were rear-end crashes, it is perhaps surprising that 'following too close' was recorded so infrequently. The findings show that these crashes were more often due to distractions, inadequate positioning of a vehicle, failing to detect the other vehicle or misjudging the speed and distance of the other vehicle.

TABLE XIII
Distribution of RUMs coded for Multi-Vehicle Crashes where Priority was Irrelevant
(Adelaide in-depth data)

RUM	*CRASHES*	*DRIVERS*
24	1	1
33	7	12
34	1	2
37	3	5
43	1	2
44	1	2
51	7	15
63	1	2
64	1	2
65	1	2
85	3	6
86	1	2
TOTAL	28	53

TABLE XIV
Flow Chart Decisions Coded for Drivers in Multi-Vehicle Crashes where Priority was Irrelevant
(Adelaide in-depth data)

FLOW CHART UDA			*DECISION*		
			Yes	*No*	*Unknown*
1	d	No signal			
	e	Speed			
	f	Distraction			
3	a	Obstruction			
	b	Saw other unit		[illegible]	[illegible]
	c	Look		2	27
4	b	Inadequate control/positioning	10		1
	c	Following too close	5		1
	f	Assumed no conflict	1		
	g	Misjudged speed/distance	8		2
5	b	Obvious action	1		2
	c	Appropriate		2	1

Most frequent flow chart decisions

Table XV presents the most frequent flow chart decisions and summarises the types of crashes in which they occur. The Table shows that the most frequent decisions, in descending order, were 'assumed no conflicting traffic movements', 'failed to see', 'visual obstruction', 'distraction', 'BAC >0.05 g/100 mL' (not a flow chart decision but data already available and so able to be treated as one), 'excessive speed', 'inadequate control', 'inappropriate evasive action', 'misjudged speed or position', and 'ped ran onto road'. It can be seen that the most common type of crash for the top four flow chart decisions was RUM 21 (cross traffic).

There was much overlap between the different flow chart decisions, e.g. a large proportion of those who assumed no conflicting traffic movements did not see the other vehicle. *Table XVI* shows a matrix of each of the most frequent flow chart decision cross-tabulated against each other.

TABLE XV
Distribution of Most Frequent Flow Chart Decisions for the Most Frequent Types of Crashes and Different Road Users (Adelaide in-depth data)

TYPE OF CRASH	*Conflict*	*Saw (no)*	*Obstruction*	*Distraction*	*BAC >.05 g/100mL*	*Speed*	*Control*	*Appropriate (no)*	*Misjudge*	*Ped ran onto road*
PED. ACC										
-ped		20	15	5	5					24
-driver		22	16	5	2			1		
BICYCLE										
CRASH		6	6							
-cyclist	9	9	6	1	0	1	3	1	2	
-driver	14			3	0	3		1	1	
SINGLE										
VEHICLE										
-Rum 52				5	6	0	3	3		
-Rum 82				6	10	2	15	1		
-Other				5	17	15	25	4		
-Total				16	33	17	43	8		
MULTI-VEHICLE										
-Rum 21	106	80	78	20	13	29		6	5	
-Rum 24	32	19	21	5	6	0		6	5	
-Rum 31	69	37	46	16	3	2		2	3	
-Rum 44	16	9	5	6	1	1		1	1	
-Other	20				7			2		
-Total	243	160	155	62	30	38		17	21	
TOTAL	265	217	198	92	70	59	46	28	24	24

	Conflict	*Saw(no)*	*Obstr*	*Distrac*	*BAC*	*Speed*	*Control*	*App.(no)*	*Misjudge*	*Ped ran*
Conflict		160	150	47	55	35	0	12	0	0
Saw(no)			148	47	51	30	0	7	0	18
Obstr				23	38	23	0	6	0	15
Distrac					32	6	11	4	8	5
BAC						22	22	13	5	13
Speed							15	8	2	0
Control								7	0	0
App.(no)									2	0
Misjudg										0
Ped ran										

The Table shows that there is high correlation between the three most frequent flow chart decisions. Of the 265 drivers who assumed no conflicting traffic movements, 60 per cent had not seen the other vehicle and 59 per cent had a visual obstruction. Also 62 per cent of those who did not see the other vehicle had a visual obstruction. This suggests that a large proportion of drivers assumed no conflicting traffic movements because a visual obstruction prevented them seeing the other vehicle.

'Distraction' was the next most frequent flow chart decision. This decision occurred proportionally more often with a 'no' response to the 'saw other unit' decision than any other flow chart decision.

BAC's greater than 0.05g/100mL occurred most frequently in combination with 'inadequate control' in single vehicle crashes. Also 'speeding' and 'lack of control' are frequently both coded for drivers involved in single-vehicle crashes. Both of these results are consistent with the analysis of single-vehicle crashes.

'Misjudged speed or distance' and 'pedestrian ran onto road' occurred most frequently in conjunction with BAC greater than 0.05g/100mL.

5 DISCUSSION

First, the flow chart developed during this stage of the Project has been shown to be both reliable and informative when applied to information from an in-depth study. While the reliability for allocating RUMs and Lohman UDAs were high, the reliability for the flow chart was slightly higher, despite the increased detail. It appears that the systematic approach to driver information and the clear criteria aided the reliability of the flow chart decisions. The flow chart provided more practice on decisions because once a particular type of crash is being coded, the same decisions are encountered each time, rather than only one error being assigned per crash. The fact that the criteria for making flow chart decisions were designed by the coders may have also been a factor.

The next stage in the Project involves other coders using the flow chart for police report forms. This will give a better indication of how well the chart can be used by those who were not involved in its design and whether it can obtain enough information from the police forms.

In addition to being reliable, the flow chart results also need to provide valid information. The different types of crashes are compared below with other studies to obtain an indication of the validity of the flow chart responses. It will also allow comparison between various previous studies.

2.5.1 Pedestrian Crashes

The flow chart was able to accommodate most of the pedestrian crashes; 81 per cent were coded.

It was also able to give quite detailed information about what happened. The most common type of pedestrian crash involved pedestrians stepping onto the road from the vehicle's side of the road. In most cases the vehicle was not seen by the pedestrian although there were visual obstructions in only a small proportion of these crashes. From the data it is not possible to determine whether the pedestrian did not look for a vehicle or whether he looked but failed to see. The second most frequent type of pedestrian crash involved a pedestrian emerging from behind parked vehicles. Again a large proportion of vehicles were not seen by the pedestrian. Many of the pedestrians in this category were children and so the parked vehicle may have been responsible for obstructing both the pedestrian's and driver's view.

In the tri-level study only one category was available specifically for pedestrian crashes, and this was called 'pedestrian ran into traffic'. Treat *et al.* state that typically such crashes have involved people running out into traffic, often without looking at all, many such pedestrians being children. It is difficult to compare this finding with the present study because the frequency of not looking was not known and Treat does not give enough information about the situations in which these crashes occurred.

The TRRL in-depth study gave a greater range of errors to be attributed to pedestrians. One hundred and forty seven crashes in their study involved pedestrians (Sabey and Staughton 1975). *Table XVII* shows the distribution of errors in the TRRL study and a comparison with this study where similar categories could be determined.

In order to gain an estimate of 'failed to look', half of the unknowns were added to 'no' responses. This is not accurate but a reasonable approximation. It is interesting that this result is very close to that found in Sabey and Staughton. Examination of the other categories also reveals the results to be quite comparable.

2.5.2 Bicycle Crashes

Eighty-six per cent of bicycle crashes were coded by the flow chart. Thus the results have shown that the flow chart is able to cater for bicycle crashes. There were not enough bicycle crashes to enable the results to be compared with other studies.

TABLE XVII
Comparison of Driver Errors Assigned in TRRL Study with Similar Combinations of Flow Chart Decisions Coded in this Study with Adelaide In-

TRRL study (Sabey and Staughton 1975)	*% of Crashes*	*This study*	*% of crashes*
Lack of care	78.9	No applicable category	
Failed to look	46.3	Look (no) + 1/2(unk)	43.8
In dangerous position	25.9	Priority irrelevant	17.1
Looked, failed to see	15.6	Looked (yes) + Saw (no)	11.4
Distracted	13.6	Distraction	
Misjudged speed/distance	6.8	Misjudged	8.6
Wrong decision	0.7	No applicable category	
SAMPLE SIZE	147	SAMPLE SIZE	43

2.5.3 Single-Vehicle Crashes

There were 68 single-vehicle crashes, 87 per cent of which were able to be coded by the flow chart.

Forty-eight per cent of drivers involved in single-vehicle crashes had a BAC greater than 0.05g/100mL. The most frequent flow chart decision was 'no control'. This is consistent with the results of Storie (1975) who found that the most frequent feature of single-vehicle crashes was that of the driver losing control of the vehicle.

By cross-tabulating 'losing control' with other flow chart decisions it was possible to gain a greater understanding of why the vehicle lost control. More drivers lost control on a straight road than on a curve. Speed seemed to be an important contributory factor for drivers losing control on a curve, while distractions appeared to be highly related to drivers losing control on a straight road.

Twenty-four per cent of drivers failed to detect an object or vehicle on the road. Analysis of the blood alcohol levels revealed an over-representation of drivers with BACs greater than 0.15g/100mL. Since most of these crashes involved hitting a parked vehicle, the results are consistent with those found by Charlesworth *et al.* (1985) which showed an over-representation of drivers with BACs greater than 0.15g/100mL in 'hitting parked vehicle' crashes.

The results show that a detailed picture of what has happened in single-vehicle crashes can be determined by examining combinations of different flow chart decisions. Also, the results appear both logical and consistent with previous studies.

2.5.4 Multi-Vehicle and Total Crashes

Only three of the 170 multi-vehicle crashes could not be coded. Since a large proportion of crashes are multi-vehicle, it is important that the flow chart cater for most multi-vehicle situations.

It is not possible to compare the results of the multi-vehicle crashes with multi-vehicle crashes in other studies because other studies have tended to include these results with total crashes. Thus, the results of all crashes are compared with other studies in *Table XVIII.*

First of all, the results are compared with Treat *et al.* (1976). It would be expected that the percentages in the present study would be high because such a large number of decisions were made for each crash. In Treat *et al.* only the most important causal factors were assigned and thus only about one or two causal factors would have been attributed to each crash, where as in this study there was the potential for many UDAs to be recorded per crash. The results reflect this but show considerable consistency in the order of different types of UDAs. While 'assumed no conflicting traffic movement' was higher in this study because it overlapped with so many of Treat *et al*'s categories, the four highest causal factors recorded in Treat are in the same order as the UDAs in this study.

This not only shows that the results are very consistent, but it also shows how adaptable the flow chart is in enabling comparison with other studies.

Comparison with the driver errors recorded in the Adelaide study also supports this. *Table XIX* shows the percentages of the highest ranking errors in the Adelaide study and compares them with related combinations of flow chart decisions developed in this study. The ranking for both is equivalent. Since the same data have been analysed, it would be expected that the same general results occur, but it again shows how the flow chart decisions can be combined to allow comparison.

TABLE XVIII

Comparison of Causal Factors Assigned in Indiana Tri-level study with Similar Combinations of Flow Chart Decisions Coded in this Study with Adelaide in-depth data

'eat et al. (1976)	%	*This study*	%
Improper lookout	17.6	Saw(no) when (priority(no) + distr(no))	26.0
Excessive speed	7.9	Speed(yes)	19.0
Inattention	9.8	No appropriate code	
Improper evasive action	4.8	Appropriate(no) + obvious(yes)	7.9
Internal distraction	5.7	Outside(no)	16.0
Improper driving technique	6.1		
Inadequate defensive driving	2.4	Assumed no conflict(yes)	37.0
False assumption	4.5		

McLean et al. (1979)	*(%)*	*This study*	*(%)*
Fail to accomodate to visual restriction	20.3	Saw(no) + obstr(yes)	25.4
Secondary activity	13.9	Distraction	15.8
Inadequate monitoring	11.3	Saw(no) + obstr(no)	11.7
Insufficient information available	5.3	No applicable code	
Travelling too fast	4.2	Speed(yes)	10.1
Fail to respond appropriately in emergency	2.9	Obvious(yes) + approp (no)	7.9
SAMPLE SIZE	583		583

By examining *Tables XVIII* and *XIX* it becomes clear that while the different categories used in Treat *et al.* and McLean *et al.* mean that the list of driver errors are quite different, when the flow chart has been combined to fit the different definitions as closely as possible, the different list of errors are really due to the different definitions applied.

Table XX shows the distribution of 'unsafe driving actions' found in Lohman *et al* and the distribution of these same errors which were recorded in this study. The definitions should be very close because the definitions described in the Lohman study were applied to each crash.

TABLE XX
Comparison of UDAs Coded in North Carolina study (Lohman et al 1976) with the Same UDAs Coded in This Study Using Lohman et al's Definitions with the Adelaide In-depth Data

Lohman's Unsafe Driving Actions	*Lohman et al.(%)*	*This study (%)*
Following too closely	16.0	4.6
Pulling in front of traffic	9.0	29.0
Backing when unsafe	8.7	0.7
Turning in front of traffic	4.7	15.1
Speeding too fast for conditions	4.5	4.3
Running a traffic control	4.4	3.6
Changing lanes or merging	4.3	0.7
Speeding (above speed limit)	3.7	5.6
Turning too wide or'sharp	3.4	2.6
Driving left of centre	2.8	0.3
Turning from the wrong lane	2.0	2.0
Driving under influence of alcohol	1.2	6.6
Driving too close to kerb side	1.2	7.0
Passing a turning vehicle	1.2	1.0
Improper parked/stopped vehicle	1.1	0.7
Pulling from parked position	1.1	2.3
Hit parked vehicle while leaving	0.8	0.0
No signal or improper signal	0.5	0.7
Going straight in turning lane	0.3	0.0
Crossing the line of a lane	0.3	0.0
SAMPLE SIZE	26 272	304

Comparison of the list of Lohman *et al.* (1976) unsafe driving actions show large discrepancies between this study and Lohman. Some of this could be due to errors in coding. However, this could have only accounted for a very small proportion of crashes. It seems more likely that the sample of crashes examined in this study was very different in the two studies. First, Lohman *et al* confined the analysis to one and two-vehicle crashes, thus eliminating pedestrian, bicycle and more than two vehicle crashes. This differs from the Adelaide in-depth study which included a sample of all road crashes to which an ambulance was called in the Adelaide metropolitan area. Differences may also be due to the fact that the studies were conducted in different countries although the similarity between the results of this study and Treat *et al.* does suggest that that the effect of this factor may be minimal.

The difference between the unsafe driving actions found in this study and those found in Lohman *et al.* shows how important it is to know the sample from which a list of UDAs is derived.

2.6. SUMMARY

In summary, this stage of the Project has developed a flow chart for coding driver behaviour in road crashes. The flow chart has been found to be both reliable and able to provide detailed information.

The re-analysis of the Adelaide in-depth study has shown that the four most frequent flow chart decisions were 'assumed no conflicting traffic movements', 'failed to see', 'visual obstruction', and 'distraction'. These driver behaviours occurred most frequently in cross traffic crashes. The next most frequent factor in this sample was driving with a BAC greater than 0.05g/100mL. This was found in a high proportion of single-vehicle crashes. 'Excessive speed' was the next most frequent flow chart decision. This occurred in both single- and multi-vehicle crashes, but was proportionally higher in single-vehicle crashes. 'Inadequate control' was the next most frequent and this flow chart decision was only available for single-vehicle crashes. There was a category 'inadequate control or positioning' which was in the 'priority irrelevant' section of the flow chart but this could not be combined with the 'inadequate control' category because inadequate position was also included. In Stage 2 this category will be divided in two to allow combining of these two different flow chart cells. 'Inappropriate evasive action' was the next most frequent decision. This error was distributed through all types of crashes. 'Misjudged speed or position' was the next most frequent flow chart decision and this occured in a range of multi-vehicle crashes, including a few involving bicycle riders. 'Pedestrian ran onto road' was equal in frequency to the 'misjudged' category. This flow chart decision obviously was only recorded in pedestrian crashes.

The study has allowed comparison of results of different previous studies and consequently provided some information on why the results of various studies have differed. It was found that often the results were not so different when the flow chart decisions of this study were combined to match other definitions. Thus, some differences had been due to different criteria used in the different studies. Also, the comparison with Lohman *et al.* (1976) suggested that a difference in sample can greatly affect the list of most frequent unsafe driving actions. This emphasises the need to examine the type of sample from which a list of UDAs has been obtained and cautions people from stating that a particular behaviour is unsafe without defining the level of severity or the type of crash in which the behaviour is unsafe.

The results have also shown that the Victorian Road Traffic Authority's RUM code can successfully provide the situational information required. Where there were enough crashes the combination of RUMs and flow chart decisions provided very useful information on what the driver did and the situation in which he did it.

The main aim of designing the flow chart was to develop a system of assigning driver errors from the police report forms in Stage 2 of the project, because it is at this stage that we determine how effectively driver behaviour information can be obtained from this data source. The real test of the flow chart therefore is how well it performs in Stage 2. Can it be used reliably at this stage and can sufficient information be obtained? Stage 1 has shown that the flow chart can be reliable and informative with in-depth data but is there enough information in the police report forms for it to be successful in Stage 2?

CHAPTER 3:
APPLYING THE FLOW CHART TO POLICE CRASH REPORT FORMS

K.D. Charlesworth

3.1 AIM OF STAGE 2

The aim of Stage 2 was to determine how effectively information on unsafe driving actions could be obtained from police crash forms. Variables relating to crash details such as 'location' and 'time of day' and to driver and pedestrian characteristics such as 'age' and 'sex' are already stored on a file at the Road Traffic Authority. The RTA also codes each crash into road user movements (RUMs). These are the same codes as those used in Stage 1. Thus the mass data contain quite a lot of information, including situational data, but they do not contain information relating to driver behaviour.

Additional behavioural information is contained in the narrative and diagram on the police crash forms but this is not extracted and stored on file. Stage 2 involved using the flow chart developed in Stage 1 to code the behavioural information on the report forms. The coding was done by two independent coders, in order that reliability could be measured.

A specific aim was thus to determine how much information there is on the police forms which needs to be recorded and how reliably this can be done using the flow chart. If enough information can be obtained and if it can be done reliably, then the driver behaviour information (flow chart decisions) can be analysed in conjunction with the variables which already exist on the mass accident data file. If little driver behaviour information is obtained, this will be either because insufficient information is available on the police crash forms or because the method adopted is not suitable for extracting the information.

It was decided that both rural and metropolitan crashes would be included in the sample under four severity levels (fatal, hospitalised, medical attention and property damage) and that both Victorian and South Australian data sources would be used. Crash data from 1984 were selected as they were the most current complete data set then available.

3.2 PROCEDURE

3.2.1 Obtaining the Stratified Sample

A total of 1600 crashes were selected (800 from Victoria and 800 from South Australia) made up of 200 cases of each of the four injury levels (100 metropolitan and 100 rural).

'Metropolitan' covered crashes on roads with speed limits less than 100 km/h and 'rural' covered crashes on roads with speed limits of 100 km/h in Victoria or 100-120 km/h in South Australia.

In Victoria, five injury levels are assigned to people involved in crashes:

(1) Killed or died within 30 days
(2) Injured, admitted to hospital
(3) Other injury, requiring medical attention
(4) Other injury, not requiring medical attention
(5) Not injured.

For the purpose of this analysis, levels (4) and (5) were combined to produce four injury levels - fatal, hospitalised, medical attention and property damage. A crash was classified into these four injury levels based on the most severe injury received in the crash.

In South Australia, people involved in crashes are categorised into five different injury levels:

(1) Not treated
(2) Treated by private doctor
(3) Treated at hospital
(4) Admitted to hospital
(5) Fatal

In order for the injury levels to be as consistent as possible with Victoria, level (1) became 'property damage', levels (2) and (3) were combined to create 'medical attention', level (4) became 'hospitalised' and level (5) remained entitled 'fatal'.

To select the 100 crashes in each cell (a cell being a sample of crashes of a particular injury level and area, e.g. fatal - metropolitan), the total in each cell was determined for both Victorian and South Australian 1984 data (*Tables XXI* and *XXII*). In order to obtain a sample of 100 crashes from the data set, the first step was to determine the percentage of the total number of crashes in a cell which was required. There were, for example, 325 fatal metropolitan crashes in Victoria in 1984. Thus, 30.77 per cent of the total was required for a sample of 100 crashes.

TABLE XXI
Type of Injury by Location of Crash (Victorian Mass Crash Data, 1984)

TYPE OF INJURY	*LOCATION OF CRASH*	
	Metropolitan	*Rural*
Fatal	325	259
Hospitalised	4798	1536
Medical Attention	7985	1337
Property Damage	22215	2969

TYPE OF INJURY	*LOCATION OF CRASH*	
	Metropolitan	*Rural*
Fatal	110	92
Hospitalised	1740	630
Medical Attention	5570	695
Property Damage	28095	2254

The next step was to use the sample procedure in SPSS to select a random sample (e.g. 30.77 per cent of the total Victorian metropolitan fatal crashes). This procedure rarely resulted in exactly 100 crashes, usually deviating by up to five. When the result was less than 100, the procedure was repeated.

When the result was greater than 100 crashes, a program was used to randomly delete crashes until there were only 100. This procedure was carried out for each cell for Victoria. For South Australia, the total frequency of fatal-metropolitan and fatal-rural crashes was so close to 100 crashes that these totals were used. For all other cells 100 crashes were selected using the above procedure. All mass data for those crashes were then stored on a separate file.

3.2.2 Collection of Reports

The report forms for these crashes were collected from The Road Traffic Authority. A list of the accident numbers in the sample was easily obtained from the file storing the sample data. For property damage crashes in Victoria, a large percentage of crashes could not be obtained because the '513' report forms which contained the diagram and police narrative were often not sent to RTA. For all other categories, and for the South Australian data, there were very few missing report forms.

3.2.3 Adapting the Flow Chart

In order to check whether the flow chart would be adequate for all types of crashes (since it previously only needed to cater for Adelaide metropolitan casualty crashes), the distributions of RUMs in Victoria and accident types in South Australia were examined.

'Hit animal' was such a frequent RUM in rural crashes that it was decided to include this category in the single-vehicle section of the flow chart. The only other alteration was in the 'priority irrelevant' stream of the flow chart, where 'inadequate control or poor positioning' was divided into two separate flow chart decisions. This was because the inclusion of property damage crashes resulted in more crashes in the 'priority irrelevant' stream because of the increase in rear-end and overtaking crashes. By separating the 'inadequate control or poor positioning' decision, more details on crashes of these types would be coded. This also led to further minor alterations in that section of the flow chart. The flow chart as used in Stage 2 is given in Appendix C.

3.2.4 Assigning Flow Chart Decisions

Two coders were instructed on how to use the flow chart. Twenty crashes from the Adelaide in-depth study were used as practice items.

Since there were so few Victorian property damage crashes, it was decided to begin analysing these first. The forms were coded in the same order. After the Victorian property damage crashes were completed, one from each cell was coded and this same order was followed until completion of the Victorian data. Analysis of the South Australian data followed.

3.2.5 Storing of Data

At this point it is necessary to detail how the data were stored, because this process was important in enabling matching between different files in order that the two coders' responses could be checked for reliability and the flow chart decisions could be amalgamated with the mass data. In addition, it was important to minimise human error, and since there were so many report forms to be coded, the method of recording needed to be the most efficient in terms of speed and accuracy. The ideal system would have been to have the coders input their responses directly into the computer via a terminal. However, without sophisticated software, this may have led to too many errors, including deletion of information. Thus a more manual process was designed.

The two coders were each given a list of the accident numbers. The coders wrote the flow chart decision and the response (Y)-yes, (N)-no, (U)-unknown, or (I)-irrelevant, and followed each response by a letter designating which driver or pedestrian was being coded. Coding of vehicles were followed by 'A', 'B' and 'C' respectively and a pedestrian was followed by 'P'. (Questions 1(a) to 1(g) were only answered if the response was 'yes' or 'unknown').

The following is an example for a pedestrian crash:

32968 1DYA 1HNA 3ANA 3BUA 3CUA 3DYA 3EYA 6AYA 6CUA 5AUA 5BUA
1HNP 3ANP 3BUP 3CUP 3DYP 3ENP 7ANP 7BUP 7CUP 7DNP

Eg. 1HNA = (a 'no' response to question '1H' for driver A)

The coders also noted those reports which were uncodable or unavailable. It should be noted here that the coders found this procedure satisfactory and, after practice, were able to code about ten reports per hour.

The data was then punched into the computer. A separate file was constructed for each coder's responses. It was intended that the key punch operator would use a file which already contained the accident numbers and add the flow chart decisions. The operator felt that it would be more efficient to begin a new file and copy the accident number from the sheets which contained the flow chart decisions. This, unfortunately, decreased efficiency because there were many errors in the accident numbers. A program was designed to check the accident numbers in the two coders' files so that errors could be detected and manually altered. This was a time consuming process.

A program was then written to move the responses for particular flow chart decisions to specific columns and drivers/pedestrians to particular lines. 'No' was provided as the default reponse for questions 1(a) to 1(g). Also, all alphanumerics were converted to numerics. The above example, at this stage is:

```
32968 1 22212222  24411      44 1 4
32968 2
32968 3
32968 4 22222222  24412         2442
```

The next step was to delete lines with no flow chart information in order to improve the speed of further processing.

The mass data and flow chart decision files then were arranged to allow their amalgamation. As in stage 1 of the project, the SIR database management system was used. The files consisting of the flow chart decisions for coders 1 and 2 became records 3 and 4. Record 1 was the mass data including selected variables relating to the crash, e.g. 'time of day', 'RUM'. Record 2 included variables relating to the driver and pedestrian. It was necessary to adapt the data in the mass accident data file so that information relating to each driver and pedestrian was stored on a separate line in a way which allowed matching with the same driver in records 3 and 4. Accident numbers were used to relate each crash on each record and the number of the person (1, 2, 3, or 4) was used to relate the drivers and pedestrians.

The SQL language in SIR was used to analyse the data.

3.3 RESULTS

3.3.1 Victorian Data

Unavailable Report Forms

Of the 800 accident numbers requested, 154 were missing according to coder 1, and 152 according to coder 2. Of these they agreed for 147 crashes. This small amount of error could be due to forms being misplaced between the two coders or one of the coders may have coded 'unavailable' for the wrong accident number. Of the 147 agreed upon, 135 were property damage crashes. These were unavailable because, as already explained, many of the '513' police report forms are not sent to the Road Traffic Authority.

Uncodable

According to both coders, 14 crashes could not be coded. There was disagreement on only one crash. Of the 13 agreed upon, six were fatal, three were hospitalisations, three required medical attention and one was a property damage crash. Twelve of the 13 were crashes involving pedestrians.

Matched Data

After excluding uncoded and unavailable reports there were 627 crashes in record 3 (flow chart responses for coder 1) and record 4 (flow chart responses for coder 2) which matched on accident number. This meant that there were 1038 drivers/pedestrians whose flow chart responses could be compared between the two coders. It should be noted here that not all drivers of a particular crash may match because if one coder has coded two drivers and the other has coded one, there will be mismatching for the second driver. Likewise, if one driver has coded a driver as the driver of vehicle A and the other has coded a driver as the driver of vehicle B there will be a mismatch. The same problems occur when records 3 and 4 are being matched with record 2 (driver information). If the RTA coder has coded a driver differently to coder 1 or 2, mismatches occur. Of the 1085 drivers for whom a form was available according to coder 1, 1057 matched with record 2. All crashes in records 3 and 4 matched with those in record 1 (crash information). While it should be kept in mind that some data were lost due to mismatching, overall it appeared to affect only a small proportion of crashes.

Reliability

Table XXIII gives the amount of agreement between the two coders for each of the flow chart decisions which represent unsafe driving actions (UDAs). There was agreement for 68 per cent of cases for which coder 1 had attributed an error. In cases where coder 1 had responded that there was no UDA or that it was unknown, there was 90 per cent agreement. There were a few decisions which appear to have particularly lower agreement than average. In cases where coder 1 responded 'no' to 'saw other unit' there was only 46 per cent agreement; 'poor positioning' resulted in 32 per cent agreement and there was only 26 per cent agreement for cases where coder 1 responded that there was obvious evasive action that could have been taken. Thus, while there was quite good reliability in assigning flow chart responses overall, there were a few exceptions which should not be overlooked.

Table XXIV gives the distribution of 'yes', 'no', and 'unknown' responses attributed by coder 1 for flow chart decisions. Very few UDAs were in fact recorded. The highest recorded UDAs in descending order were: 'assumed no conflict', 'inadequate control', 'saw other unit-no', and 'ran control'. However, due to the high proportion of 'unknown' responses, this may not be a true indication of the most common UDAs. Note that 'inadequate control' appears in both the single-vehicle and multi-vehicle sections of the flow chart. It was the single-vehicle decision which accounted for the highest frequency of UDAs.

In order to gain an understanding of why there were so many unknowns, it is necessary to examine the proportion of 'unknown' responses for individual flow chart decisions. First of all, the proportion of 'unknowns' was particularly high for flow chart decisions relating to pedestrian crashes. This is consistent with the finding that most 'uncodable' crashes were pedestrian ones. This would suggest that there is very little information on pedestrian and driver behaviour on these report forms. This implies that the police crash reports contain relatively less information on these types of crashes.

There are other flow chart decisions which were expected to be difficult to determine and therefore would result in a high proportion of unknowns. As expected, 'saw other unit' and 'failed to look' have a high proportion of

TABLE XXIII
Extent of Agreement Between Coders of Flow Chart Decisions: Victorian Police Crash Forms, 1984.

FLOW CHART DECISION	*UDA present (Coder 1)*		*UDA not present or unknown (Coder 1)*		*Total matched drivers*
	Agree	*Disagree*	*Agree*	*Disagree*	
1 a Suicide	0	0	1006	17	1023
b Asleep	7	1	957	58	1023
c No headlights	1	0	1018	4	1023
d Inadequate signal	0	1	1003	19	1023
e Excessive speed	9	9	862	143	1023
f Distraction	38	14	964	7	1023
g Out					
h Single					
2 a Hit animal	6	0	221	0	227
b Fail to detect	12	8	168	18	206
c Inadequate control -(single-vehicle)	152	8	5	0	165
3 a Obstruction	54	39	597	84	774
b Saw other unit	50	58	549	108	765
c Look	7	31	541	62	641
d Ped being coded					
e Driver being coded					
4 a Priority					
b Following too close	31	9	265	23	328
c Inadequate control -(multi-vehicle)	39	9	200	23	271
d Poor positioning	17	37	144	21	219
e Ran control	53	11	62	13	139
f Assumed priority	2	1	107	25	135
g Assumed no conflict	216	28	124	54	422
h Misjudged speed	2	16	455	103	576
5 a Evasive action taken					
b Obvious action	22	64	429	252	767
c Appropriate action	25	1	0	32	58
6 a Driver priority					
b Disobeyed rule	3	0	1	2	6
c Assumed ped	2	2	24	8	36
6 a Pedestrian priority					
b Misjudged vehicle	0	3	43	9	55
c Ped ran onto road	7	7	36	7	57
d Assumed driver	3	1	29	0	33
TOTAL	758 68%	358	9810 90%	1092	

unknowns. Another flow chart decision which would appear to be one which would lead to a high frequency of 'unknowns' is 'distraction'. The result, in fact, is that there were no 'unknown' responses for this flow chart decision. This raises the question of the criteria upon which coders make a decision. They were instructed to respond 'yes' if there was evidence that a behaviour was performed, 'no' if there was evidence that a behaviour was not performed, and 'unknown' if they did not know if a behaviour was performed. At the same time they were instructed to try to be consistent so that they would maintain reliability with the other coder, and endeavour to minimise unnecessary unknown responses. In the case of 'distractions', it appears that coder 1 has responded 'no' if there was no evidence of a distraction, assuming that if a distraction was involved it would have been included on the report. This certainly appears to be a false assumption for this particular flow chart decision. *Table XXV* compares the frequency of 'unknown' responses for both coders for each flow chart decision and reveals that this applies to coder 2 in addition to coder 1.

Table XXV also shows that while overall there is a similar rate of assigning 'unknown' responses between coders, 'excessive speed' appears to be a particular case where there is a substantial difference. This suggests confusion over the criteria for this particular decision. If there is no evidence of speeding, does the coder put 'no', assuming that evidence would have been there if speeding had occurred, or do they put 'unknown' in this situation?

TABLE XXIV

Distribution of Flow Chart Decisions Coded by Coder 1 (Victorian Police Crash Forms, 1984)

FLOW CHART UDA			DECISION				
					Unknown		
			Yes	No	Number	% of Total	Total
1	a	Suicide	0	1028	9	1%	1037
	b	Asleep	8	946	83	8%	1037
	c	No headlights	1	1032	4	0%	1037
	d	Inadequate signal	1	1021	15	1%	1037
	e	Excessive speed	19	837	181	17%	1037
	f	Distraction	53	982	4	0%	1039
	g	Out					
	h	Single					
2	a	Hit animal	6	230	0	0%	236
	b	Fail to detect	22	177	16	7%	215
	c	Inadequate control -(single-vehicle)	175	1	4	2%	180
3	a	Obstruction	96	637	61	8%	794
	b	Saw other unit	91	122	587	73%	800
	c	Look	47	42	633	88%	722
	d	Ped being coded					
	e	Driver being coded					
4	a	Priority					
	b	Following too close	44	289	26	7%	359
	c	Inadequate control -(multi-vehicle)	55	219	35	11%	309
	d	Poor positioning	67	175	16	6%	258
	e	Ran control	70	76	7	5%	153
	f	Assumed priority	5	124	24	16%	153
	g	Assumed no conflict	256	15	174	39%	445
	h	Misjudged speed	29	376	209	34%	614
5	a	Evasive action taken	149	346	455	48%	950
	b	Obvious action	89	209	514	63%	812
	c	Appropriate action	46	59	40	28%	145
6	a	Driver priority					
	b	Disobeyed rule	4	4	1	11%	9
	c	Assumed ped	4	0	33	89%	37
7	a	Pedestrian priority					
	b	Misjudged vehicle	4	13	39	70%	56
	c	Ped ran onto road	14	5	38	67%	57
	d	Assumed driver	4	22	26	50%	52

While the lack of UDAs extracted from the reports can partly be explained by some confusion over criteria and some decisions being particularly difficult, there are more general issues. Is there simply not enough information on the report forms? An examination of a few individual report forms does suggest that even in cases where there was some evidence of a behaviour being performed, the coders were reluctant to record it. This may be explained by the high emphasis on reliability. In cases where they were not sure they have tended to respond 'unknown'. This would be a sound approach except it appears that there were probably too many cases in which this was happening, resulting in a loss of information. A more lenient approach may have increased the incidence of recorded UDAs.

A further factor, which may be affecting the number of UDAs extracted from the police forms, is the injury level of the crash. In order to examine this, the distribution of errors at different injury levels is presented in *Table XXVI*. It appears that there are fewer UDAs recorded in fatal crashes than other injury levels. This presumably is due to drivers being killed and therefore unable to be interviewed. Hospitalised crashes account for the highest number of UDAs and this may be because police are more likely to interview drivers of these crashes rather than those requiring medical attention or involved in property crashes. While there are differences between the different injury level crashes, they do not contribute significantly to the overall low rate of recording of UDAs.

TABLE XXV
Comparison of 'Unknown' Responses Given by Coders 1 and 2 for Flow Chart Decisions Involving a UDA (Victorian Police Crash Forms)

FLOW CHART DECISIONS			*Coder 1*	*Coder 2*
1	a	Suicide	9	16
	b	Unconscious	83	97
	c	No headlights	4	0
	d	Inadequate signal	15	19
	e	Excessive speed	181	273
	f	Distraction	4	0
	g	Out		
	h	Single		
2	a	Hit animal	0	1
	b	Fail to detect	16	9
	c	Inadequate control (single-vehicle)	4	11
3	a	Obstruction	61	71
	b	Saw other unit	587	578
	c	Look	633	615
	d	Ped being coded		
	e	Driver being coded		
4	a	Priority		
	b	Following too close	26	18
	c	Inadequate control (multi-vehicle)	35	12
	d	Poor positioning	16	18
	e	Ran control	7	12
	f	Assumed priority	24	24
	g	Assumed no conflict	174	176
	h	Misjudged speed	209	182
5	a	Evasive action taken	455	309
	b	Obvious action	514	554
	c	Appropriate action	40	3
6	a	Driver priority		
	b	Disobeyed rule	1	3
	c	Assumed ped	33	38
7	a	Pedestrian priority		
	b	Misjudged vehicle	39	44
	c	Ped ran onto road	38	42
	d	Assumed driver	26	8
TOTAL			3234	3133

TABLE XXVI
Distribution of the Most Frequent UDAs at Different Injury Levels (Victorian Police Crash Forms, 1984)

Injury level	*FLOW CHART DECISION* Conflict	Control	Saw (no)	Obstruc.	Ran control	Total	Total Number of drivers	% of drivers with UDA
Fatal	66	54	34	20	18	192	313	61
Hospitalised	81	53	52	37	24	247	321	77
Medical attention	79	54	27	28	20	208	299	70
Property damage	30	14	9	11	8	72	104	69

3.3.2 South Australian Data

Tables XXVII, XXVIII and *XXIX* present the South Australian equivalent to *Tables XXIII, XXIV and XXV. Table XXVII* shows that agreement for UDAs present was 73 per cent whilst that for UDAs not present or unknown was 93 per cent. This result is similar to that found for Victoria. Again, disagreement was particularly high for 'saw other unit' and 'obvious action'. Unlike the Victorian data, 'poor positioning' appears to have reasonable agreement.

TABLE XXVII

Extent of Agreement Between Coders of Flow Chart Decisions (South Australian Police Crash Forms, 1984)

FLOW CHART DECISION	*UDA Present (Coder 1)*		*UDA not present or unknown (Coder 1)*		*Total matched*
	Agree	*Disagree*	*Agree*	*Disagree*	*drivers*
1 a Suicide	1	0	1157	3	1161
b Asleep	4	0	1094	63	1161
c No headlights	0	1	1158	2	1161
d Inadequate signal	1	2	1139	19	1161
e Excessive speed	5	3	1054	99	1161
f Distraction	54	31	1060	16	1161
g Out					
h Single					
2 a Hit animal	10	0	320	5	335
b Fail to detect	20	12	262	19	313
c Inadequate control -(single-vehicle)	269	3	1	0	273
3 a Obstruction	40	25	686	61	812
b Saw other unit	32	34	645	100	811
c Look	2	14	609	44	669
d Ped being coded					
e Driver being coded					
4 a Priority					
b Following too close	30	2	258	53	343
c Inadequate control -(multi-vehicle)	15	9	219	30	273
d Poor positioning	26	19	165	31	241
e Ran control	58	12	67	14	151
f Assumed priority	0	1	119	27	147
g Assumed no conflict	215	38	174	44	471
h Misjudged speed	1	17	508	85	611
5 a Evasive action taken					
b Obvious action	1	77	720	162	960
c Appropriate action	30	1	0	15	46
6 a Driver priority					
b Disobeyed rule	3	0	1	1	5
c Assumed ped	0	1	34	2	37
7 a Pedestrian priority					
b Misjudged vehicle	0	2	38	8	48
c Ped ran onto road	2	4	41	3	50
d Assumed driver	1	0	38	9	48
Total	820 73%	308	11567 93%	915	

TABLE XXVIII
Distribution of Responses Given by Coder 1 (South Australian Police Crash Forms, 1984)

FLOW CHART DECISION	*Yes*	*No*	*Unknown*		*Total drivers*
			Number	*%*	
1 a Suicide	1	1193	1	0%	1195
b Unconscious	4	1102	89	7%	1195
c No headlights	1	1193	1	0%	1195
d Inadequate signal	3	1177	15	1%	1195
e Excessive speed	8	977	210	18%	1195
f Distraction	89	1101	5	0%	1195
g Out					
h Single					
2 a Hit animal	11	339	1	0%	351
b Fail to detect	42	284	13	4%	339
c Inadequate control	289	2	2	1%	293
d -(single-vehicle)					
3 a Obstruction	67	723	49	6%	839
b Saw other unit	116	69	654	78%	839
c Look	38	17	667	92%	722
d Ped being coded					
e Driver being coded					
4 a Priority					
b Following too close	37	316	34	9%	387
c Inadequate control -(multi-vehicle)	291	2	3	1%	296
d Poor positioning	59	224	36	11%	319
e Ran control	75	83	12	7%	170
f Assumed priority	2	141	22	13%	165
g Assumed no conflict	263	15	215	44%	493
h Misjudged speed	27	408	247	36%	682
5 a Evasive action taken	116	256	755	67%	1127
b Obvious action	84	187	744	73%	1015
c Appropriate action	33	64	21	18%	118
6 a Driver priority					
b Disobeyed rule	3	0	4	57%	7
c Assumed ped	1	3	41	91%	45
7 a Pedestrian priority					
b Misjudged vehicle	3	6	45	83%	54
c Ped ran onto road	6	3	42	82%	51
d Assumed driver	1	36	11	23%	48

TABLE XXIX
Comparison of 'Unknown' Responses Given by Coders 1 and 2 for Various Flow Chart Decisions (South Australian Crash Forms)

FLOW CHART DECISION		*Coder 1*	*Coder 2*
1 a	Suicide	1	2
b	Unconscious	88	83
c	No headlights	1	0
d	Inadequate signal	15	7
e	Excessive speed	210	258
f	Distraction	5	2
g	Out		
h	Single		
2 a	Hit animal	1	0
b	Fail to detect	13	8
c	Inadequate control-single-vehicle	3	9
3 a	Obstruction	49	57
b	Saw other unit	654	660
c	Look	667	710
d	Ped being coded		
e	Driver being coded		
4 a	Priority		
b	Following too close	34	21
c	Inadequate control-multi-vehicle	3	24
d	Poor positioning	36	30
e	Ran control	12	13
f	Assumed priority	22	11
g	Assumed no conflict	215	231
h	Misjudged speed	247	230
5 a	Evasive action taken	755	890
b	Obvious action	744	936
c	Appropriate action	21	0
6 a	Driver priority		
b	Disobeyed rule	4	9
c	Assumed ped	41	44
7 a	Pedestrian priority		
b	Misjudged vehicle	45	49
c	Ped ran onto road	42	48
d	Assumed driver	11	7
TOTAL		3939	4339

Table XXVIII gives the distribution of responses for flow chart decisions for coder 1. The pattern for proportion of unknowns appears very similar to that found in Victoria, with a high proportion of unknowns for pedestrian-related flow chart decisions and 'saw other unit' and 'failed to look'. Again, no drivers were coded as being distracted.

The results suggest that the extraction of information in the report forms for Victoria and South Australia are very similar and that the coders were consistent in their use of the flow chart.

3.3.3 Comparison between Stages 1 and 2

Table XXX gives the frequency and proportion of flow chart decisions which represent UDAs for Stage 1, Stage 2 (South Australia) and Stage 2 (Victoria). While the proportion of UDAs recorded in Stage 2 was similar between Victoria and South Australia, there were proportionally more UDAs detected in Stage 1 than Stage 2. This reflects the extra information available as a result of the Adelaide in-depth study and may also reflect the reluctance of coders to assign UDAs in Stage 2. These two factors interact, because the reduced amount of information on the report forms causes the coders to be more cautious.

TABLE XXX
Comparison of Results from Stage 1 (Adelaide in-depth Data), Stage 2 (Victorian Police Crash Forms) and Stage 2 (South Australian Crash Forms)

		Stage 1 In-depth Data		Stage 2 Victorian Police Forms		Stage 2 S.A Police Forms	
FLOW CHART DECISION		Number	%	Number	%	Number	%
1 a	Suicide	4	1%	0	0%	1	0%
b	Unconscious	4	1%	7	1%	4	0%
c	No headlights	2	0%	1	0%	0	0%
d	Inadequate signal	7	1%	0	0%	1	0%
e	Excessive speed	59	11%	9	1%	5	0%
f	Distraction	92	17%	38	4%	54	5%
g	Out						
h	Single						
2 a	*Hit animal*						
b	Fail to detect	17	3%	12	1%	20	1%
c	Inadequate control -(single-vehicle)	46	9%	152	15%	269	15%
3 a	Obstruction	196	36%	54	5%	40	5%
b	Saw other unit (no)	217	40%	50	5%	32	5%
c	Look (no)	38	7%	7	1%	2	1%
d	Ped being coded						
e	Driver being coded						
4 a	*Priority*						
b	Following too close	5	1%	31	3%	30	3%
c	Inadeq. control/position -(multi-vehicle)	11	2%	22	2%	41	4%
d	Ran control	10	2%	53	5%	58	5%
e	Assumed priority	6	1%	2	0%	0	0%
f	Assumed no conflict	265	49%	216	21%	215	19%
g	Misjudged speed	24	4%	2	0%	1	0%
5 a	Evasive action taken						
b	Obvious action	18	3%	22	2%	1	0%
c	Appropriate action (no)	28	5%	25	2%	30	3%
6 a	Driver priority						
b	Disobeyed rule	0	0%	3	0%	3	0%
c	Assumed ped	3	1%	2	0%	0	0%
7 a	Pedestrian priority						
b	Misjudged vehicle	2	0%	0	0%	0	0%
c	Ped ran onto road	1	0%	7	1%	2	0%
d	Assumed driver	0	0%	3	0%	1	0%
TOTAL		538		1023		1161	

One exception is the high proportion of 'inadequate control' in the Victorian and South Australian report forms compared to the in-depth study. This is probably due to the difference in type of samples. The fact that the report forms included rural crashes means that there were more single-vehicle crashes and therefore more situations where drivers lost control of the vehicle.

3.3.4 Mass crash data

It had been intended that the flow chart decisions would be combined with crash and driver information from the mass crash data. However, since so many 'unknowns' were recorded, the UDAs recorded represented too small a proportion of the sample for any analysis in conjunction with the mass crash data to be valid.

Nevertheless, it is still important to determine whether the method used for storing the data allows combination of mass data variables with flow chart decisions. It was decided to crosstabulate a flow chart decision with a variable from record 1 (crash information) and record 2 (driver information).

Table XXXI shows the distribution of RUMs for crashes for which 'inadequate control' (single-vehicle) was attributed. Since this flow chart decision is in the single-vehicle stream of the flow chart, RUMs should be single-vehicle or hit-parked vehicle crashes. The inclusion of RUM 3 (a pedestrian crash) and RUM 15 (a bicycle crash) is dubious, and suggests that a few mistakes do occur. It is possible that Coder 1 has coded a pedestrian or bicycle crash as single-vehicle, or that an RTA officer coded the RUM incorrectly. Nevertheless, two errors in 175 cases is not considered to be a problem.

When 'inadequate control' was crosstabulated with 'sex', it was found that 132 drivers were male, 37 were female, and in six cases the sex was unknown. Thus it appears that the method of storing data has allowed an easy comparison of flow chart decisions with mass crash data.

TABLE XXXI
Distribution of RUMs for Single-Vehicle Crashes for which 'Inadequate Control' was Coded (Victorian Police Crash Forms, 1984)

RUM	*Frequency*	*RUM*	*Frequency*
3	1	73	5
15	1	74	19
41	1	76	4
52	6	81	11
56	2	82	39
62	3	83	13
71	7	84	29
72	29	86	5

3.4 DISCUSSION

The technique was not as successful in Stage 2 as it was in Stage 1. The basic problem was not reliability, but the fact that too few UDAs were recorded. In fact, the fewer UDAs recorded, the higher the reliability, as there was about 90 per cent agreement on decisions where it was found that no UDA was present or it was unknown if a UDA was present or not.

At this stage, it is not possible to be certain why so many 'unknowns' were coded. A proportion of the problem must be due to the smaller amount of information on the report forms compared to the in-depth study. If it is because there is simply no information on the forms regarding particular flow chart decisions, then nothing can be done to improve the amount of information extracted from them.

However, an examination of a very small sample of crashes did suggest that there was some information regarding flow chart decisions which was not used fully by the coders. For example, there were cases where there was evidence of drivers skidding, and coders had not considered that the drivers were speeding. It appears that, because of the emphasis on reliability and the need for extrapolating the information, coders tended to use the 'unknown' category too frequently.

Even if the method for assigning errors was changed, it is possible that there is too little information on the police report forms (and there does appear to be some flow chart decisions for which no information is available). But, without exploring new ways of handling the data, this is uncertain.

The flow chart itself appears to have been very successful. It was easily learnt by coders, it was used quickly and consistently and it seemed to cater for all types of crashes ecountered in the sample. However, the criteria for different responses need to be tightened, the coders need to be encouraged to use the information on the report forms more fully and to code it when they are 'reasonably sure' that an error has been committed. This 'reasonably sure' criterion would need to include some subjective probability and this, of course, could decrease the level of reliability.

An alternative method is to use more than two coders so that the majority reponse is taken as correct. A further suggestion is to use a panel of coders so that alternative decisions can be weighed up and decided upon.

It should be recognised that the coding was quite a quick process and using a panel of coders could result in much longer times being taken to code the reports. If individual coders analysed the reports more fully to extrapolate extra data, then this would also slow the process.

The fact that comparison of flow chart decisions and mass crash data was possible shows that the method of storing the data was successful. If a large number of report forms were to be analysed in the future it would be worth considering the development of software to allow inputting of responses via a terminal with safeguards so that information was not accidently deleted. A system which allowed flow chart decisions to be presented via the terminal would be one approach.

3.5 SUMMARY

The flow chart approach developed in this project and described earlier in this report was applied to a sample of Victorian and South Australian police crash forms in order to assess how effectively unsafe driving actions could be extracted from this source of data. It was found that the Project flow chart was used reliably by two independent coders. The flow chart also had the advantage that it was learnt easily by coders, it was able to be used quickly and it seemed to cater for all types of crashes. Unfortunately, few driver errors were extracted. It appears that this was because the coders adopted a conservative approach in order to maintain good reliability and that this resulted in a very high proportion of 'unknown' responses. This meant that any analysis of the driver errors with other variables from the mass accident data would have been invalid. Two UDAs were crosstabulated with information from the mass crash data in order to test how well the storage of data had allowed such analysis. It was found that the storage of data on the SIR database management system resulted in easy amalgamation of flow chart results with the mass crash data.

If the report forms were to be analysed again with the Project flow chart, a different approach would need to be adopted. Coders should be instructed to code a UDA if there appears to be evidence of it, rather than only assigning a UDA when they are sure. However, because this approach will decrease reliability, it will be necessary to use about six coders, the majority decision being taken as being correct. Alternatively, coders could be grouped in pairs, each pair reaching a decision and the majority taken as correct. It is hoped that this approach would decrease the frequency of 'unknown' responses, and increase the extraction of UDAs.

CHAPTER 4:
STAGE 3 – FEASIBILITY OF OBSERVING UNSAFE DRIVING ACTIONS

P.T. Cairney

4.1 AIM OF STAGE 3

This chapter reports Stage 3 of the study, which was aimed at assessing the feasibility of observing unsafe driving actions (UDAs). This is a key step in arriving at the final product of the investigation, viz. a comprehensive plan for investigating unsafe driving actions.

The focus of this study was necessarily on techniques rather than concrete results. Consequently the report is descriptive in character rather than analytical. As well as exploring observation techniques, the study tried to assess the applicability of newly-developed video analysis equipment to the measurement of speeds and headways. Inevitably, there were problems and some of these data are incomplete.

No attempt was made to follow the procedure laid down by any other single investigator. Rather, the approach was to formulate a systematic observation technique appropriate to the situation in hand, bearing in mind the reported experience of other investigators.

4.2 STATIONARY OBSERVATIONS

A high proportion of urban casualty crashes occur at intersections and junctions. For Melbourne in 1981, Cairney (1986) found that 66 per cent of urban casualty crashes occurred at intersections. Consequently, a careful examination of the driving patterns at intersections was considered a logical first step. In the course of developing the technique, three signalised intersections and two unsignalised T- junctions close to ARRB were selected: since the intent of the study was to establish the viability or otherwise of observing UDAs, sites with high volumes were chosen. One of the signalised intersections had evident operational problems at high volumes, while both the unsignalised sites had operational problems and high crash incidence, relative to other unsignalised sites in their vicinity.

Several preliminary observations were made in an attempt to devise a suitable coding scheme for UDAs. In a situation where direct observation of traffic is involved, many of the aspects of unsafe driving examined in the earlier part of the project cannot be detected. For example, patterns of the drivers' search behaviour or the effect of distractions cannot be detected by unobtrusive observation of traffic. Such behaviour can only be observed in-car. Likewise, the observers' subjective assessment of speeds results in only speeds greatly divergent from the norms being identified.

Since the majority of intersection crashes are of the vehicle-to-vehicle or vehicle-to-pedestrian type, the focus of interest was in the conflicting patterns of vehicle movements. In this situation, the UDA method is almost synonymous with the conflict analysis technique first developed by Perkins and Harris (1967) and subsequently modified along divergent lines by several investigators (see e.g. Asmussen 1984). Although there is divergence in the reported results and in the hypothesised relationship between conflicts and crashes, there is consensus that disaggregation of conflict types is necessary before useful data can be obtained. After a few preliminary attempts with other schemes, the method described shortly was selected as a scheme that covers all the logical possibilities for conflicts and which facilitates identification and recording of conflict types. Trial observations showed this technique was relatively easy to apply.

Preliminary observations also made it clear that reliable results could only be obtained by limiting observations to a restricted number of traffic movements: three approach lanes from the same direction seemed to represent an upper limit. Because of the time needed to organise and record results from memory and rough notes, it is not possible for one person to observe crossing traffic effectively while the stream being observed is stopped at signals. Initial experience with the technique using three observers indicated the need to restrict the area under observation: in most cases, to the roadway immediately before the intersection (about 3-10 m, depending on the site), the intersection itself, and 10-20 m of carriageway beyond the intersection. As experience with the technique accumulated, a reasonable level of agreement between observers was attained.

Video recordings of traffic movements at the intersection were made while the observations were in progress. These were effected by means of the ARRB Video Trailer, a facility which enables a video camera to be raised on a gas-operated telescopic mast to a height of some 10 m above the intersection (Troutbeck and Dods 1986). The main purpose in making these recordings was to compare the video recordings with the field observations. These records also provide scope for objective measurements of traffic behaviour and may also be useful in that they provide a permanent record of events, from which behaviours of interest can be scrutinised in greater detail.

The ARRB Video Analysis Data Acquisition System (VADAS) was used to analyse the traffic movements recorded on cassette to provide vehicle counts data and, where appropriate, vehicle speeds and headways. To date, only enough data have been fully analysed and presented to demonstrate the possibilities of the method.

4.2.1 Observational Technique

Observers were provided with a supply of recording forms showing the pattern of possible conflicting movements at intersections. These forms are illustrated in *Figs 2a* and *2b*. Only conflicting movements with vehicles travelling in the direction in which the observers were looking were recorded, whether these conflicts resulted from movements by crossing traffic, traffic from the opposite direction turning across the traffic stream, or traffic travelling in the same direction. No attempt was made to include conflicts involving cyclists or pedestrians. Observers were instructed to record, in the appropriate cell of the diagram, all instances where there was evidence of a particular combination of movements resulting in an evasive movement by one of the vehicles. In practice, the evasive manoeuvres observed consisted of either braking or swerving, and only a small subset of the possible conflicts were observed in any number.

After initial examination of the site, boundaries to the area to be observed were agreed. In the case of signalised intersections, observations began with the onset of the green signal, or the green turn arrow in cases where a leading green-arrow turn phase was provided, and concluded with the last vehicle to clear the intersection after the onset of the yellow signal. Records were tidied

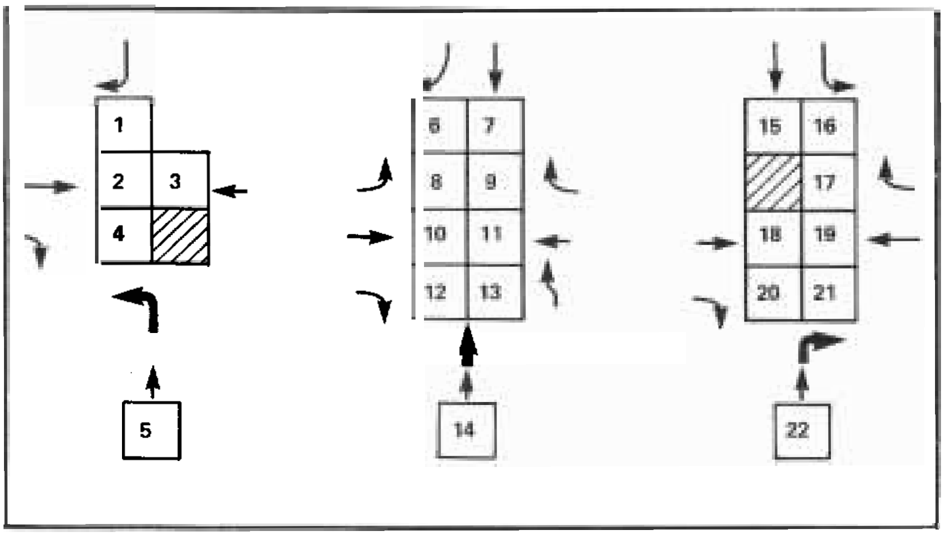


Figure 2(a) - Movement types for intersection observations

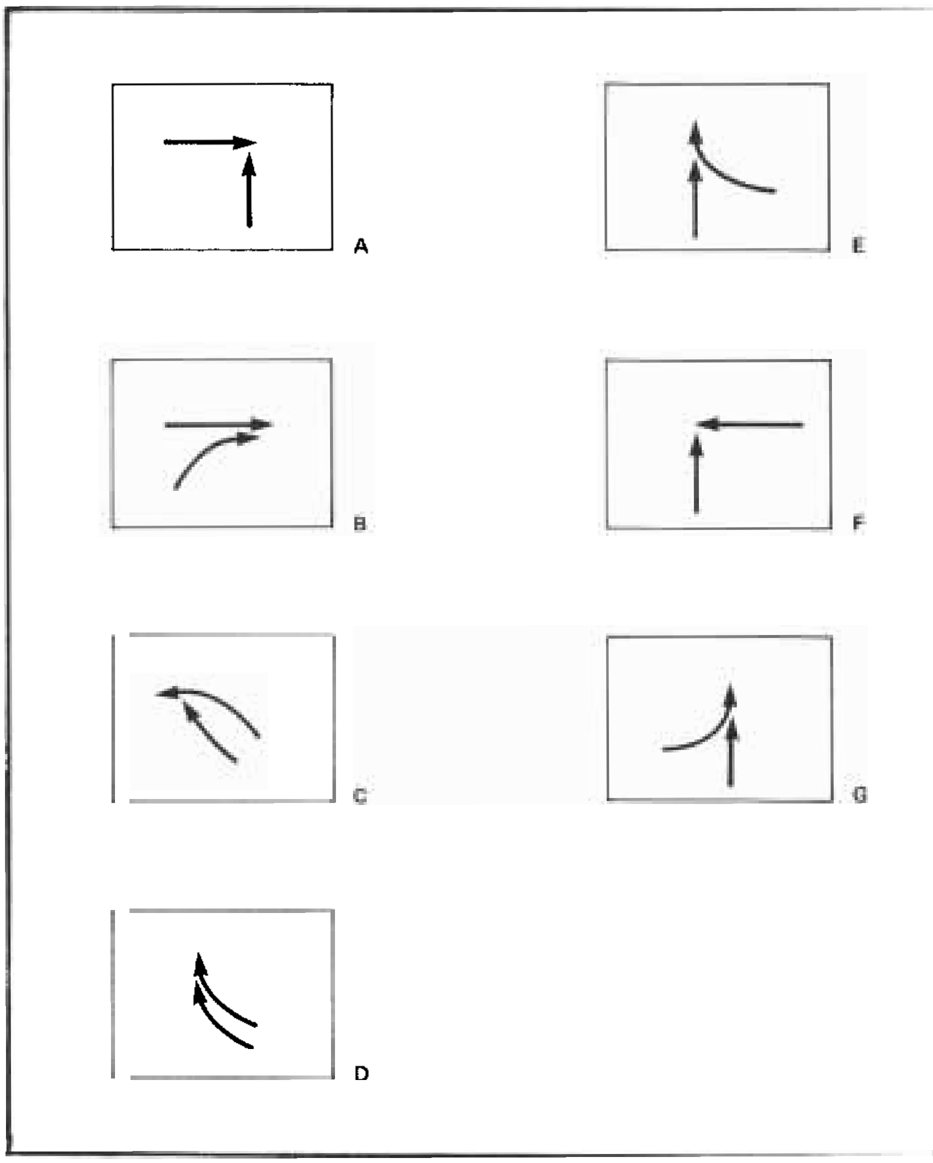


Figure 2(b) - Movement types for roundabout observations

up and systematised during the period when the crossing traffic had priority, as observers sometimes had insufficient time between events during the green and yellow periods to record all events. In the case of non-signalised intersections, the observation period was broken up into 5 minute segments. As fewer conflicts were observed at these sites, there was no need to provide a break between observations.

4.2.2 Video Observations

The video trailer was positioned near the intersection, the pneumatic mast raised and the camera manipulated using a remotely-controlled pan and tilt mechanism to achieve a satisfactory view of the intersection. In most cases, the view was from above and slightly behind the observers' position. The outline of the road scene as seen through the camera is shown along with the conflict and speed data for each site (Appendix D). Although the process of erecting the camera was very obvious to drivers, the apparatus was fairly inconspicuous once in position. The trailer is similar to the type used by public utilities, and the grey pole looks like lighting or other similar poles. Although a few drivers were obviously aware of the camera, the majority seemed unaffected by its presence.

The high mounting was necessary in order to enable detection of separate traffic streams. At lower levels, vehicles can easily be obscured by other vehicles making accurate volume, speed and headway determinations impossible. The high mounting overcomes this problem. It was thought that the high mounting might similarly overcome any problem of conflicts being obscured by other traffic. The conflict patterns were analysed by having the observers view the video record, using the same definitions and procedures as they used in the field. A digital clock output was recorded on the video record, allowing precise matching of events recorded on video with those recorded in the field.

4.2.3 Speed and Headway Data

The video tapes were analysed using the ARRB video analysis system. This equipment detects changes in luminance level at a number of pre-selected points on a video image. Detection occurs if the change in luminance level departs from the resting state by a set amount: comparison with a reference point which is not affected by the traffic ensures that the system is not responsive to changes in ambient illumination.

The system allows for up to 15 detector points plus one reference point to be deployed on the screen. Whenever a detector point is triggered, the event is recorded on an ARRB VDDAS data logging system. Output from this system is then available for further analysis. Fuller technical descriptions of the system and its underlying principles are given by Troutbeck and Dods (1986) and Dods (1982).

Analysis programs have been developed which allow the user to specify paths connecting a number of detector points (Troutbeck and Dods 1986). The output from the system includes a listing of the times at which vehicles following the nominated path passed through the point on the path designated as the control point. From this, counts of vehicles undertaking particular manoeuvres were easily found.

With 15 points available, it was generally possible to record up to five movements satisfactorily in each screening. Where image size and camera positions permit, it is possible to record other manoeuvres with subsequent runs through the tape. It was possible to process the major manoeuvres of interest on a single run. These manoeuvres varied according to site characteristics, but generally included all through movements, and volumes for at least one lane of crossing traffic.

The deployment of detector points is shown subsequently on the outline diagram of each site (Appendix D), and arrows indicate each traffic movement which defined a path through the points. For convenience, observations at each site were divided up into two or three periods, sometimes of unequal length. Actual counts are presented in the summary tables accompanying each site diagram.

A computer program was written which extracted speed and headway data from the output of the manoeuvre analysis program. By having detector points at known distances apart, it was possible to utilise the time between successive detections to calculate the speed of the vehicle. The time between successive detections at a nominated point gave headways directly. Unfortunately, this analysis is complicated by the fact that traffic slows down when confronted with a yellow or red light. As an approximation to recording only freely-flowing traffic, only vehicles travelling in excess of 10 km/h were recorded. To exclude noisy data, an upper limit of 100 km/h was set.

The video analysis system has a facility which allows events to be entered on the data cassette, along with the output from the detector points. In retrospect, this could have been used to indicate periods where traffic was starting up following the onset of the green signal, free-flowing periods, and periods when the traffic began slowing down again following the onset of yellow.

The speed and headway data were then analysed via SPSS to eliminate headway data for vehicles falling outside the specified range of speeds and to obtain frequency distributions for both speeds and headways. Summary statistics are presented in each site report.

4.2.4 Site Reports

Site reports are presented in Appendix D. Data are reported separately for each observation session, as the camera position was varied slightly on different visits to the same site. The diagrams for each session were traced in outline from the video image so that the roadway configuration and the position of the recording points were reproduced very precisely.

The first column of the table accompanying each diagram refers to the conflict type, the second column to the number of each type of conflict detected by only one of the observers, and the third column to the number detected by both observers: the headings of the subsequent columns are self explanatory.

For the Melbourne sites, casualty crashes occurring between 1979 and 1981 are given, broken down by RUM codes. These do not translate readily into the conflict types used in the present study.

4.2.5 Results

Results of the conflict observations from all Melbourne sites are summarised in *Table XXXII*. It is obvious that more incidents were detected with observers in the field than could be seen from the video. In part this is due to difficulties in restricting field observations within defined boundaries and in part it is due to the very different impression gained from the two methods. The lower viewing angle of the field observer made it appear that vehicles came close to making contact, when in fact it is apparent from the overhead view offered by the camera that often they did not. The sounds of braking and acceleration, which are absent from the video record, may also be a factor which affects judgement in the field.

Bearing in mind the exploratory nature of the study and the observers' lack of training and experience, a reasonable degree of agreement was obtained. Column 3 of *Table XXXII* shows the number of incidents which both observers detected, and Column 4 shows this as a percentage of total incidents detected by all observers. Summarised over all incident types, there was agreement in 54 per cent of cases. Agreement was particularly good for cross-traffic conflicts (Type 11 - 100 per cent), rear-end with left-turners (Type 5 - 64 per cent) and rear-end, same-direction (Type 14 - 63 per cent). It was poorer for right against conflicts (Type 6 - 28 per cent) and lane change conflicts (Type 13 - 34 per cent) because both of these were confused with rear-end conflicts. It was often not clear whether the primary reason a vehicle was slowing was to safely pass close to a vehicle waiting to make a right turn, or to avoid a rear-end collision with the vehicle in front. Similarly, the lane change manoeuvre caused braking by following vehicles and there was confusion amongst the observers as to how to code this. Agreement was similarly poor between observers for conflicts involving right-turning cross traffic with through traffic –Types 12 (44 per cent) and 9 (36 per cent). These tended to occur at the beginning of the green period for the through traffic: since the potential conflict situation was resolved by the through traffic delaying its start, no evasive action was evident and the existence of a conflict was questionable.

So far as the video records were concerned, taking all possible observations into account, only 134 of the 595 incidents observed in the field could be identified on the video record. Considering reliable incidents to be those

TABLE XXXII
Summary Analysis of Melbourne Intersection Data

MOVEMENT	*FIELD OBSERVATION*						
	At least one bserver	*More than one observer*	*% Seen by two observers*	*Total Video*	*Video and at least one observer*	*Video and both observers*	*% Seen video and both observers*
2							
4	1						
5	47	30	64	8	5	4	13
6	57	16	28	27	7	5	31
7	5			1			
8	2						
9	14	5	36	3	1		
10	1	1	100	1			
11	16	16	100	14	13	3	19
12	9	4	44	5	4	3	75
13	103	37	34	44	29	21	57
14	331	209	63	108	74	59	28
15				3			
16							
17	2	2	100	9			
18							
19							
20							
21							
22							
TOTAL	595	324	54	233	134	96	30

OBSERVATION TIME 11.18 HOURS

recorded on the video and seen by both observers, then 96 of 324 were reliably recognised (i.e. 30 per cent). Of these, only the through traffic with right turner (Type 12 - 75 per cent) and the lane change (Type 13 - 57 per cent) showed reasonable agreement. The reasons for this have already been discussed.

Turning to the conflict types themselves, over half were of the rear-end type. Many other investigators have found these to be of limited value in predicting crashes, and many investigators exclude them from consideration. Of the types of conflicts which are most commonly implicated in serious crashes (i.e. the cross traffic conflict Types 10 and 11, and the right-against conflict Type 6) few were observed, and very few observed reliably. Only at one of the Melbourne sites, the Station Street/Canterbury Road intersection, were there many conflicts, and it was apparent that most of them were the result of parking immediately downstream of the intersection. With the beginning of the clearway provisions at 4.00 p.m. the conflicts diminished as the parked cars moved. Although this intersection stood out in terms of its conflict history, its crash record was not substantially different from the other intersections observed.

As can be seen from the site reports and the summary in *Table XXXIII*, very few conflicts were detected at the Adelaide sites: the summary Table reinforces this point. The level of agreement, 54 per cent, corresponds exactly with that obtained from the Melbourne observations. *Table XXXIII* shows that most of the conflicts observed were once again of the rear-end type. One site, the Britannia roundabout, accounted for more than half the conflicts. Of the conflicts at the intersection sites, 25 of the 46 conflicts were observed by both observers.

TYPE	*Number detected by one observer*	*Number detected by both observers*
6	1	2
13	1	4
14	12	17
15	4	2
16	1	0
19	2	0
TOTAL	21	25

In view of the small numbers of conflicts observed, the video tapes were not examined to see how reliably these events could be identified. Instead, it was decided to concentrate intensively on the Britannia roundabout data to determine how well the field observations and the video recordings could be reconciled. The tape was wound back for a few minutes' play time, and the segment re-run two or three times before it was agreed that no incident could be detected. This resulted in 62 per cent agreement between the video record and the field observations for the morning sessions and 78 per cent agreement between the video and field observations for the afternoon session.

In the course of these second viewings of the videos, many more incidents came to light, and many of the incidents reported by one observer in the field were confirmed. As can be seen from the site reports (Appendix D), most of the conflicts observed during the morning session were of type D, which involved an entering vehicle conflicting with a vehicle on the roundabout. For the evening session, type C was dominant; this type involved another vehicle on the roundabout cutting in front of a vehicle on the roundabout in order to exit.

Thirty-four conflicts were identified by the observers in the field compared to 30 identified on the first run of the video. Although the effect is small, the field observations again resulted in more conflicts being detected than did the first examination of the video tapes. Although agreement between observers in the field was less than would ideally be desired, experience with this site showed that, with persistence, good agreement between video and field observations could be achieved. However, the time for analysis was approximately four times as long as the time taken to observe the data in the field.

4.3 CAR-FOLLOWING TECHNIQUE

As an alternative to stationary observation, unsafe driving actions were observed from a moving vehicle. This method generally followed that of Lohman *et al.* (1976), but at this exploratory stage, the categories of unsafe action observed were left open, each unsafe action being recorded soon after it occurred. Categorisation was carried out subsequently.

Observations were carried out by the author, a reasonably experienced driver with no claim to special abilities or training, but with a reasonable knowledge of the literature on driving skills and traffic crashes. Observations were made from a moving vehicle, a normal, medium sized saloon car equipped with a digital clock for easy recording of the times at which incidents happened. The investigator acted as both driver and observer. As far as possible, the observation vehicle was kept at a normal, safe distance behind a vehicle travelling in the traffic stream. If that vehicle turned off the route, then the observation vehicle continued until another vehicle was caught up with or overtook the observer's car. Nearly all the observation time was spent following a vehicle. As soon as was convenient after an incident was observed, the observer pulled over and recorded the type of incident, the time, and the approximate location on a map of the route. In no case did the observer allow more than two incidents to occur before pulling over to complete the records, as it was clear that short-term memory limitations would result in unreliable recall if this amount of information was exceeded.

All types of incident were recorded: some were technical offences only, which posed no real danger, such as a motorist who crossed barrier lines marking the edge of a painted island to reach an empty right-hand turn lane, or some failures to signal at one-lane approaches to a road fork. Most of the incidents observed involved lane changes and overtaking manoeuvres.

Since only one observer carried out this phase of the study, there is no indication of the reliability of the results. This is unlikely to be a problem with rural driving since incidents occur very infrequently. There is a greater probability of missed incidents with urban driving, since the driving task itself is more demanding and there is more traffic, and hence more opportunity for incidents to occur. It seems likely that using one person as both driver and observer may result in conservative estimates of the number of incidents.

4.3.1 Urban Routes

The two urban routes were arterial roads close to ARRB, which had featured in the earlier observer- and video-based phase of the investigation. The first route, Canterbury Road between Springvale Road and Elgar Road, was approximately 5.4 km long (see *Figs 3a* and *3b*). It featured a three-lane divided roadway with a wide median at the east end, changing to a two-lane divided road with a narrow median running through a busy shopping centre. The median being insufficiently wide to accommodate turning vehicles, delays were frequently encountered by traffic in the right-hand lanes. This changed to a four-lane undivided road which passed through another smaller shopping area, where problems were very evident with vehicles pulling out from behind vehicles in the parking spaces close to the intersection.

The second route, Middleborough Road from High Street Road to Springfield Road, intersected the Canterbury road route (see *Fig. 3c)*. Its southern extremity consisted of a steep climb, with a four-lane undivided road section, giving way to a section of divided road, which in turn reverted to undivided road. It differed from the Canterbury Road route in that it had less shopping adjacent to it and it carried a larger volume of heavy trucks.

All observations were made during weekdays in moderate to heavy traffic. Times and outcomes are shown on the site reports.

4.3.2 Rural Routes

The first rural route selected was the Maroondah Highway from the junction of the Warburton Highway just east of Lilydale to the junction with the Healesville-Kooweerup Road, just west of Healesville, a distance of approximately 24 km (*Fig. 3d).* This consists almost entirely of two-lane rural road in open, slightly undulating country, and passes through one small settlement only.

The second route was the La Trobe Valley section of the Princes Highway, starting just east of Yarragon and ending at the eastern end of Traralgon, a distance of approximately 48.5 km (*Fig. 3e).* This route passed through the small settlements of Yarragon and Trafalgar, the larger town of Morwell, and skirted the town of Moe. It included sections of undivided two-lane and four-lane road, divided four-lane road and rural freeway. The section through Morwell included a reasonably busy shopping street and section of divided road with several sets of traffic signals.

4.3.3 Site Reports

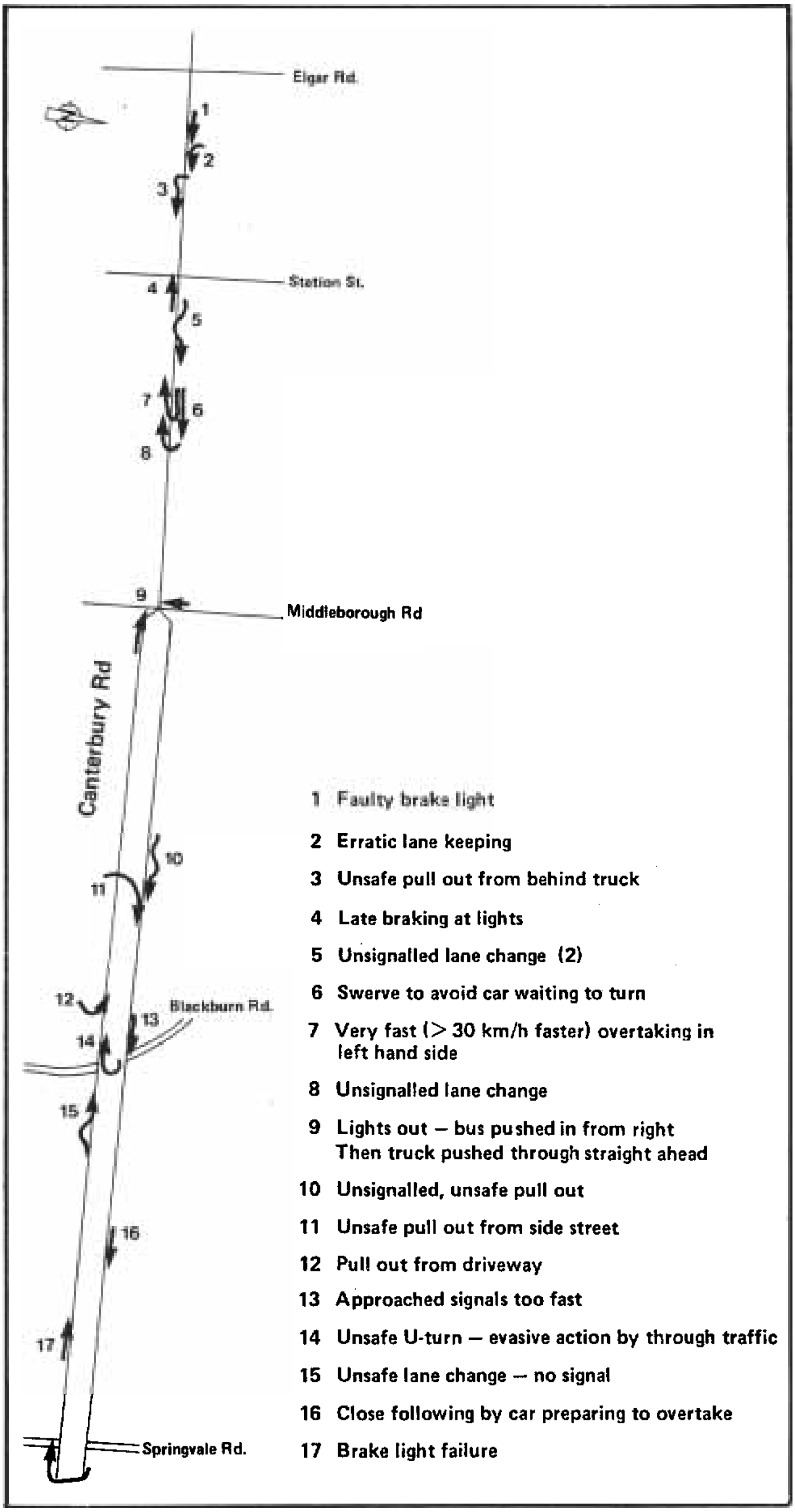


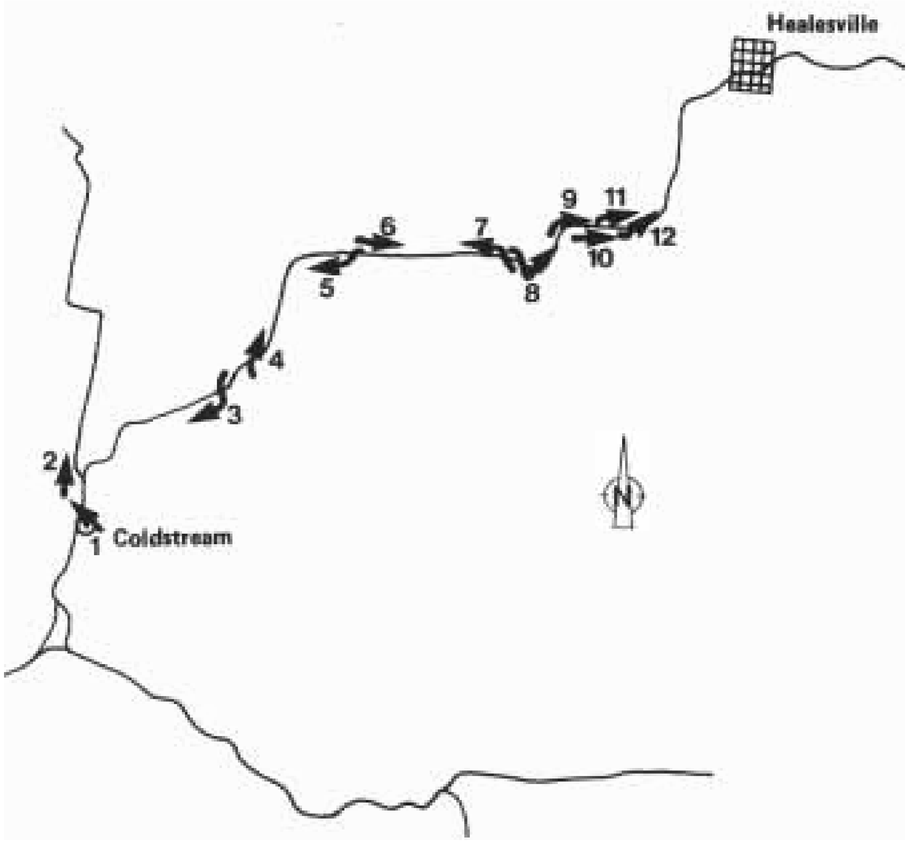
Figure 3 (a) - Observations of UDAs, Cantebury Rd, Session 1

1 Faulty brake light
2 Unsafe pulling from side road – forced braking
3 3 vehicles forced their way in without signalling to avoid parked car
4 Very late change from middle to right lane
5 Small car waiting to turn right, hidden by normal size car behind – unsafe situation
6 Pulling out from behind parked car
7 Edging out from behind parked cars (no signals)
8 Late manoeuvre to avoid road works caused several cars to brake
9 Very fast (> 30 km/h faster) on left
10 2 vehicles tried to overtake on left – conflicting manoeuvre
11 Car backing out from driveway with trailer created unsafe situation
12 Pulled out late from side-street causing braking (mild)
13 Unsafe overtaking on left followed by weave to right
14 Car sticking out
15 Turning van – 3 unsafe overtakings
16 2 cars sticking out
17 Truck waiting to turn through median causing hold-up
18 Very fast overtaking and swerving
19 some problem with car
20 Truck forced way into lane
21 Brake light failure
22 Late left turn from wrong lane
23 Unsignalled lane change
24 Signalled but sudden lane change from left hand lane
25 Pull out from driveway – following car had to brake
26 2 unsignalled lane changes – same car
27 Unsignalled lane change to avoid parked car
28 2 vehicles move towards cenre lane simultaneously
29 Unsignalled lane change
30 Very poor lane keeping

Figure 3 (b) - Observations of UDAs, Cantebury Rd, Session 2 and 3

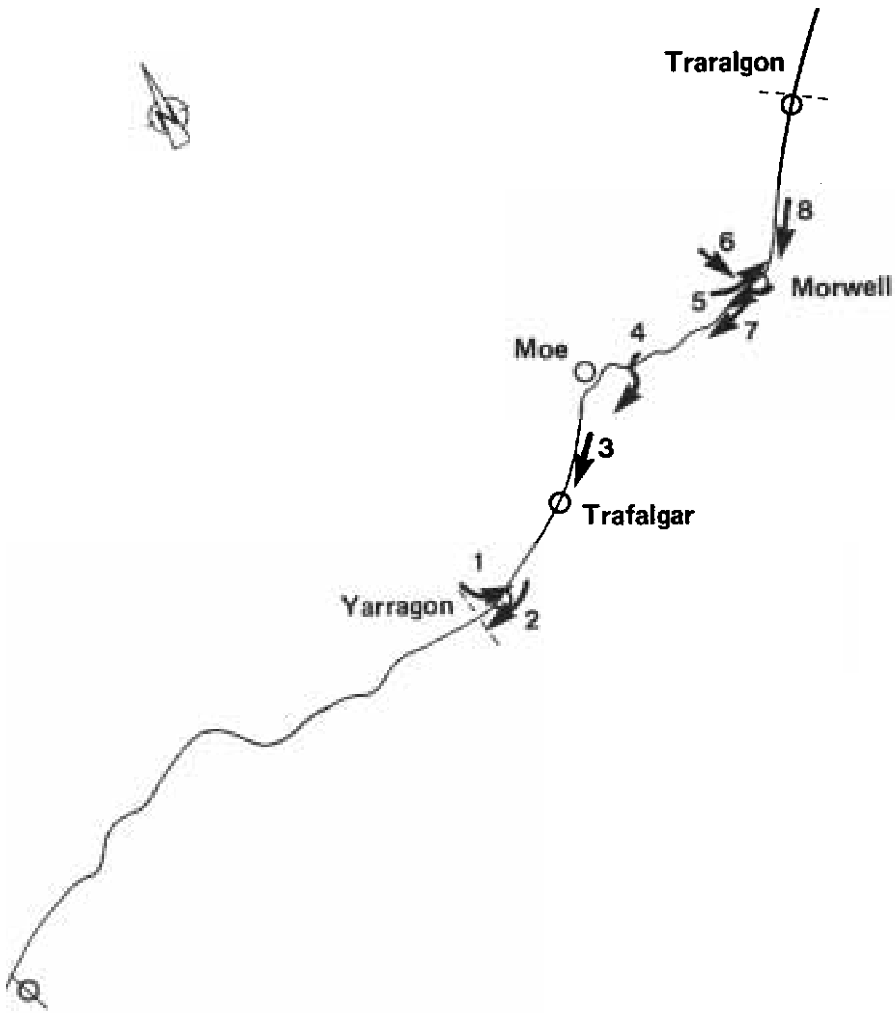
1 Sudden overtaking by truck
2 Overtook to approach RH turn lane
— crossed barrier lines — technical offence only
3 Unsafe lane change
4 Violent braking —
5 Unsafe pull from behind vehicle making RH turn
6 Erratic weaving around turning vehicles
7 Late turn in front — on red
8 RH turn on red

Figure 3 (c) - Observations of UDAs, Middlebourough Rd



1 Semi reversed across road, blocking both carriageways
2 Unsignalled turn-off
3 Late cutting back in — following cars forced to brake
4 Dangerous late overtaking — 30 m barrier line crossed, oncoming vehicle
5 Overtaking — cut back in late, forced braking
6 2 Motor cycles on wrong side of semi-barrier lines
7 Motorcycle overtook then travelled 100 m on wrong side of semi barrier lines
8 This was an extremely unsafe manoeuvre — overtook a vehicle which was already overtaking, and went onto opposite gravel shoulder before cutting back in face o oncoming traffic — reckless driving
9 Encroached on barrier lines — oncoming vehicle tooted
10 Abandoned overtaking — over 10 m of semi barrier lines
11 Late, but signalled turn-off
12 Vehicle over semi-barrier lines

Figure 3 (d) - Observations of UDAs, Maroondah Hwy



1 Hesitant driving straddled lane
2 3 vehicles went through town at speeds greatly in excess of 60 km/h
3 Overtaken by vehicle which was well across barrier lines
4 Car turning off cut in from centre lane, forcing semi to brake
5 Ute changed lanes without warning at lights, forcing braking
6 Semi forced its way into traffic causing braking
7 Small car travelling slowly held up traffic
8 Bad wobble on semi trailer whilst being overtaken

Figure 3 (e) - Observations of UDAs, Princes Hwy

4.3.4 Results

Urban Observations

The results are summarised in *Table XXXIV.* The Canterbury road sessions resulted in by far the highest number of conflicts, and produced similar estimates of overall conflict rates. The other urban site, Middleborough Road, produced a considerably lower estimate. In both cases, the most frequent type of incident was related to lane-changing, and many of these were related to pulling out from behind parked vehicles, either without signalling or in a manner which required evasive action on the part of other drivers. Turning vehicles blocking the right-hand lane was another major source of unsafe actions on the section with the narrow median strip. Overtaking manoeuvres were yet another major source of incident, many of them the result of hasty manoeuvres to get past right-turning vehicles, although two very fast overtakings on the left were observed: in these incidents, the overtaking vehicle was travelling at speeds well in excess of the 60 km/h limit, and an estimated 30 km/h or more faster than the vehicle being overtaken.

TABLE XXXIV
Results Summary Car-Following Technique

	Canter-bury 1	*Canter-bury 2 & 3*	*Middle-borough*	*Maroon-dah*	*Princes*
OVERTAKING					
Sudden overtake			1		
Very fast overtake	1	2			
Overtaking on left and weave		1	1		
Erratic weaving			1		
Unsafe pull from behind right turning vehicle	1	3	1		
Following too close before overtaking	1				
Conflicting overtaking manoeuvres		1			
Late overtaking				2	
Late cutting back in from overtaking				2	
Reckless overtaking				1	
Crossing barrier or semi-barrier lines			1	5	1
LANE CHANGE					
Unsignalled or sudden lane change	4	6			
Erratic lane-keeping	1				
Pulling out from behind right turning vehicle	2	7			
Forcing way into lane		1			2
Conflicting move to centre lane		1			
Poor lane keeping		1			1
Late manoeuvre to avoid road banks		1			
INTERSECTIONS AND JUNCTIONS					
Unsafe pulling out from driveway	1	1			
Unsafe pulling out from side street	1	2			
Right turn on red signal			2		
Approach to signals too fast, late braking	2				
Priority conflict at non-functioning lights	2				
Unsignalled or late signalled turn-off				3	
Left turn from wrong lane		1			1
SPEED					
Greatly in excess of speed limit					3
Slow vehicle holding up traffic					1
OTHER					
Late detecting stop in front, violent braking					
Backing out unsafely			1		
Turning vehicle blocking lanes					
Hidden vehicle (small car waiting to turn		6		1	
observed by normal size car)		1			
Faulty brake lights	2	2			
Unstable vehicle					1
TOTAL	19	37	8	14	10
RATE PER HOUR	6.2	8	2.7	2.1	1.4

Rather fewer incidents at intersections and junctions were observed. A total of five incidents involving pulling out from driveways or side streets were observed, and two involving disobedience of traffic signals. Two incidents were observed involving fast approaches to traffic signals, and two incidents were observed during a brief failure of the traffic signals at the Canterbury/Middleborough road intersections.

It seemed that many of the incidents observed were technical driving faults rather than seriously unsafe driving actions. For example, one faulty brake light seems unlikely to be a major contributory factor to crashes, and many of the incidents pulling out from behind parked or right-turning vehicles, although they did force following vehicles to brake, seem to have been well anticipated by the following drivers. The one instance of crossing the barrier lines was a technical fault only with no possible safety implications, the lines demarking the edge of a painted island which the driver crossed to reach an empty right-turn lane.

Rural Observations

The rural driving involved situations with much less traffic than the urban driving, and with much fewer opportunities for conflicting traffic movements. Not surprisingly, the overall rate per hour for incidents was much lower, although the observations made in the heavy recreational traffic yielded results only slightly lower than one of the urban sessions.

Apart from three incidents which were technical faults where drivers failed to signal at the junction of the Maroondah and Melba Highways, nearly all the incidents observed on the Maroondah Highway related to overtaking. One of these was a highly irresponsible manoeuvre where a car overtook a car which was itself overtaking, and ran for some distance with two wheels on the gravel shoulder, before cutting back in the face of oncoming traffic. Some of the barrier line infringements were of a technical nature only, such as overtaking vehicles not returning to their own side of the road in time and travelling a short distance straddling the lines. However, in a couple of instances, motorcyclists rode for some distance only just on the wrong side of the semi-barrier lines while they overtook a string of cars; although they no doubt could edge back over if faced by oncoming traffic, this had the potential to create an unsafe situation for the following cars.

Very few incidents were observed on the Princes Highway; nearly all of them occurred in sections of the route passing through the towns. The speeding incidents all occurred at the same time, and involved three cars travelling at least 20 km/h in excess of the 60 km/h limit. Both the 'forcing into lane' conflicts happened in towns, as did the 'slow vehicle' and 'poor lane keeping' incidents. It is suspected that these may have been the result of drivers looking for destinations or facilities.

4.4 COMPARISON WITH OTHER STUDIES

Direct comparisons with the Lohman *et al.* study are difficult as they produced no direct statistics of the different types of conflicts observed, only estimates. The relevant comparison is with their weekday, daytime data, a total of 29 sites. Each behaviour category was observed for an hour at each site. Estimates of the percentage of vehicles committing each of the UDA categories, and estimates of the average number of unsafe actions per hour per site, can be derived from their Table IV-1.

It should be noted that there are considerable differences in the patterns of UDAs at different sites. Of the particularly dangerous behaviours, 'turning in front' was observed at only three sites, producing an average of 0.54 UDAs per site per hour. 'Pulling in front' was observed at only ten of the sites, producing an estimate of 3.47 UDAs per site per hour. In the present study, conflict Types 6 and 22 were equivalent to Lohman *et al's* 'turning in front' manoeuvre. For the Melbourne sites, *Table XXXII* shows that 16 of the Type 6 manoeuvres were agreed upon by more than one observer in 11 h 18 min of observation, yielding an estimate of 1.42 UDAs of this type per site. Manoeuvres 8, 9, 10, 11 and 12 were equivalent to the Lohman *et al.* category, 'pulling in front', and 26 of these were observed, giving an estimate of 2.32 per observation hour. The Lohman *et al* category, 'left of centre' would have been observed had it occurred. No effort was made to count the number of violations of traffic control devices in the present study as the team was more concerned with developing a method for observing conflicts. With some care devoted to the setting up of the video camera, it should be possible to obtain this information in future studies.

Comparison of the number of 'speeders' and 'short headways' can be obtained from the analysis using the ARRB video vehicle presence detector. Because this data analysed is incomplete, the comparison is made on the basis of percentages calculated from the available data and from the Lohman *et al* figures. While *Lohman et al.* found only 2 per cent of vehicles observed had headways of less than 0.7 s, the present study found 21.9 per cent with headways of less than 1 s. Although the comparison is not exact, it suggests that headways observed in the present study tended to be shorter. So far as speeds are concerned, Lohman *et al.* reported 4.8 per cent exceeding the speed limit by 8 km/h or more. In the present study using only the data confined to roads with a 60 km/h speed limit, 9.2 per cent exceeded the limit by more than 10 km/h but less than 30 km/h. A further 3.1 per cent appeared to exceed the limit by 30 km/h or more. This figure seems suspiciously high and could not be accepted without a more careful examination of the data.

In summary, the 'turning in front' and 'pulling in front' manoeuvres were observed at roughly the same rate as the Lohman *et al.* study, and the percentage of drivers exceeding the speed limit was greater. There did appear to be a much larger proportion of drivers adopting shorter headways in the present experiment. Time was not available to make a more precise comparison, but it should be borne in mind that the headway results showed great variability, although this was mainly due to a high proportion of very long headways.

Lohman *et al.* also reported a minor investigation in which they undertook approximately 380 km of daytime driving, using a technique similar to that followed in the present study, but observing only the speeding, left of centre, traffic control device offences, and pulling in front and turning in front UDAs. Other than speeding, the incident rate was approximately 1 per 50 km of travel. In the present study 24 incidents were observed in the course of 1209 km of rural travel, which yields an identical estimate of 1 UDA per 50 km travel. The 326 km of urban travel yielded an estimate of 1 UDA per 5.8 km of travel. If the less serious incidents are discarded, the estimate is probably around 1 per 12 km of travel. Direct comparison with Lohman *et al.* is not possible since they did not disclose how much rural and how much urban travel they undertook. Nevertheless, both phases of both studies are in agreement that turning in front and pulling in front manoeuvres, which are associated with a high probability of a crash, occur very rarely.

Glauz *et al.* (1986) have recently published an interesting account of the expected conflict rates at different types of intersections. The relevant comparison is with their category of medium volume, signalised intersections. They observed 14 such intersections for a total of 26 h 40 min each.

Comparisons can be made between the ratios of different types of conflict found in that investigation and the present one. Their most common type of conflict was the 'slow vehicle' conflict, i.e. a rear-end conflict, Type 14 in the present scheme. Using this as a base the ratios of other type of conflict in both studies can be calculated. The results are given in *Table XXXV.* This is a very crude comparison as it contains some data from unsignalised sites (which contributed very few conflicts) in the present study, and the comparisons depend critically on similarity in definitions of slow vehicle or rear-end conflict. Despite the very obvious differences in the relative occurrence of some conflict types, most of the ratios for comparable movements are within an order of magnitude of each other. Even with a data base as large as that assembled by *Glauz et al.*, a very few conflicts can make an enormous difference to ratios. Consequently, the degree of agreement between the two studies is encouraging, the major difference being the very high proportion of cross-traffic conflicts in the present study. The Adelaide data, however, are greatly at odds with both the other data sets. However, this merely reflects the fact that too few conflicts were observed there for any meaningful analysis to be possible.

TABLE XXXV
Comparison of Results of Present Study with Glauz et al. (1986)

Code: Present	*Description: Glauz et al. (1986)*	*CONFLICTS PER MANOEUVRE*		
		Glauz et al	*Present study Melbourne*	*Present study Adelaide*
22	Right (left*) turn same direction	0.35		
14	Rear end (slow vehicle*)	0.02	0.18	
5	Left (right) turn same direction	0.33	0.14	
6/15	Opposing right (left*) turn	0.08	0.08	0.23
21/19/17	Right (left*) turn from right (left*)	0.0012	0.03	
9/11	Cross traffic from right (left*)	0.0008	0.10	
3	Left (right*) turn from right (left*)	0.0009		
18	Right (left*) turn from left (right*)	0.0014		
12/8/10	Cross traffic from left (right*)	0.0006	0.0096	
4/2	Left (right*) turn from left (right*)	0.0098		

4.5 DISCUSSION

Despite a discouraging start, modifications to the observation technique in terms of limiting the area of the intersection to be examined did bring about reasonable agreement between observers. Although no more than 50 per cent of incidents detected were agreed on by two observers, this is reasonable progress when measured against the years taken to develop comparable techniques elsewhere and the intensive, highly structured 2-3 week training course required to produce trained observers. Thus, from the point of view of being able to develop a reliable technique for field observation, the results are reasonably encouraging.

A reasonable number of conflicts were observed at the Melbourne sites, and the rate at which conflicts and other UDAs were observed, and their relative frequency, were broadly similar to the results reported by Glauz *et al.* (1986) and Lohman *et al.* (1976). However, only 30 per cent of the conflicts identified by two observers in the field were observed on the video. This suggests that the two techniques yield vastly different results. Efforts to develop sophisticated, automated conflict analysis must therefore await the development of a better understanding of the relation between field and video observations.

In other respects, the outcome of this part of the study was less encouraging. In Adelaide, very few conflicts were observed, apart from at the Brittania roundabout site. In Melbourne, most of the conflicts observed happened at one intersection operating near capacity: in terms of its crash history it was no worse than the neighbouring intersections which were also observed. In common with investigators, the types of conflict most likely to be associated with injury-producing crashes were very rare.

Observation techniques could almost certainly be made more reliable by limiting the range of unsafe driving actions or conflicts observed at any time, and by restricting observations to one, or at most two, traffic lanes under most circumstances. This would be achieved at the expense of increasing the amount of time required for the observations and of making an already tedious task even more so. The development of a truly adequate training program for observers would also be necessary to ensure reliable results.

On the basis of the experience in the present study, it seems unlikely that observers using video will detect the same conflicts as observers in the field. Careful viewing of video tapes on a one-pass basis produced about 30 per cent agreement with field observations. The technique was pushed near its limit with the Britannia roundabout data: on the second pass through the tape, the observers referred to the field records and replayed segments of tape several times to pin down specific incidents recorded on the field sheets. Fourteen out of the 18 incidents reported in the field data were detected on the second viewing of the video record: however, forty-three incidents were detected overall using the video. This session alone lasted about twice as long as the field observations, to which must be added the first pass of the video tape. This situation is, besides, not typical: many complex interactions between traffic are constantly happening, so it is not surprising that field observers picked up only a fraction of these.

The video apparatus was useful, however, in producing measures of volumes, speeds and headways. The analysis system was originally developed to record and analyse complex traffic movements, and the ad hoc adaptations which had to be resorted to were time consuming. Although it is not possible to state how reliable the system was in this particular application, its originators claim up to a 97 per cent detection rate, and accurate speed estimates for samples of vehicles (Troutbeck and Dods 1986). It is a considerable advantage to be able to use a system like this which counts several traffic movements, and which can measure speeds in a multi-lane context. With more analysis time, changing the disposition of the analysis points would provide information about more traffic movements in each scene.

This application of the video system is encouraging. Some development work remains to be done with the system, and experience accumulated with new applications. The development of some simple software would greatly aid its application to the present task, and would eliminate the need for much time consuming file-creation and editing. The usefulness of this software will be greatly enhanced if it has the capacity to allow the selection of data in response to external events, e.g. changes in traffic signals.

The car-following aspect of the study was similarly encouraging, even allowing for the very liberal interpretation of UDA adopted. While the rate of incident detection was low for rural weekday driving, this was not unexpected. On the other hand, one of the urban routes did enable the detection of a large number of UDAs. Marginally more UDAs could probably be detected using an observer as well as a driver, and this may also allow more precise location of the UDAs; this could be extremely useful in studies where the focus is on UDAs in relation to the road environment. On the other hand, it does double observation costs. A further improvement might be to use a tape recorder to record incidents, though this may require extensive practice before location information can be adequately encoded. At present, the method is of unknown reliability; this may be a problem in an urban environment where many incidents are occuring, but is unlikely to be an issue in rural driving situations unless the observers are using vastly different criteria, to those used in this study.