FATAL CRASHES INVOLVING HEAVY VEHICLES

K.W. OGDEN,
Professorial Fellow,
Department of Civil Engineering,
Monash University,
Melbourne, Australia

P.F. SWEATMAN,
Road User Research Pty Ltd,
Melbourne, Australia

F. SCHNERRING,
Leader, Traffic Systems Safety Branch, Road Safety Bureau,
Roads and Traffic Authority of New South Wales,
Sydney, Australia

1. INTRODUCTION

In 1989, a major study of crashes involving heavy vehicles in the State of New South Wales (NSW), Australia was undertaken. Part of the study involved a detailed investigation of all fatal heavy vehicle crashes occurring on two principal long distance routes in 1988 and 1989 (Sweatman, et al, 1990a,b).

Figure 1 shows the location of the two routes. These are the two principal interstate routes in NSW, the Hume Highway which runs south-west from Sydney, connecting eventually to Melbourne, Victoria, and the Pacific Highway which runs north from Sydney along the coast, connecting eventually to Brisbane, Queensland.

The key element in this part of the study was a first hand inspection of the site of every fatal crash involving a heavy vehicle (>4.5t gross vehicle mass) which occurred on these two highways. Together with the site visit, attempts were made to assemble as much information as possible about every crash, from a range of relevant sources.

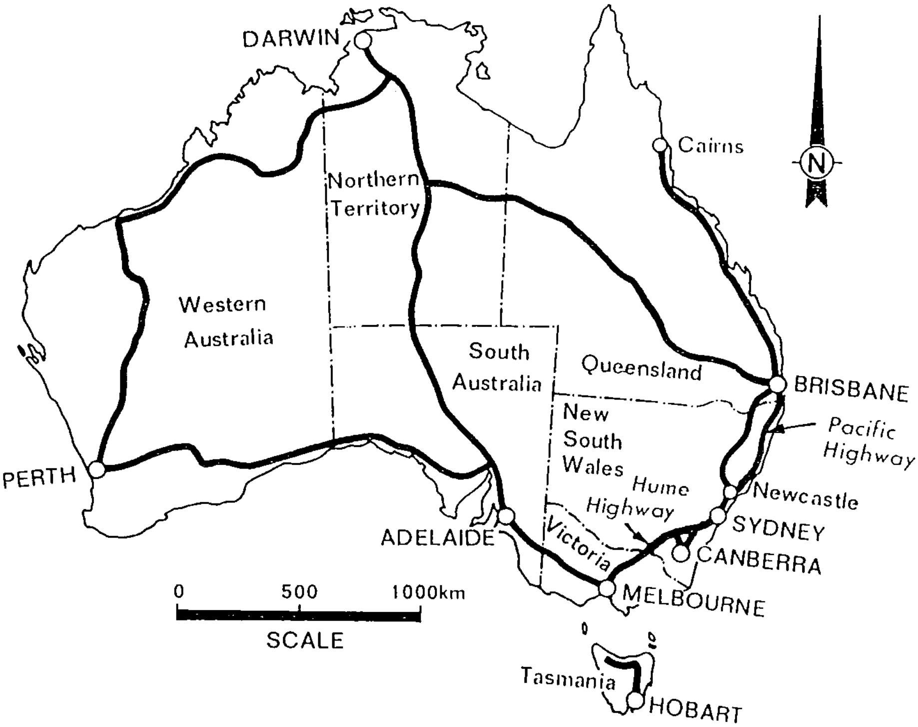
This method was adopted because the State's mass accident data base could not, and was not designed to, provide detailed information about all of the factors involved in each crash. Therefore, it was necessary to seek ways of finding out more about the crashes, including an inspection of each site.

2. THE HIGHWAYS

The area of interest on the Hume Highway ran from the fringe of the Sydney metropolitan area to the Victorian State border, a distance of 536 km. This route is being progressively upgraded, and in late 1989 a total of 266 km of the highway in NSW was divided (49 per cent). However, most of this is at the northern end, where all but a few kilometres of the first 170 km are divided, mostly to freeway standard.

Traffic volumes on the Hume Highway vary considerably, being quite high between Sydney and the intersection with the Federal Highway to Canberra, and much lower in the less populated area to the south. For example, 100 km south of Sydney, the AADT

Figure 1. National Highway Network, showing study routes



is about 20,000 veh/d (20 per cent heavy vehicles), while 70 km north of the Victorian border it is about 5,600 veh/d (35 per cent heavy vehicles).

There were 36 fatal crashes involving heavy vehicles on this highway in 1988 and 1989. There was a degree of clustering of these crashes, with three sections which comprised 27 per cent of the length of the highway accounting for 61 per cent of the crashes.

The area of interest on the Pacific Highway ran from the just north of the junction with the New England Highway (the National Highway route connecting Sydney and Brisbane) to the Queensland border, a distance of 685 km. It should be noted that although the Pacific Highway is not part of the National Highway system, it is used by many long distance and interstate vehicles, mainly because it has fewer hills. It also serves a number of important regional centres along the route which include tourism, agriculture, timber, mining, etc.

The Pacific Highway is generally of a low geometric standard. Virtually none of it is divided (apart from sections through towns), i.e it is a 2-lane 2-way rural highway over most of its length. Traffic volumes are typically about 6,000 - 8,000 veh/d AADT, with about 15 per cent heavy vehicles.

There were 47 fatal crashes on this highway in 1988-89 involving heavy vehicles. There was a degree of clustering here also, with four separate sections which comprised 24 per cent of the length of highway accounting for 47 per cent of the crashes.

3. STUDY APPROACH

The study was predicated on the reality that most crashes involve a multitude of factors, involving the heavy vehicle driver, the road environment, the heavy vehicle itself, and (if present) other road users and other vehicles.

The study approach is presented diagrammatically in the flow chart (Figure 2). The sources of information reflected in Figure 2 were as follows.

3.1 Traffic Accident Data Base

Data from the mass accident data base of the Roads and Traffic Authority was extracted for each crash. This showed a wealth of data, related to the crash (e.g. time, location, weather, speed limit, etc), the traffic units involved (vehicle registration, vehicle type, manoeuvres, speed, number of occupants, etc) and casualties (age, sex, type of casualty, blood alcohol, etc).

3.2 Police Reports

These forms (the P4 form) are completed by police who attend the scene of the crash. They are one of the prime inputs to the mass data base, so there is inevitably some duplication. A very valuable feature of the P4 form was that it included a sketch of the crash manoeuvres, as well as a narrative description.

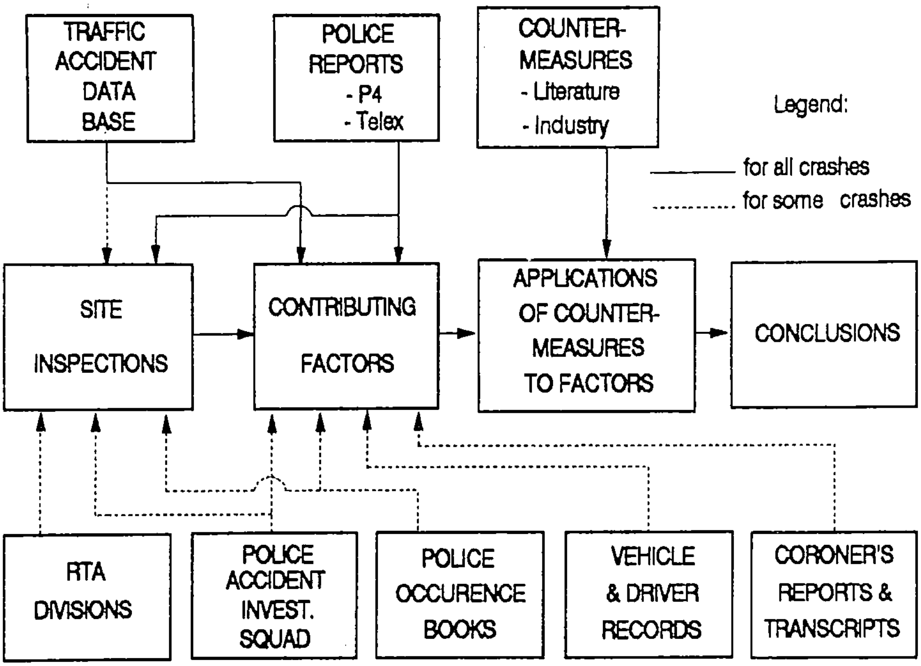
3.3 Police Telex

For all fatal crashes, a telex is forwarded to Police headquarters in Sydney within 2 hours of the crash occurring, and to the Road Safety Bureau of the Roads and Traffic Authority (RTA) within 24 hours. This includes some of the same information as on the P4 (including a narrative), and indicates whether any legal action is contemplated.

3.4 Roads and Traffic Authority Divisions

Most sites were visited in the company of an engineer from the relevant RTA Division. Discussions with these officers was invaluable, as they often were aware of

Figure 2. Study Methodology



the background to the site, whether any remedial works had been undertaken (or were contemplated), and were often familiar with details of the particular crash in question.

3.5 Police Accident Investigation Squads (AIS)

All AIS units covering the length of both highways were visited. The function of an AIS is to prepare prosecution briefs against persons considered responsible for serious traffic crashes. As such, these were often the source of valuable additional information, in the form of witness' statements, mechanical inspection reports, drivers' log book extracts, etc, as well as the investigating officers comments or opinions about the crash.

3.6 Police Occurrence Book

Major events such as fatal road crashes are recorded in these books, kept at each police station. However, the narrative was usually identical to that on the police telex.

Although occasionally examination of the occurrence yielded some useful additional information, this was rare, and it was not considered necessary to visit every police station to inspect the occurrence books. Therefore this source was examined only when a police station was visited for another reason.

3.7 Vehicle and Driver Records

Taking due care to ensure that privacy constraints were observed, attempts were made to ascertain the driving history of all heavy vehicle drivers involved in the crash, while registration records were examined to determine heavy vehicle ownership and some additional features of the vehicle. A total match was not possible, since the match could only be made on the basis of name and address, but some useful additional information was extracted in this way, particularly about differences in the crash involvement of owner drivers and employed drivers.

3.8 Coroners Reports and Transcripts

A coronial enquiry is not held for every fatal traffic crash, and those that are held are conducted in a local court. There is no central registry of enquiries or their results. For this reason, a limited study was conducted of about a dozen coronial enquiries; these yielded useful background (e.g. witnesses statements), but the quantity of hard useful information additional to that which was obtainable from other sources was fairly limited, and so no attempt was made to seek a coronial finding for every crash.

The balance of this paper describes how these data were used, and follows the form of the flow chart.

4. CONTRIBUTING FACTORS

Based upon a literature review and a pilot study of about 15 crashes, a list of potential contributing factors to a crash was developed. There were six categories of factor as follows:

- heavy vehicle driver factors
- car driver factors
- heavy vehicle factors
- car factors
- road factors
- environment factors

The driver factors included driver *states* (i.e non-transient factors such as alcohol, experience) and *behaviours* (i.e. transient factors such as speed, manoeuvres, etc).

The particular factors in each category were as follows: (n.b. fatigue was not coded as a specific factor, since there was rarely evidence of fatigue per se. However, a number of behaviours were coded which could have resulted from fatigue, e.g. asleep, inappropriate evasive action, no avoidance, inattention).

- driver states (heavy vehicle and car drivers; pedestrians; cyclists): alcohol, drugs, ill health, inexperience, attitude (e.g. prior aggressive behaviour, speeding);

- driver behaviours (heavy vehicle and car drivers): excess speed, slow speed, asleep, aggressive behaviour, inappropriate evasive action, over-compensation, no avoidance, inattention, close proximity;

- heavy vehicles: load security, brakes, instability (jackknifing, rollover), other defects;

- car: all factors;

- road: friction, roughness, roadside object, delineation, alignment (horizontal and vertical), sight distance , road standard (divided/undivided; intersection geometry), road works, shoulder;

- environment: rain (raining or wet road), light (night/day), object on road.

These factors were considered for each crash, based upon the information which was available. In each case, the criterion was that the absence of the particular factor might have meant that the crash would not have occurred, or that its severity might have been reduced (i.e. non-fatal).

5. CRASH FACTOR ANALYSIS

Using the above criterion, an assessment was made for each crash of the relevance of each crash factor. Application of this methodology yielded the following results (the percentages shown refer to the proportion of all crashes where the particular factor was considered likely to have been a factor).

- **truck driver states**
  - truck driver attitude (e.g. aggression, not wearing seat belt) - 10 per cent
  - alcohol - 13 per cent
  - driver age not a significant factor
  - driver experience not a significant factor
  - employee drivers over-represented compared to owner-drivers and family drivers

- **truck driver behaviours**
  - excess speed for the conditions - 28 per cent
  - driver inattention - 17 per cent
  - driver falling asleep - 15 per cent
  - inappropriate evasive action - 11 per cent

- **car driver states**
  - alcohol - 14 per cent
  - inexperience - 8 per cent

- **car driver actions**
  - slow speed - 20 per cent
  - driver inattention - 18 per cent
  - driver falling asleep - 11 per cent
  - excess speed - 11 per cent

- **vehicle factors**
  - truck instability - 18 per cent
  - 87 per cent of these in association with poor road alignment

- **road factors**
  - road standard (undivided road) - 80 per cent
  - road alignment (esp horizontal curvature) - 48 per cent
  - roadside object - 33 per cent
  - road shoulder - 24 per cent
  - delineation - 21 per cent

- **environment**
  - night time conditions - 51 per cent
  - wet conditions - 28 per cent

It is of interest to note that if the various road user factors are combined, the importance of fatigue, speed and alcohol is apparent. In particular, falling asleep or driver inattention (which may indicate fatigue) was a factor in 60 per cent of crashes, excess speed was a factor in 39 per cent, and alcohol was a factor in 34 per cent.

6. COUNTERMEASURES

Following the analysis of contributory factors, the next task was to assess the potential countermeasures applicable to each. This required the development of a listing of available or potential countermeasures. This listing was based primarily upon the literature, and included both currently available technology and proposals which are at this stage still experimental (e.g. fatigue detectors, energy absorbing nose cones). Particular attention was also paid to industry views about ways of tackling the problem, both because the industry is concerned about safety, and because the efficacy of many of the countermeasures would be dependent upon their acceptance by the industry.

This is not the place for a detailed discussion of heavy vehicle crash countermeasures, but the listing included measures directed at: vehicles, truck and coach drivers, speeds, roads and traffic, other road users, management and regulation of the industry, research, enforcement, and use of rail.

7. APPLICATION OF COUNTERMEASURES TO CRASHES

Having developed the list of countermeasures, each was then considered for its applicability to each crash. In essence, this stage of the analysis involved an assessment as to whether each countermeasure, had it been present, would have been likely to have prevented the crash from occurring, or reduced its severity. This approach enabled the study to consider a broad range of issues, contributing factors, and potential countermeasures. Much of this phase of the study was conducted in a "conferencing" format, in which a group of people representing a wide range of skills (e.g. traffic engineering, vehicle engineering, driver behaviour, industry perspective, etc) were acquainted with the information, and an assessment was made as to the application of each countermeasure.

It was found that this approach was very useful for assessing factors directly related to the site and circumstances of the crash itself. However, information about factors remote from the crash are rarely known in detail. Thus these factors can only be assessed as relevant to the crash, not as specific countermeasures applicable to that crash. (Examples might include operator licensing, use of rail, etc).

The main countermeasures (those applicable to 25 per cent or more of crashes) are listed below. It should be noted that only the applicability or effectiveness of the countermeasure was assessed, not its cost-effectiveness. As before, the percentages refer to the proportion of total crashes where that particular countermeasure would likely have either prevented the crash or reduced its severity, had it been present.

- **direct countermeasures**
  - divided road - 73 per cent
  - reduced truck front end stiffness - 48 per cent
  - traffic engineering black spot treatment - 32 per cent
  - improved road delineation - 30 per cent
  - improved road shoulders - 26 per cent
  - truck cab crashworthiness - 24 per cent
  - truck seat belt wearing - 23 per cent
  - speed limiters - 21 per cent
  - rumble strips on edge or centre line - 21 per cent

- fatigue detectors in trucks - 20 per cent

factors relevant to crashes

- rail use - 50 per cent
- increased truck payload limits - 50 per cent
- road user education and training (not truck driver) - 39 per cent
- electronic enforcement of speed and alcohol - 28 per cent
- management and regulation of the industry - 24 per cent
- truck driver licensing; demerit system - 25 per cent
- police enforcement at black spots - 23 per cent
- heavy vehicle defensive driving training - 21 per cent

8. CONCLUSIONS

The study enabled conclusions to be drawn about each of the elements of the road system, namely the road, vehicles, heavy vehicle drivers, car drivers, and the road system environment. In addition, some comments can be made about the efficacy of the methodology which was used in the study.

8.1 Roads

8.1.1 Divided roads

There is no question that divided roads are safer; 73 per cent of crashes might not have occurred had the road been divided.

8.1.2 Provision of sealed shoulders

These both lessen the chance of a driver losing control, and provide space to avoid a collision (e.g. rear end collision into a slow or stationary vehicle). Sealed shoulders were considered as potential countermeasures in 27 per cent of crashes.

8.1.3 Delineation

Improved delineation is important, especially at night when much truck activity occurs. Lane and edge lines, raised reflective pavement markers, chevron markers, bridge width markers, etc are all important. Improved delineation could have affected 30 per cent of crashes.

8.1.4 Safety audit

An operational audit of existing roads, aimed at identifying in a systematic fashion the scope and priority for traffic engineering improvements is suggested.

8.1.5 Overtaking lanes

These are of value on highly trafficked 2-lane roads.

8.1.6 Roadwork practices

There is a need to ensure adequate advance warning, safe route and traffic control through the worksite, and ensure that the site is left in a safe condition when work is not in progress.

8.2 Vehicles

8.2.1 Speed limiters

Fitting a device which limits the maximum speed of a heavy vehicle could be valuable in controlling excess speeds on the open road. It is not relevant to crashes where speeds are excessive for the conditions where such speed is less than the speed limit. Speed limiters may have been helpful in 28 per cent of crashes.

8.2.2 Heavy vehicle front end stiffness

Since 48 per cent of crashes were head-on, having a more forgiving heavy vehicle front end may reduce the severity of some crashes. Research is under way overseas on this, and it should be monitored for application in Australia.

8.2.3 Cab crashworthiness

A more crashworthy heavy vehicle cabin may have produced a non-fatal outcome in 24 per cent of crashes. Similar comments could be made about research and application to those made for front end stiffness.

8.2.4 Seat belts in trucks

Truck seat belts may have helped in 23 per cent of crashes. The Australian Design Rules for truck seat belt fitting and mounting are being reviewed, and there is also a need for education and enforcement to encourage more widespread use of truck seat belts.

8.2.5 Fatigue detectors

More research is needed, but an effective fatigue detector is potentially a very valuable countermeasure.

8.3 Heavy vehicle drivers

8.3.1 Licensing, training and driver education

At least 25 per cent of crashes were associated with low level of truck driver skill. There is a need for higher skill levels in the industry, and for a specific training facility for heavy vehicle drivers in NSW as in some other States.

8.3.2 Drugs and alcohol

Drug and alcohol use by heavy vehicle drivers was a factor in at least 8 per cent of crashes. There is a need for education and enforcement of alcohol use, and for more information about drug usage by heavy vehicle drivers.

8.3.3 Control of driver hours

The current situation with the use of log books is ineffective. Control should be more targeted than just aggregate hours, which take no account of previous driving patterns, or other work activities. Research is needed on a more effective procedure and enforcement practices.

8.4 Car drivers

8.4.1 Driver education

The main targets of car driver education, so far as their involvement in heavy vehicle crashes is concerned, are fatigue, inattention, and speed (too fast or too slow).

8.4.2 Alcohol and drugs

As for truck drivers.

8.5 Road system environment

8.5.1 Use of rail

As many as 50 per cent of trucks involved in crashes were on journeys which potentially were suited to rail. Of course, in reality, rail use would be unlikely to gain all of these under any circumstances since factors affecting mode use are varied. Perhaps a better interpretation is to say that even under maximum possible rail use, only 50 per cent of crashes would be affected.

8.5.2 Increased truck payload limits

Similarly, 50 per cent of movements were amenable to carriage by higher productivity trucks (e.g. B-doubles). If the productivity gain is 25 per cent, then there would be maybe a 10 per cent reduction in truck crashes.

8.5.3 Heavy vehicle speed limits

Excess heavy vehicle speed was a factor in 28 per cent of crashes. There is no agreed direct link between a posted heavy vehicle speed limit and safety; as noted above, the study concluded that speed limiters were effective.

8.5.4 Management and regulation of the industry

There is potential for an Operators Licensing system, affecting such things as speeds, hours, drugs, mechanical condition, etc; better management and regulation was relevant to 28 per cent of crashes. While such as system may be based on industry self-regulation, it needs legislative backing. Tachographs are a useful management tool, but there are reservations about their use as an enforcement device.

8.5.5 Speed and alcohol enforcement

Enforcement should focus on these aspects and be targeted to "black spots". There is potential for electronic enforcement, e.g. speed cameras, ignition interlock devices, etc.

8.6 Methodology

8.6.1 Crash analysis

The method of analysis developed and used in this study was efficacious, especially for factors directly related to each crash. Factors remote from the crash ("related factors") cannot be treated with as much confidence.

8.6.2 Data sources

Police-based data sources concentrate on driver factors. There is little follow up on road, vehicle or environment factors, even though attention to these elements can be highly cost-effective in a wider sense. Therefore there is a need for more detailed analysis of heavy vehicle crashes to ascertain factors pertinent to this type of crash.

8.6.3 Speeds and drugs

These factors are clearly important, but at present there is little reliable data.

9. REFERENCES

Sweatman PF, Ogden KW, Haworth N, Pearson RA and Vulcan P (1990) *New South Wales Heavy Vehicle Crash Study: Final Technical Report.* (Federal Office of Road Safety, Canberra).

____ (1990b) *Heavy Vehicle Safety on Major NSW Highways: A Study of Crashes and Countermeasures.* (Roads and Traffic Authority of New South Wales, Sydney).

10. DISCLAIMER

The views expressed in this paper are those of the authors and not necessarily those of the sponsoring or employing agencies.