Vehicle Safety Risk Assessment – Project Overview and Initial Results

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ABSTRACT

The goal of Queensland Transport's Vehicle Safety Risk Assessment project is to obtain a more detailed picture of where crashes of various severity are occurring, the prevalence of various types of crash configuration and the influence of passenger car safety technology on road safety.

The safety of Australian passenger cars has improved substantially throughout the 1990's due to various initiatives including the Australian New Car Assessment Program (ANCAP), new Australian Design Rules and improved safety technology built into vehicles by manufacturers. However, the 1990's also saw a change in the Australian new car market with the emergence of small Korean and Japanese cars and also a larger number of off-road passenger 4 wheel drives (4WDs).

The project will examine the impacts of the vehicle safety improvements and changes in the Australian car market as reflected in Queensland road crash data.

The project will use a recently completed link between Queensland Transport's road crash database and registration database to allow an in-depth review of the Queensland crash data through a breakdown of crash information by speed zone, injury type and severity, number of vehicles, type of crash and vehicle details.

This paper will outline the objectives of the Vehicle Safety Risk Assessment Project and how the objectives are to be met including data analysis chain and limitations on the data. The paper will also include an initial analysis of the first set of crash data that has been linked with the registration computer.

INTRODUCTION

Queensland Transport has a safety responsibility for all road users. To better focus activities, information on the range of crash scenarios on Queensland roads is required.

The safety of Australian passenger cars has improved substantially throughout the 1990's as the result of various initiatives including ANCAP, new Australian Design Rules and improved in-service standards and inspection programs. These initiatives have improved both the active and passive safety of passenger cars.

The improvements in the level of occupant protection that are now available in new passenger vehicles have been demonstrated through laboratory crash tests conducted in the ANCAP and studies conducted by MUARC. Anecdotal evidence indicates there has been improvement in car handling and braking, however, the impact of these initiatives on the Queensland road safety picture is not clear.

The impacts of programs aimed at improving active and passive safety, and the change in the make up of the Australian new car fleet, need to be explored and quantified.

For example, at the beginning of the 1990's approximately 45% of all new cars sold were large "family" cars (i.e. Commodore and Falcon). By 2000 this had dropped to approximately one third with small cars as the largest growing segment of new car sales with the introduction of Korean car manufacturers into the Australian market (VFACTS data for various years).

The increased number of small cars and also a larger number of 4WDs being sold leads to a mass and geometric incompatibility and a potential for greater injuries in the small car occupants in the event of a car to car crash. However, if the use of cars over this time has not significantly changed, eg small cars mainly used in urban areas in low speed zones, the increase in small cars into the Queensland car fleet should not have a detrimental effect on road safety.

A summary of questions that arise from considering the improvements in vehicle technology and the change in the car market are:

1. Is vehicle compatibility an issue in Queensland?
2. What is the effect of the increase of small cars and 4WDs?
3. Are the improvements in occupant protection demonstrated in laboratory crash tests reflected in real crashes?

4. Does the improved handling and braking of newer cars lead to a lower crash rate?
5. Do different groups of cars have different types of crashes in Queensland?
6. Is there a crash (and corresponding occupant fatality/injury) mode that is becoming a larger proportion of the Queensland road toll?

To answer these questions, provide a snapshot of the current situation and identify emerging trends that will assist Queensland Transport in terms of setting its vehicle safety program over the next 5 years it is appropriate to evaluate the crashes that have occurred in Queensland in terms of the performance of the vehicle.

The project will take advantage of the newly acquired ability to link TRAILS (the Queensland registration computer database) and the crash database to give breakdowns of accident information by speed zone, injury type and severity, number of vehicles, size of vehicle, type of crash and vehicle make, model and year of manufacture (YOM).

This information will be used to focus future programs (including ANCAP). It will do this by providing information on which vehicle categories are relevant to testing and if current tests are appropriate or complete.

PROJECT OBJECTIVES AND EXPECTED OUTPUTS

The goal of the Vehicle Safety Risk Assessment project is to obtain a more detailed picture of where crashes of various severity are occurring, the prevalence of various types of crash configurations and the influence of passenger car technology on road safety for input into a revised vehicle safety strategy.

To meet this goal the following objectives have been identified:
1. To collate data on the vehicle crash trends in Queensland.
2. To gain insight into the relative risks associated with various vehicle classes.
3. To identify which crash configurations present high and/or increasing risks of injuries and associated trends.
4. To identify, if possible, the impact of new technology and vehicle accessories on crash and injury trends in Queensland.

From this project the following outputs and links to other major vehicle safety projects and policy development will be created:
1. Tailoring ANCAP crash tests to vehicle construction configuration, e.g. rollover tests rather than side impact for 4 wheel drives.
2. Consumer information for purchasing to gain the safest car for their particular use.
3. Fleet purchasing policy aimed at providing the safest car for their operation while meeting other community and corporate obligations, e.g. reduction in emissions.
4. Vehicle safety policy development especially for input into national standards development and the ability to significantly influence improvements in national standards, e.g. accelerate introduction of international standards into Australian Design Rules.

Initially, it was intended to review the data from periods that aligned with previous analysis of ANCAP crash test results (Hurnall and Coxon, Improvements in NCAP Results for Australian Vehicles, 16th International Conference for the Enhanced Safety of Vehicles, 1998, Windsor, Canada and Hurnall, Western Australia Road Safety Conference, November 1999, Perth) to allow a comparison of the laboratory tests from ANCAP with real world crash data. These analyses have shown that the level of occupant protection in passenger cars has improved since the beginning of the program in 1993 through reviewing the ANCAP results of the major sellers in the Australian new vehicle market in 1993, 1995, 1997 and 1999.

It was intended to link the crash data for these years, i.e. 1993, 1995, 1997 and 1999 with:
1. Speed zones and road types.
2. Injury type (e.g. fatal, hospitalization, minor or property damage) and occupant location.
3. Vehicle make model and market category.
4. Number of vehicles in the crash.
5. Crash type (e.g. head-on, angle, rear-end, rollover, etc).

INITIAL RESULTS

A major new Queensland registration computer system was developed to combine vehicle registration, vessel registration and driver licensing information. The major implementation, which involved migrating registration records from the existing system across to the new system occurred in early 1999. Consequently, any registration data prior to 1999 cannot be easily accessed and this project had to be restricted to crashes from 1 January 1999.

At the time of preparing this paper details of the vehicles involved in crashes in the first 6 months of 1999 were available. This is a total of 14,877 vehicles across all speed zones.

Involvement Rate by Year of Manufacture

The first stage of the analysis is to review all of the crash data to consider if any particular grouping of vehicles by year of manufacture is over represented in crashes. The number of passenger vehicles registered, by year of manufacture, in Queensland during 1999 is taken from the Australian Bureau of Statistics Motor Vehicle Census, Report 9309.0, 31 October 1999. Data for 1999 has been adjusted to represent only the first half of the year.

Table 1 summarises the number of vehicles, by year of manufacture groupings, involved in all crashes and across the main speed zones, 0-60 km/hr, 65-80 km/hr and 85+ km/hr. During 1999 the maximum speed limit in Queensland was 100 km/hr except for approximately 2,000 km of major highways that had a 110 km/hr limit.

Table 1 – Jan-Jul 1999 Crashes by Year of Manufacture (YOM)

YOM	All Crashes		0-60 km/hr speed zones		65-80 km/hr speed zones		85+ km/hr speed zones	
	No.	Multiple	No.	Multiple	No.	Multiple	No.	Multiple
To 1970	159	0.74	117	0.76	19	0.70	23	0.66
1971-78	896	1.08	665	1.12	101	0.96	130	0.97
1979-82	1668	1.11	1221	1.14	213	1.12	234	0.96
1983-86	2468	1.08	1769	1.08	313	1.08	386	1.04
1987-89	1647	0.95	1165	0.94	220	1.01	262	0.94
1990-91	1244	0.94	847	0.89	167	1.00	230	1.07
1992-93	1294	1.00	921	1.00	150	0.92	223	1.07
1994-95	1517	1.02	1105	1.04	180	0.96	232	0.97
1996-97	1584	1.00	1093	0.97	210	1.05	281	1.10
1998-99	1200	0.86	846	0.85	148	0.85	206	0.92
Total	13677	1.00	7945	1.00	1721	1.00	2207	1.00

Note: The vehicles from crashes that have not been identified by YOM have not been included in this analysis. There were a total of 1,199 vehicles that do not have YOM details on the crash database.

To judge the representation in crashes the number of vehicles as a multiple of the percentage of the car fleet is calculated (Table 1). For example in 1999 there were 26788 vehicles with a YOM up to 1970, 1.57% of the Queensland car fleet. However, these vehicles represented 1.16% of all passenger cars in crashes in Queensland, a multiple of 0.74.

When crashes in all speed zones are considered only those vehicles with a YOM prior to 1970 and 1998/99 have a reasonably lower representation. Vehicles with a YOM from 1971 through to 1986 have a slightly higher representation in crashes while the other groups (YOM from 1987 to 1997) have a multiple close to 1.

These results are reflected when the data is evaluated in each of the three chosen speed zones with some minor differences. In the 0-60 km/hr and 65-80 km/hr speed zones there is a larger decrease in representation for the 1989/99 YOM vehicles, while in the 85+ km/hr speed zone the larger decrease is for pre 1970 vehicles.

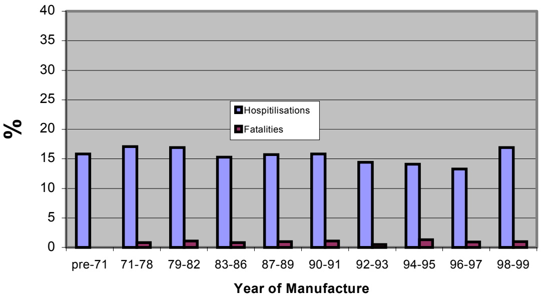
While the performance of vehicles, (active safety measures such as handling and braking) have improved it does not appear to be reflected in this data.

Injury Risk

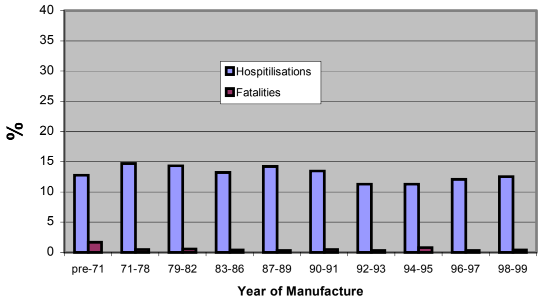
The next stage is to consider the injury risk to the vehicle's occupants related to the YOM, speed zone and crash configuration. For this paper the crashes resulting in fatalities or hospitalisations are considered. Figure 1(a), (b), (c) and (d) below, show the rates of hospitalisation or fatality (as a percentage of all crashes) for all crash types across the different speed zones.

When all crash types across all speed zones are considered (Figure 1(a)) there does not appear to be any significant change or trend depending on YOM. In fact the number of fatalities for each YOM grouping is approximately 1%. This could be due to the relatively small number amount of data, 132 fatalities and 2044 hospitalisations.

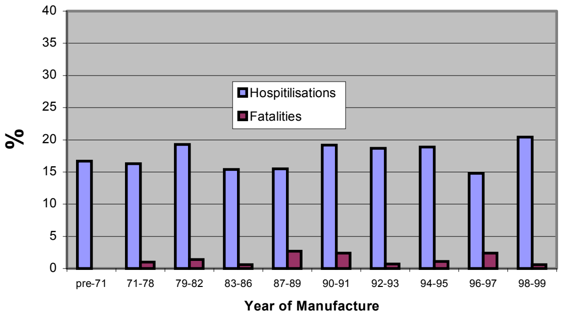
Figure 1 – Fatal crash and hospitalisation crash percentages for all crash types



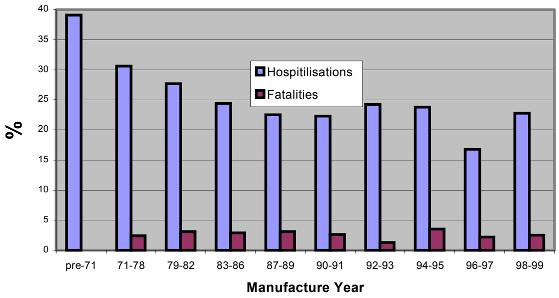
(a) All speed zones



(b) 0 – 60 km/hr speed zones



(c) 65 - 80 km/hr speed zones



(d) 85+ km/hr speed zones

The risk of a fatality increases with the increase in speed zones, as expected. However, there does not appear to be any significant trend related to YOM within a speed zone.

When the risk of a hospitalisation from all crashes is considered across the speed zones there is a downward trend for the higher speed zone (Figure 1(d) - 85+ km/hr) through to 1987/88 and then flattening out for newer vehicles (with a dip at 1996/97 YOM). The other speed zones do not show any significant trends, which is unexpected, given the significant improvements in occupant protection in passenger cars from 1993 as measured in the ANCAP tests and demonstrated in research undertaken by Monash (Newstead, et al) for the Used Car Safety Rating program.

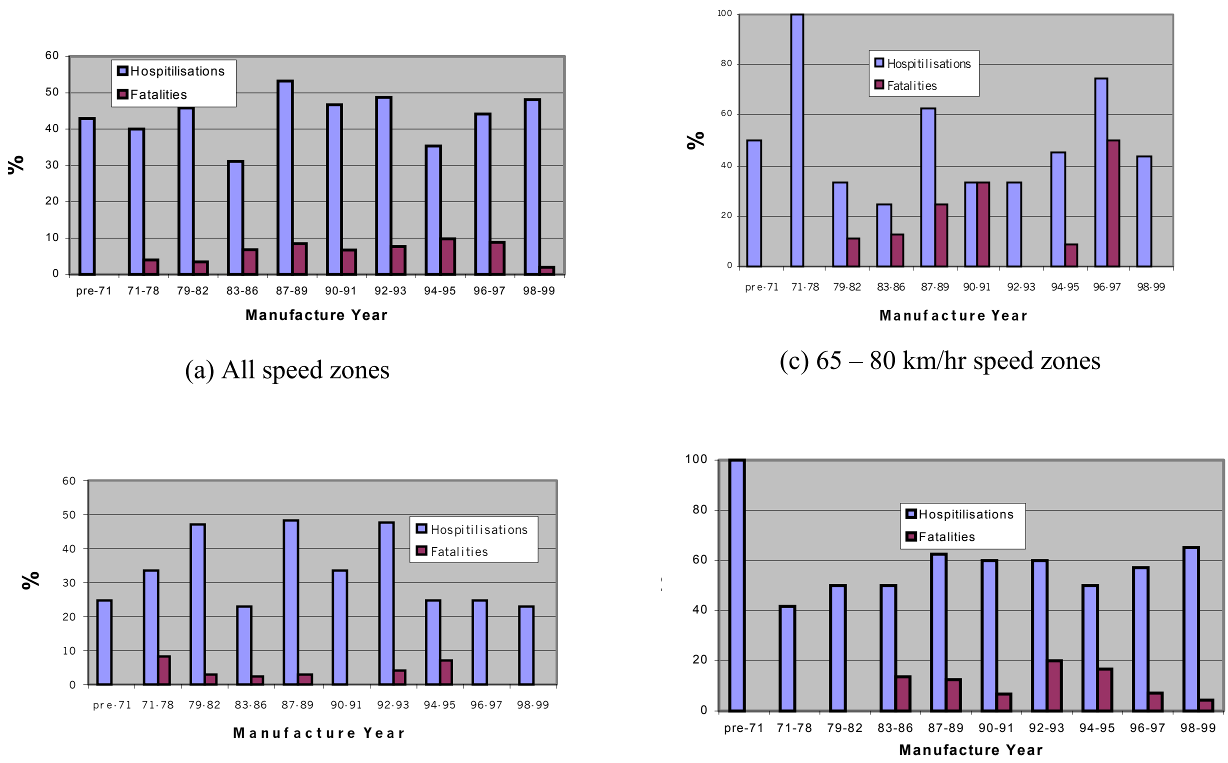
The next step in this analysis was to consider head-on only crashes to determine if there was any trend in the risk of fatality or hospitalisations. Figure 2 shows the rates of hospitalisation and fatality (as a percentage of all crashes) for head-on only crash across the speed zones. During a more detailed study the actual impact point for "angle" crashes will need to be conducted to determine if the crash is actually a "head-on" crash. This may then affect the overall trends outlined in Figure 2.

Again there are no significant trends by YOM when head-on only crashes are considered across all speed zones for either hospitalisations or fatalities. However, there is a higher risk of a fatality, up to 8 times, and also an increased risk of a hospitalisation, up to 3 times, for head-on crashes only than for all crashes.

Similarly there are no significant trends when each individual speed zones is considered. There may be a trend in the 0-60 km/hr speed zone (figure 2(b)) where cars with a post 1995 YOM have a lower risk of hospitalisation than many of the previous years. However, pre-1971 and 1983-86 YOM groups also have this low risk.

The ANCAP test results have shown a major improvement in occupant protection in terms of reducing the risk of fatal injuries for head-on crashes. Therefore, it was expected that a reduction in fatalities with a corresponding increase in hospitalisations would be demonstrated by this data. To show this, the data may need to be expressed in terms of exposure to crashes or a larger sample may indicate some trends.

Figure 2 – Fatal crash and hospitalisation crash percentages for head-on crashes



(a) All speed zones

(c) 65 – 80 km/hr speed zones

(b) 0 – 60 km/hr speed zones

(d) 85+ km/hr speed zones

Small Cars

One of the objectives of this project is to examine the impact of the changing makeup of the Queensland car fleet on safety. Throughout the 1990's the new passenger car sales configuration changed with an increase in the sales of both small cars and more recently, 4WDs. While the mass of these vehicle categories has a direct impact on the relative safety of occupants of these vehicles any negative impact on the overall road safety picture may be reduced due to the particular road environment the vehicles operate in.

For this paper the impact of small cars in the Jan-June 1999 crash data was considered. Small cars are defined as cars with a mass of less than 1250 kg. However, a practical application of this cut off was used to ensure cars that are directly marketed in this class that may have a mass of just over 1250 kg were included.

The initial analysis, Table 2, shows that a larger percentage of crashes with small cars occur in the lower speed zones, i.e. 0 – 60 km/hr and 65 – 80 km/hr. 25 % of crashes in these speed zones involved small cars while only 18 % of crashes in the highest speed zone involved small cars.

Another interesting result is that the small cars showed a lower level of involvement in fatal crashes than for both hospitalisation and total crashes across all speed zones. This may just be due to the small sample sizes in each of these speed zones, or a product of the use of small cars, i.e. predominantly used in the lower speed zones and used less frequently than larger cars and commercial vehicles.

Table 2 – Crashes Involving Small Passenger Cars

Speed Zones	0 - 60 km/hr			65 – 80 km/hr			85 + km/hr			All		
Crash Types	Total	Hosp	Fatal	Total	Hosp	Fatal	Total	Hosp	Fatal	Total	Hosp	Fatal
All vehicles	8756	1042	52	1494	239	19	2071	424	65	12321	1705	136
Small Cars	2224	299	7	373	54	5	382	75	7	2979	428	19
Percent - small	25%	29%	13%	25%	23%	26%	18%	18%	11%	24%	25%	14%

LIMITATIONS OF THE DATA AND CURRENT ANALYSIS

The main limitation of the data used in this analysis is the relatively small sample size, crashes spread across 10 YOM groupings representing 30 years of vehicle manufacture and 3 speed zone groupings. It is expected that when the crash data for all 3 years, 1999, 2000 and 2001 is available the sample sizes will be correspondingly larger.

While the analysis was able to demonstrate the under-representation of early model cars (up to 1978) and late model cars the low number of crashes in some of the speed zones made it difficult to determine if there were any significant trends in crash rates related to YOM.

Similarly the small sample size for fatalities also makes it difficult to identify any trends in relation to YOM groupings.

Another major limitation of the project is that no vehicle use data is available to provide a picture of the level of exposure within the different speed zones depending on YOM.

FUTURE WORK

The projects intention is to use the Queensland crash and vehicle data for the full 3 years, i.e. 1999, 2000 and 2001. The crash and vehicle data will initially be analysed in a similar method to that above for a macro look and then will be gradually “drilled down”.

One of the initial steps will be to separate the vehicles into their relevant market segments of light, small, medium, large, compact 4WD, large 4WD and utility. VFACTS data can be used to identify the numbers of each of these market groups sold in Queensland. These groups can then be analysed in terms of exposure across the different speed zones. This step is intended to identify if there are any trends in vehicle safety due to the changes in the Australian car market over the last few years.

The next step in drilling down will be to analyse the types of crashes, i.e. head-on, rollover, angle, single vehicle, etc, for each of these market segments and in terms of injury severity. If any trends are identified the information would be useful in assisting development of vehicle standards programs to target specific vehicle types that may be over-represented in a particular crash configuration.

In future work the analysis will be based on the age of the vehicle rather than the year of manufacture. This will allow examination of the impact of new cars progressively.

CONCLUSIONS

The Vehicle Safety Risk Assessment project aims to obtain a more detailed picture of vehicle safety and this paper included an initial analysis of the first 6 months data (Jan to June 1999) available. This data links the Queensland Transport crash database with the registration details to provide vehicle make, model and year of manufacture.

The analysis conducted did not show any significant trends for involvement in crashes based on the YOM except for pre 1970 and the newest vehicles, i.e. 1998/99. Similarly, there were no trends for fatalities or hospitalisations. The risk of a fatality increases with the increase in speed zones, as expected. However, there does not appear to be any significant trend related to YOM within a speed zone, except for the 85+ km/hr zones where there is a decreasing risk of hospitalisation for newer vehicles.

The full 3 years of data, 1999, 2000 and 2001 may provide sufficient sample sizes to identify trends when the data is analysed by YOM, speed zone, crash type and injury level.

REFERENCES

Australian Bureau of Statistics (ABS) (1999) Motor Vehicle Census, Report 9309.0, Canberra.
Newstead, Cameron and My Le, Vehicle Crashworthiness Ratings and Crashworthiness by Year of Manufacture, MUARC Report No.150, March 1999.
Hurnall and Coxon, Improvements in NCAP Results for Australian Vehicles, Proceedings of the 16th Enhanced Safety of Vehicles Conference, Windsor, Ontario, Canada, June 1998.
Vfacts, Vehicle Retail Sales, Federal Chamber of Automotive Industries, various years.