Modifying the Road Environment to Respond to the Needs of Young and Old Road Users: A Case Study

Connell, D., Levett, S., de Roos, M. and Job, S.
NSW Centre for Road Safety, RTA

Summary

This paper presents the results of a case study arising from an in-depth investigation and analysis of crashes occurring at the junction of the Princes Highway and Fern Street at Gerringong in NSW, Australia. The study examined possible crash causal factors and assessed the effectiveness of the various crash reduction countermeasures available to reduce the level of road related trauma experienced by older drivers. The study also investigated the unusual over-representation of female drivers at this location and the effects of the engineering countermeasures.

The study’s findings indicate that older male drivers and female drivers in general seem to be affected by pressure from other drivers to get through the intersection, resulting in them attempting to drive through gaps in the passing traffic that are too small to be safely traversed. It also showed that only a reduction in speed limit for vehicles on the Princes Highway (the top of the T) would provide unsure exiting drivers with enough confidence and time to select appropriate gaps in the approaching traffic.

Keywords
Older Drivers, Younger Drivers, Crashcam, Road Safety Engineering, T-Junctions.

Introduction

In New South Wales, Australia, as in developed countries generally, young drivers and older drivers (especially those over 75 years) are significantly over-represented in fatal and serious crashes. New South Wales drivers over 60 years old represent 18% of drivers but 22% of driver fatalities, with the over-representation increasing exponentially with age. Young drivers are over-represented for a number of reasons critically including inexperience and risk-taking [1], whereas older drivers are over-represented for different reasons. While frailty is a key factor in older driver over-representation, even when it is allowed for, drivers aged 75 and over remain over-represented in fatal crashes [2]. Factors contributing to this remaining over-representation include a variety of visual impairments [3 & 4] combined with a general lack of self-awareness of the visual losses in those suffering them [5], hearing loss, physical mobility and muscular control losses which appear to contribute to crash risk [6], dementia and other cognitive impairments [7]. Furthermore, the visual and cognitive deteriorations are likely to be factors resulting in problems of gap acceptance as drivers, with evidence for these problems even when the situation is simplified by the lack of observer movement- i.e., as a pedestrian waiting to cross a road [8].

While many measures have been adopted to address young and older drivers through licensing regulation, training, and testing, the safe systems approach, formally adopted in New South Wales, would also suggest the deployment of road engineering measures to address the problem. A number of the studies of older road user crashes identify the complexity of the situation as a factor contributing the older driver crash likelihood [7]; and the well established increased over-representation of old drivers in intersection crashes. This factor along with others especially related to visual impairments, and crash severity amelioration may be addressed in road design [3]. The present paper presents a case study of the application of a number of treatments designed to decrease decision complexity, allow clearer visual determination of other drivers behaviour, and increase allowed reaction time, in a complex high crash rural highway intersection. Outcomes of these treatments are reported.
Figure 1: Princes Highway and Fern Street T-junction – following completion of civil works (Late 2006)

Background to Case Study
The junction of the Princes Highway and Fern Street (see Figure 1) is located near the coastal town of Gerringong on the south coast of New South Wales, Australia. Fern Street is the more northerly of two main access roads from the Princes Highway leading into Gerringong. The town of Gerringong has become a popular area for retirement couples looking to move away from the city for a less hectic seaside lifestyle in the country. This has led to a high number of older drivers having to travel from Gerringong in the south to the main city of Wollongong to the north for medical and other services that are not available in Gerringong. The Fern Street T-junction has constantly exhibited a high number of
similar type crashes over the seven (7) years between 2002 and 2008. The high number of severe crashes meant that the junction was identified as a “black spot” and prioritised for remedial works seeking to reduce these crashes.

**Princes Highway Review**

NSW has actively adopted the strategy of undertaking road safety route reviews of its major highways [10]. These reviews are firmly based in a safe systems approach while drawing on the evidence accrued from the scientific analysis of road user behaviour. The Princes Highway was the second major highway in NSW to undergo a Road Safety Route Review. These reviews have resulted in highly cost effective works delivering reductions of over 50% in fatalities [11]. This Road Safety Route Review of the Princes Highway was undertaken in December 2004.

A range of analyses and inspections were undertaken during the review including:

- an analysis of reports on fatal crashes
- analysis of crash trends such as severity, crash type and crash factors, particularly in relation to the identification of safety benefits arising from the major upgrades on the highway since 1996
- a desk based audit of the highway using GIS based video imaging to identify areas requiring closer scrutiny
- physical inspections of the highway to examine locations and circumstances of fatal crashes
- a review of speed limits and an assessment of the road from both a behavioural and road environment perspective
- comments from a range of stakeholder groups and individuals on significant safety issues relating to the Highway

Based on the various areas of analysis, a road safety strategy was developed for the Princes Highway. A range of remedial treatments and interventions were developed to support this goal.

**Fern Street Junction**

The junction of the Princes Highway and Fern Street was one of the sites identified in the Princes Highway Road Safety Route Review as requiring remedial action to reduce crashes. The junction is what’s known in Australia as a half-seagull type T-junction which manages potential vehicle conflict by channelising turning vehicle movements (See Figure 2 below).

The configuration of the Fern Street junction does not allow northbound vehicles to turn right from the Princes Highway into Fern Street. This means that the only decision drivers exiting from Fern Street have to make is to select an adequate gap in the southbound Highway traffic to cross the single southbound lane into the sheltered northbound acceleration lane. There is more than 600 metres of sight distance from Fern Street to vehicles travelling south on the Princes Highway which is generally considered to be more than adequate for the 100 km/h speed limit of the Highway.

Vehicles exiting Fern Street must cross over a railway level crossing as they approach the junction. “STOP” signs are installed at the junction for vehicles exiting Fern Street. Fern Street traffic must give way to all southbound Highway traffic except for those turning left into Fern Street.

**Traffic Volumes**

In 2005 the traffic volume southbound on the Princes Highway, through the intersection, was approximately 5500 vehicles per day whilst approximately 3930 vehicles per day were entering the intersection from Fern Street. The junction is currently very close to operating at saturation levels for drivers exiting Fern Street and there are often long queues of vehicles waiting to exit northbound onto the Highway.
Crash Analysis
An interrogation of the RTA’s crash database over the three years from 2002 to 2004 showed that twelve (12) of the fourteen (14) crashes that occurred (86 %) were of the right-near type where the vehicle travelling west on Fern Street and emerging from the stem of the T-junction was struck on their right by a vehicle travelling southbound along the Princes Highway (see Table 1). Vehicles in Australia travel on the left hand side of two lane roads so it was the driver and any rear right passengers that were struck by the through vehicle. As the Princes Highway at this time was speed zoned at 100 km/h and Fern Street speed zoned at 60 km/h the higher speeds on the Highway meant that there were a greater number of serious injury crashes than would usually be expected at this type of junction.

Table 1: Crashes at the intersection of Princes Highway & Fern St, Gerringong

<table>
<thead>
<tr>
<th>Year</th>
<th>FATAL</th>
<th>INJURY</th>
<th>TOWAWAY</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>2003</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>2004</td>
<td>1</td>
<td>1</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>2005</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>2006</td>
<td>0</td>
<td>3</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>2007</td>
<td>0</td>
<td>2</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>2008 (P)</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>TOTAL</td>
<td>4</td>
<td>3</td>
<td>7</td>
<td>33</td>
</tr>
</tbody>
</table>

Crashcam Installation
The Road Safety Branch, (now Centre for Road Safety) of NSW Roads & Traffic Authority installed a “Crashcam” incident recording system at the site to gather information on what could be causing the crashes that were occurring at the junction and how to address them. This system was installed in August 2004. Crashcam is a hi-tech crash detection and recording system that works by detecting sounds associated with traffic crashes and near misses then recording the moving images for analysis. This data is constantly recorded and deleted. A predefined series of sound frequencies which typify road crashes are set in the computer to enable Crashcam to detect occurrences of crashes or near misses (e.g. noise from skidding braking tyres or glass breaking) caused by the noise source. When the microphone detects these noises, the computer is triggered to retain and not delete, the moving images for a number of seconds before and after the noise source thereby capturing the entire event, including the factors leading up to the crash or near miss, for future interrogation and analysis. For more details on Crashcam see [12].

The majority of the crashes (86%) at the site showed that westbound vehicles exiting Fern Street were being hit by southbound vehicles on the Princes Highway in what is termed a right near crash type. (See figure 4 as example from Crashcam footage) Analysis of the incidents recorded at the junction...
show that there were many right-near type incidents that didn’t result in a crash but could have been extremely severe if they had. Although the video data showed that there were as many near miss incidents as actual crashes, it did not reveal any obvious reasons for why the vehicles exiting Fern Street drove out in front of approaching traffic.
Figure 3: CrashCam footage showing a crash between a southbound 4WD and a car towing an empty horse trailer.

Figure 4: CrashCam footage showing the second silver vehicle in the first frame following the vehicle in front without stopping.
While the 2004 fatal crash involved a 75 year old male driver a more in-depth analysis of the age and gender of the drivers showed that although there were a high number of older male drivers involved in crashes at the site, that there were also a large number of female drivers involved. (See Figure 5)

![Figure 5: Age and sex of drivers pulling out of Fern St, involved in crashes (2002-2008)](image)

**Remedial Treatments**

On the basis that drivers exiting Fern Street were unnecessarily looking to the south for northbound vehicles a temporary barrier was installed in the centre of the Highway in order to obscure views to the south of northbound traffic. This aimed to reinforce the requirement to only look north and better judge the distance of gaps between the approaching southbound vehicles.

![Figure 6: Looking south towards the Fern Street junction showing the temporary barrier in place](image)
The southbound left turn lane into Fern Street was also extended further to the north to further separate through vehicles and those turning left. All these remedial civil works were completed by the end of 2006.

Causal Factors
Crashes at the intersection continued after these works, with crash rates of 4.8 per annum prior (2002-2006) versus 4.5 post (2007-2008). Casualty crashes did not decrease. This indicates that the crash problems at the junction were associated with a combination of factors other than the layout of the T-junction. Speculation on why these two groups of drivers have a problem at saturated T junctions indicates that they may be a result of the high pressure being exerted on non-confident drivers waiting on the stem of the T by the large number of vehicles behind them waiting to exit northbound. It is also possible that older drivers as well as the female drivers are unduly affected by the pressure of trying to select an appropriate gap, without delaying those behind them and consequently misjudging the speed or distance away of the approaching traffic and taking gaps that are too small. Naylor & Graham [13] observed that “The current intersection design value for the perception-reaction time is 2.0sec, which has been used since the 1940’s when the driving population was much younger”. This reaction time issue maybe one of the causal factors of crashes at this intersection, raising the possibility that some design standards are outdated for the today’s driving population.

Figure 7: Looking south towards the Fern Street junction showing the completed works. (Late 2006)

Further Treatment – Speed limit reduction
Subsequently in November 2007 the speed limit on the Princes Highway to the north and south of the junction was reduced from 100 km/h to 80 km/h. When reducing speed limits the RTA is aware that although their will be an overall reduction in travel speeds, a portion of vehicles will still travel above the posted speed limit. Since the reduction in speed limit there have been another four (4) right-near crashes involving eight vehicles. The four vehicles that failed to select a suitable gap in the southbound Highway traffic were driven by males of 62, 68, 79 and 88 years old. This predominance of older male drivers still having crashes at the site indicates that the reduction in speed has allowed the females more time to select the right size gap and has eliminated them from the crash problem. However, even with this speed limit some of the older drivers still select inappropriate gaps. This is very similar to the findings of King [14] who found “Older drivers have more difficulty than younger drivers in coping with complex situations, of which intersections are an example”. It may also suggest that even at 80km/h some older drivers do not cope.

Future Upgrade
The junction at Fern Street will be closed when the Princes Highway is upgraded in the future. A single grade separated access will be provided into Gerringong that will eliminate both the southern and the northern (Fern Street) junctions. This full interchange will ultimately address the crash
problems that have been occurring at these intersections. However, until the interchange is built, the speed zoning of the Princes Highway through this section should be kept at 80 km/h to give vulnerable drivers turning north from Fern Street a better chance of selecting safer options to choose gaps in the approaching southbound traffic.

Conclusion

The major conclusion that can be made from the study of crashes at the Princes Highway and Fern Street T-junction is that the partial seagull type T-junction layout that exists at the site was operating at and still is near to capacity. It shows that this junction does not function effectively when through traffic volumes and those on the stem of the T reach a critical level, and when the mix of drivers includes numbers of older male and/or female drivers. Driver ability to select gaps and driver confidence seem to be critical factors in determining the type and number of crashes that will occur at a T-junction. The study showed that older male drivers and female drivers overall are over represented in the crash figures. This may be due to these drivers being more affected by pressure from other drivers, queuing behind, to make poor gap acceptance decisions. It also showed that a reduction in speed limit for vehicles on the top of the T provided exiting drivers more time and a greater number of appropriate gaps, however even with these changes older male drivers still struggle to select safe gaps in the approaching traffic.

References:


13. Naylor, David & Graham, Johnny - *Intersection Design and Decision-Reaction Time for Older Drivers*.

14. King, Mark – Queensland Transport. *Intersection Crashes involving older drivers: Relative involvement in urban and rural areas at night and by day.*