

ENHANCED MOTORCYCLE CRASH INVESTIGATION PROJECT

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Enhanced Motorcycle Crash Investigation Project

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Abstract:

The Enhanced Motorcycle Crash Investigation (EMCI) project involved the review of twenty-five motorcycle crashes by eight case review panels which were convened at locations around Victoria between March 2007 and January 2008. The function of the case review panels was to identify the contributory factors that they felt had been most relevant in the occurrence of the crashes and suggest what they felt to be the most appropriate countermeasures based on these. Care was taken to ensure that panel composition included specialist riding knowledge. Local members of rider organisations such as the Ulysses Club and Motorcycle Riders Association of Australia were invited to attend. In addition, the representatives invited from local government, VicRoads, and VicPol, generally had some professional interest in motorcycle safety, and many were riders themselves.

The panels felt that the main factor in all of the multi-vehicle crashes reviewed was the violation of the rider's right of way by another road user. In all sixteen multi-vehicle crashes the panels were of the opinion that the other road user had either failed to detect the presence of the motorcyclist or had failed to correctly judge his distance and approach speed. The panels proposed a number of actions in relation to this issue, the main one being the need to conduct a comprehensive, scientific study on the issue of motorcycle inconspicuousness in general traffic and its role in crash and injury risk.

In the nine crashes reviewed which involved only the motorcyclist, the panels judged the main factors to be inexperience (amongst learner and novice riders) and low skills currency (amongst those returning to riding after a gap in experience and those riding very infrequently). In a smaller number of this subset deliberate risk taking behaviour, such as speeding[†], was also noted by the panels as a factor. The panels proposed a number of actions that they felt would improve the quality of initial and refresher training, and the uptake of the latter.

The importance of on-going programs for the collection of in-depth crash data to improve understanding of motorcycle crash causation was also universally acknowledged by the panels.

[†]Limited data on pre-impact speed was available other than that derived from the riders' statements. There were two reasons for this. Firstly, methods of estimating delta-v from damage to a motorcycle have limited applicability. Secondly, as a retrospective investigation protocol was used, estimation methods based on quantities such as throw distances were also generally precluded.

Key Words:

Motorcycles; In-depth crash investigation;
Contributory factors.

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EXECUTIVE SUMMARY

The Enhanced Motorcycle Crash Investigation (EMCI) project involved the review of twenty-five motorcycle crashes by eight case review panels which were convened at locations around Victoria between March 2007 and January 2008. The function of the case review panels was to identify the contributory factors that they felt had been most relevant in the occurrence of the crashes and suggest what they felt to be the most appropriate countermeasures based on these.

Collectively, the panels included input from a total of one hundred and forty-six representatives from eighteen different organisations and a range of local government authorities. Panellists were identified and invited to attend by the relevant VicRoads Regional Manager in each region. Care was taken to ensure that panel composition included specialist riding knowledge. Local members of rider organisations such as the Ulysses Club and Motorcycle Riders Association of Australia were invited to attend. In addition, the representatives invited from local government, VicRoads, and VicPol, generally had some professional interest in motorcycle safety, and many were riders themselves.

The cases reviewed were drawn from a pool of thirty-three crashes which had been the subject of in-depth investigations involving interviews with the rider and forensic examination of the vehicle(s) involved and crash scene. Thirteen of the investigations were conducted during the original ECI project and a further twenty new investigations were conducted for the EMCI project. Cases were chosen for panel review from this pool by the project manager at VicRoads Road Safety Department. The main selection criteria were the completeness of the cases and that, overall, the sample should reflect a range of the most common crash types.

Given the small number of crashes, recruitment of a structured sample was not part of the study protocol. For the purposes of this report the twenty-five crashes reviewed were compared with all police reported serious injury motorcycle crashes for 2005 (source CrashStats). The analysis showed that the EMCI sample was reasonably representative (given its small size) save for two areas. Firstly, a greater proportion of the EMCI crashes (sixty percent) occurred on roads with a speed limit of eighty kilometres per hour or above compared with forty-two percent of the police reported crashes. Secondly, the EMCI sample contained a higher proportion of traffic type crashes involving more than one vehicle. Only thirty-two percent of the EMCI crashes were single vehicle loss of control crashes compared with forty-six percent of the police reported crashes. As speed is often a factor in loss of control crashes, it is therefore possible that excessive/inappropriate speed¹ is underrepresented in the aggregated contributory factors data for the EMCI sample.

The panels felt that the main factor in all of the multi-vehicle crashes reviewed was the violation of the rider's right of way by another road user. In all sixteen multi-vehicle crashes the panels were of the opinion that the other road user had either failed to detect the presence of the motorcyclist or had failed to correctly judge his distance and approach speed. The panels proposed a number of actions in relation to this issue, the main one

¹ The term *excessive speed* is used here to describe travelling above the speed limit; the term *inappropriate speed* is used to describe travelling at an inappropriate speed for the prevailing conditions.

being the need to conduct a comprehensive, scientific study on the issue of motorcycle inconspicuousness in general traffic and its role in crash and injury risk.

In the nine crashes reviewed which involved only the motorcyclist, the panels judged the main factors to be inexperience (amongst learner and novice riders) and low skills currency (amongst those returning to riding after a gap in experience and those riding very infrequently). In a smaller number of this subset deliberate risk taking behaviour, such as speeding², was also noted by the panels as a factor. Actions proposed by the panels in relation to these issues included:

- Mandating retraining and/or retesting at the time of licence renewal.
- Development of incentive based methods of improving uptake of training/re-training programs (e.g. through a rebate on completion of accredited programs).
- Investigation of the options to improve the scope of rider training and testing (e.g. by incorporating on-road observed rides).
- Reviewing overseas practice in relation to restrictions placed on learner and novice riders.

The other main issue apparent from the panel review of the EMCI cases relates to the non-use by some riders of appropriate personal protective equipment (PPE). The panels felt that inadequate protection had adversely affected the severity of the injuries sustained by the riders in seven of the crashes. All of these crashes occurred on urban roads (six on roads with speed limits of 50 or 60km/h) and all of them during journeys of relatively short intended duration (less than an hour). Actions proposed by the panels in relation to this issue included:

- Development of educational materials for novice riders regarding the need for adequate PPE, and the selection and correct use of PPE.
- Development of a star rating system, or Standard, for motorcycle PPE.
- Promotion and further development of PPE specifically designed for scooter riders.
- Introduction of a levy rebate against the purchase of high quality PPE.

On a more general point, the panels also universally acknowledged the importance of on-going programs for the collection of in-depth crash data to improve understanding of motorcycle crash causation and inform the development of effective countermeasures.

² Limited data on pre-impact speed was available other than that derived from the riders' statements. There were two reasons for this. Firstly, methods of estimating delta-v from damage to a motorcycle have limited applicability. Secondly, as a retrospective investigation protocol was used, estimation methods based on quantities such as throw distances were also generally precluded.

1. INTRODUCTION

1.1 THE ENHANCED CRASH INVESTIGATION (ECI) PROJECT

The Enhanced Crash Investigation (ECI) project ran between October 2004 and July 2006 and involved the in-depth investigation of eighty-one serious injury vehicle crashes and presentation of the findings to panels of stakeholders in the locality where the crash had occurred. The function of these panels was to review the factors which led to the crashes occurring and which influenced their severity, to develop local action plans to prevent similar accidents occurring in the future, and to identify issues that needed to be considered at the whole-of-state level. The ECI project was sponsored and managed by VicRoads Road Safety Department (RSD).

1.2 THE ENHANCED MOTORCYCLE CRASH INVESTIGATION (EMCI) PROJECT

Thirteen of the eighty-one crashes investigated during the ECI project involved motorcycles. Panel review of these crashes generated a number of actions which were motorcycle specific. These were referred to the Victorian Motorcycle Advisory Council (VMAC). VMAC had apparently been considering sponsoring a dedicated motorcycle crash investigation project themselves, though on a smaller scale than the ECI project, i.e. involving the investigation of fewer crashes.

A major component of the start-up costs for the ECI project involved obtaining ethics approval for the project from the ethics committees in the participating hospitals. For a smaller project, such as that considered by VMAC, obtaining such approvals would have consumed a significantly greater proportion of the overall budget. Therefore, in order to help VMAC get the most value from their available budget, VicRoads Road Safety Department offered to manage the motorcycle project as an extension of the original ECI project. This avoided the need to obtain new ethics approvals for the VMAC project and, as a result, reduced the cost of the project.

The EMCI project was managed by a working party involving representatives from VicRoads RSD and VMAC (Ray Newland and Roger Northam) who oversaw all stages of the project (recruitment, case selection for panels, etc) and provided advice and assistance to the contractor (MUARC). The project involved the investigation of twenty additional motorcycle crashes and the presentation of these, together with some of the motorcycle cases from the original ECI project at eight specially convened review panels.

1.3 DATA COLLECTION

As the EMCI project was an extension of the ECI project, the data collection protocol used was that which had previously been approved by the relevant ethics committees for the original study, except that, at the request of VMAC, some additional data fields were collected (for instance in relation to protective clothing). In outline, the protocol was retrospective and involved recruiting crash-involved riders while they were still in hospital. Having given informed consent, the riders had a structured interview covering events prior, during, and after the crash, as well as more general issues such as riding experience. The rider's medical records were then accessed and relevant information recorded. The motorcycle, or scooter, was then traced and inspected, along with any other vehicles involved in the crash (where possible). Following the vehicle inspections, the crash site

was visited to record the road layout and any evidence of the crash, e.g. damage to trees or roadside furniture. The crash was then reconstructed using computer modelling techniques and the previous crash history of the site examined. The data collection process is summarised in Figure 1, and fuller details of the protocol for the ECI project may be found in Appendix A.

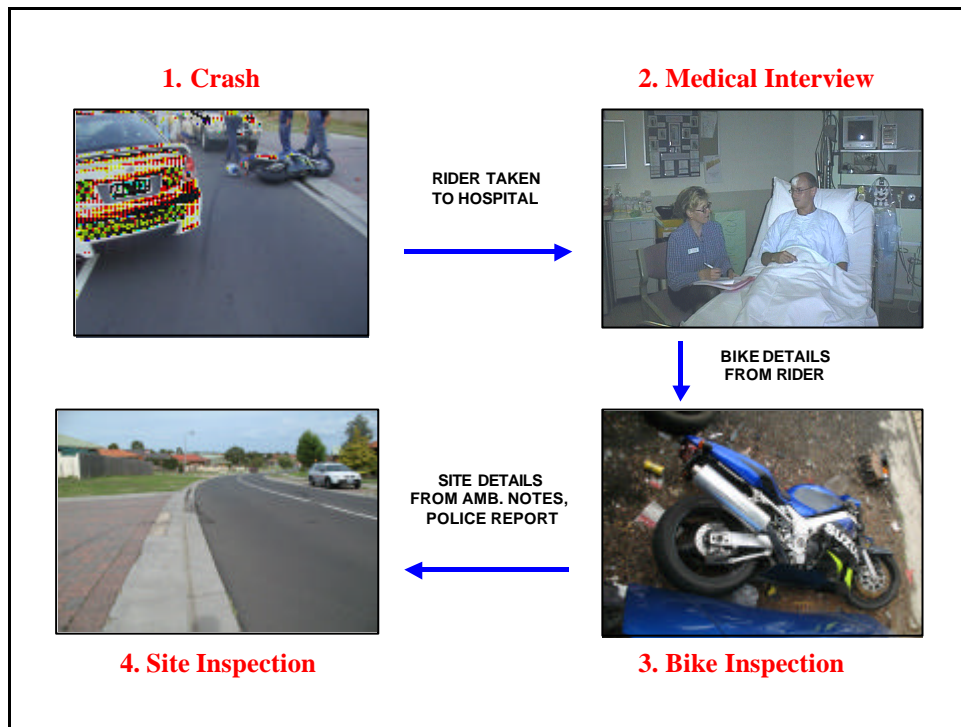


Figure 1: EMCI Data collection process

1.4 CASE REVIEW PANELS

A key stage of the ECI process is the presentation of the findings of the investigations to multi-disciplinary Case Review Panels. The panels are composed of representatives from local government, local VicRoads regions, local hospitals, emergency services, motoring/riding organisations, police, and other local organisations involved in road trauma and its consequences. Panellists are identified and invited to attend by the relevant VicRoads Regional Manager in each region.

For the EMCI project care was taken to ensure that panel composition included specialist riding knowledge. Local members of rider organisations such as the Ulysses Club and Motorcycle Riders Association of Australia were invited to attend. In addition, the representatives invited from local government, VicRoads, and VicPol, generally had some professional interest in motorcycle safety, and many were riders themselves.

At each panel three (or four) detailed crash investigations were presented for discussion. After the presentation of the case details, the panel identified the contributory factors that they felt had been most relevant in the occurrence of the crash and suggested what they felt to be the most appropriate countermeasures based on these factors.

1.5 STRUCTURE OF THIS REPORT

This report first gives a brief statistical description of the twenty-five crashes reviewed by the eight EMCI case review panels. Due to the small size of the project, recruitment of a structured sample was never part of the study design. However, some descriptive statistics are also presented relating to police reported serious injury motorcycle crashes for the calendar year 2005. These indicate that, in many aspects, the EMCI sample is reasonably representative.

The next section of the report describes the composition of the case review panels and presents two case studies. Aggregated contributory factors data for the twenty-five crashes, as identified by the case review panels, are then presented and discussed.

Based on this aggregated contributory factors data, the main issues which re-occurred across the sample are then discussed, *viz*:

- The failure of other road users to detect motorcycles in traffic.
- The non-use of adequate personal protective equipment (PPE) by a significant proportion of the riders (particularly in relation to the lower body, and particularly in urban crashes).
- Low levels of skills currency amongst the riders who were returning to riding, or who rode very infrequently.
- Inexperience or lack of skills amongst the majority of the riders who were riding on Learner permits or Probationary licences.
- Inappropriate speed (for the prevailing conditions) and excessive speed (i.e. travelling above the speed limit).

Finally, the countermeasures proposed by the case review panels in relation to these issues are discussed.

2. DESCRIPTION OF THE CASES

2.1 RECRUITMENT

Given the small number of crashes, recruitment of a structured sample was not part of the study protocol. However, a number of inclusion and exclusion criteria were employed during recruitment to broadly shape the sample and avoid undue complications. The main inclusion criteria were that the rider had sustained serious injury as a result of the crash (defined as admission to hospital for at least one night) and that the rider was capable of giving an interview (and had reasonable recall of the events surrounding the crash). Recruitment was also targeted to produce a geographical distribution of crashes across the state. The main exclusion criterion related to fatalities; crashes involving a fatality within thirty days were excluded as these would have been subject to a coroner's inquest which would have been unlikely to have concluded prior to review of the case.

The cases investigated and reviewed by the original Enhanced Crash Investigation (ECI) project included thirteen crashes involving motorcycles. A further twenty motorcycle crash investigations were conducted for the Enhanced Motorcycle Crash Investigation (EMCI) project, giving a total pool of thirty-three cases. Cases were chosen for panel review from this pool by the project manager at VicRoads Road Safety Department. The main selection criteria were the completeness of the cases and that, overall, the sample should reflect a range of the most common crash types. The following sections relate only to the twenty-five crashes which underwent the panel review process.

2.2 CRASH CHARACTERISTICS

Speed Limit. In comparison to police reported serious injury motorcycle crashes for the calendar year 2005 (source CrashStats), the EMCI sample tended to occur on roads with higher speed limits. Fifteen (sixty percent) of the twenty-five crashes occurred on roads with a speed limit of eighty kilometres per hour or above. By comparison, forty-two percent of the police reported crashes occurred on these higher speed roads.

Crash Location. Nine (thirty-six percent) of the EMCI crashes occurred on rural roads; thirty-nine percent of the police reported dataset occurred on rural roads. The close match here is largely due to the recruitment strategy discussed above.

Time of Day. Seventeen (sixty-eight percent) of the EMCI crashes occurred during daylight hours, five (twenty percent) at dusk or dawn, and three (twelve percent) at night. These figures are reasonably close to those from the police reported dataset which were; sixty-nine percent daytime, twelve percent dusk/dawn, and eighteen percent at night.

Purpose of Journey. Fifteen of the crashes occurred during recreational rides (five group and nine solo rides). Two occurred when the riders were running errands, and the remaining eight while the rider was commuting to or from work. Of the commuters only two used their motorcycle as their sole or main means of transport, the remainder said they rode to work on fine weather days but mainly used their car.

Number of Vehicles Involved. The main difference between the EMCI sample and the police reported dataset relates to the number of vehicles involved and, hence the general crash type. Eight (thirty-two percent) of the EMCI crashes were single-vehicle, loss-of-control crashes. One crash involved the rider striking an animal on the roadway and the

remainder involved at least one car. Single-vehicle, loss-of-control crashes were far more common in the police reported data set accounting for forty-six percent of the total. As speed is often a factor in loss of control crashes, it is therefore possible that excessive/inappropriate speed is underrepresented in the aggregated contributory factors data for the EMCI sample.

DCA. Table 1 gives a breakdown of the crash types for the EMCI sample and corresponding percentages from the police reported serious injury motorcycle crash dataset for the calendar year 2005.

Table 1: Breakdown of crash types for the EMCI sample.

DCA	Description	EMCI Sample		Police reported serious injury motorcycle crashes for 2005 (source CrashStats)	
		No.	%	No.	%
170 - 189	Off path on straight/curve	8	32	404	46
121	Right through	6	24	78	9
110	Cross traffic	4	16	24	3
120	Head on (not overtaking)	2	8	40	5
132	Right rear	2	8	12	1
134/135	Lane change right/left	2	8	20	2
167	Struck animal	1	4	27	3

Motorcycle Type. The motorcycles in the EMCI sample were:

- twelve tourers,
- eight sports,
- two general purpose,
- one enduro,
- one trail,
- and one scooter.

2.3 RIDER CHARACTERISTICS

Sex. All of the riders in the EMCI sample were male. Riders in the police reported serious injury motorcycle crash dataset for 2005 were ninety-five percent male.

Age. The average age of the riders in the EMCI sample was forty-two years (range nineteen to sixty-six years). The age distribution of the sample is shown in Table 2, along with comparative figures for the police reported dataset for 2005. A significant difference

between the two distributions is apparent. Sixty percent (fifteen) of the EMCI riders were aged forty years and over, compared with thirty-four percent in the police reported dataset. Only thirty-six percent (nine) of the EMCI sample were aged in their twenties and thirties as opposed to fifty-four percent of the police reported dataset.

Licence Category. Eighteen (seventy-two percent) of the riders in the EMCI sample had full licences, two had probationary licences, and the remaining five were riding on learner's permits.

Riding Experience and Skills Currency. The eighteen riders with full licences had held their licences for an average of twenty-three years (range two to forty-seven years) and the majority for more than twenty years. However, the length that a licence has been held is a poor indicator of experience and skills currency. The majority of these eighteen riders had had a gap in riding experience at some stage while fully licenced. Three of the eighteen were returning riders having recommenced riding (after a gap of between seven and fifteen years) two to three months before being involved in a crash. Another three of the eighteen said they rode very infrequently (once or twice a year).

Table 2: Age distribution of the riders in the EMCI sample.

Age/years	EMCI Sample		Police reported serious injury motorcycle crashes for 2005 (source CrashStats)	
	No.	%	No.	%
<22	3	12	103	12
22-29	4	16	212	25
30-39	3	12	245	29
40-49	7	28	183	22
50-59	5	20	79	9
60+	3	12	25	3

3. CASE REVIEW PANELS

3.1 PANEL COMPOSITION

A total of one hundred and forty-six representatives from eighteen different organisations and a range of local government authorities attended the eight case review panels which were convened between March 2007 and January 2008. Panellists were identified and invited to attend by the relevant VicRoads Regional Manager in each region. Care was taken to ensure that panel composition included specialist riding knowledge. Local members of rider organisations such as the Ulysses Club and Motorcycle Riders Association of Australia were invited to attend. In addition, the representatives invited from local government, VicRoads, VicPol, generally had some professional interest in motorcycle safety, and many were riders themselves. Table 3 shows the total number of attendees and location of the panels and Table 4 shows the total number of attendees by organisation.

Table 3: Location and size of the EMCI case review panels (exc. MUARC & VicRoads RSD employees).

No.	Date	Region	Location	Number Attended
1	27/03/07	Eastern	Traralgon	27
2	29/05/07	Metro North West	Flemington	18
3	18/06/07	Metro South East	Wantirna	15
4	04/07/07	Western	Horsham	12
5	26/07/07	North East	Benalla	19
6	21/08/07	South West	Geelong	20
7	29/11/07	Metro South East	Wantirna	14
8	31/01/08	Metro North West	Flemington	21

Table 4: Number of panellists from each organisation.

Organisation	Number of Attendees
VicRoads	49
Victoria Police	24
Local government	23
Riders (independent)	11
RoadSafe	9
Ulysses Club	7
Victorian Motorcycle Advisory Council	4
Federal Chamber of Automotive Industries	3
Motorcycle Riders Association of Australia	3
Australian Grand Prix Corporation	2
Royal Automobile Club of Victoria	2
DECA, MAS/RAV, CFA, SES, Honda, DSE, Geelong HOG, Motorcycle Dealer	9
TOTAL	146

3.2 CASE STUDIES

The two following case studies are presented as examples of the EMCI case review process conducted by the panels.

Case Study 1 – Rural, Run-off-road

Crash Description

The crash happened on the Monaro Highway about 16km north of Cann River at approximately 13.50 on a Thursday in October. It was a clear, sunny day, with only light winds, and road conditions were dry. The rider, a fifty-eight year old male, was part of a group ride travelling from Sydney to Phillip Island for the annual MotoGP. The group had left Sydney at 07.00 on the morning of the crash and had stopped for lunch at Nimmetabel about an hour and a half before the crash. The rider apparently lost control on a bend, mounted an earth bank and struck two small trees before separating from the motorcycle and hitting the ground head first. Figure 2 shows the crash scene and probable path of the vehicle.

The rider was wearing a Gore-tex BMW jacket with integral body armour, Kevlar reinforced jeans, leather motorcycle boots and gloves, and a full-face helmet with a clear

visor. He sustained a relatively severe loss of consciousness (greater than one hour) and bruising to the left side. He also fractured his right collar bone and shoulder blade, five vertebrae in the neck and upper back, three ribs on his right side, and right humerus. He was taken first to Orbost Hospital, then transferred to Latrobe Hospital, and then transferred to The Alfred the following day where he remained for fourteen nights before being transferred to a hospital back in Sydney.

The motorcycle ridden was a 1990 BMW K100 RS and on inspection no roadworthiness issues were apparent. The motorcycle was fitted with two saddle bags and was also carrying a tent and some other bulky camping equipment. Damage to the motorcycle included general grime and bark caught in the instrument panel and exhaust pipe; scratches and dents to top and sides of the fuel tank; damage to the front and sides of the faring; a cracked frame; and damage to all four turn indicators. A picture of the motorcycle is shown in Figure 3.

The rider had held a full licence for eighteen years at the time of the crash. He had owned the motorcycle from new and had clocked up approximately ninety-six thousand kilometres on it. In recent years he had been suffering from a heart condition which had necessitated a quadruple bypass operation. As a result he said, he had been riding “*a lot less than before*”, typically making one or two touring trips a year and not riding in between.

A review of the crash history of the Monaro Highway (a forty-three kilometre section from Cann River to the state border) revealed eight other motorcycle crashes in the five years before the current crash. One of these involved a serious injury, the others were all other injury. Six of the crashes were very similar, involving loss of control on a bend.

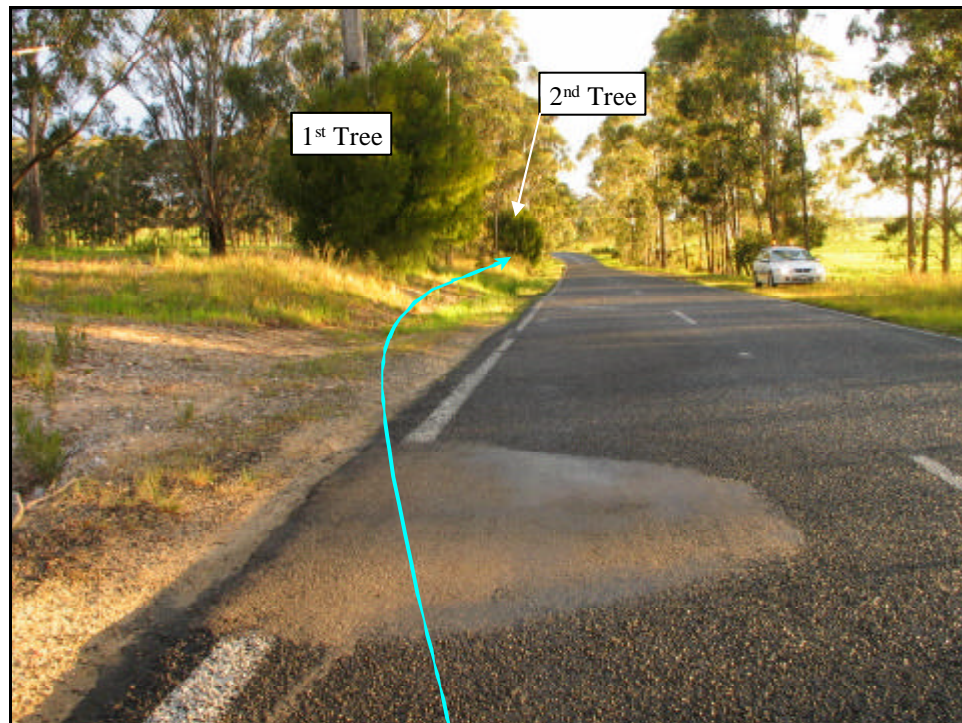


Figure 2: Case study 1 - scene of crash.

Contributing factors

The panel reviewing the crash decided that the principal factors contributing to the occurrence of the crash were an inappropriate cornering speed, fatigue, and low skills currency. The panel also determined that the absence of a shoulder and the nature of the roadside environment contributed to the severity of the crash and the nature of the injuries sustained. The panel also considered a number of other possible contributing factors, such as destabilisation of the load (camping equipment, etc), but it was not possible to confirm these.



Figure 3: Case study 1 - Motorcycle involved

Actions proposed

A number of possible actions were proposed relating to the road and roadside. These included widening and sealing the shoulders, removing trees and improving the clear zone, installing tactile edge lines, and installing barriers. Given the fairly low number of crashes it was agreed that treating the entire route would not attract a high priority but the authority responsible (VicRoads Eastern Region) agreed to conduct a more detailed study of the previous crash history³.

The other main action proposed related to rider education with respect to the planning of long distance recreational rides. The panel felt that issues such as rest-break and route planning, and alternative methods of transporting camping equipment (e.g. by a support

³ To be provided to the Victorian Motorcycle Advisory Council on completion.

vehicle), could be better addressed. It was also felt that targeted education for service providers along major recreational motorcycling routes might be beneficial.

Case Study 2 – Urban, Lane Change

Crash Description

The crash happened on North Road in the vicinity of the Ormond shopping strip, Glen Eira, on a Monday morning in December at 11.45. Weather conditions at the time were dry, clear and sunny. The speed limit on the section of road is 60km/h. The rider, a sixty-six year old male, was carrying out a local errand on his 2006 Bolwell Arriba XS. He apparently struck the offside of a Ssangyong Musso which was merging right into his lane intending to turn right through a right turn chute in the median strip. The rider felt strongly that the crash had happened because the driver had failed to look and/or see him. Figure 4 shows the crash scene and probable paths of the two vehicles.



Figure 4: Case study 2 – scene of crash

The rider was wearing a red Gore-tex Joe Rocket jacket with reflective piping and integral body armour, leather motorcycle gloves, a half-face helmet with a clear visor, track suit bottoms, and runners. As a result of the crash the rider sustained a minor loss of consciousness, a broken nose, and bruising to the face. He also fractured four ribs on his left side and multiple bones in his left foot and ankle. In addition, he had extensive abrasions to both legs and feet.

The scooter ridden was a 2006 Bolwell Arriba XS, Figure 5. Damage to the vehicle included a broken windscreen and front fairing; scrape marks along the entire right side of the scooter; major damage to the steering assembly; and minor damage to the lights.

The rider had ridden motorcycles whilst serving in the UK police force in the 1960s and early 1970s. On emigrating to Australia in 1973 he did not renew the motorcycle endorsement on his licence and had not ridden a motorcycle again until seven weeks prior to the crash when he obtained a Learner permit. He had bought the scooter as new and in seven weeks had clocked up seven hundred and seventy kilometres on it. His motivation for returning to riding was rising fuel costs.

Review of the crash history of North Road in the vicinity of the Ormond shopping strip revealed that there had been forty-four crashes on this eight hundred metre stretch in the five years prior to the present crash. Twenty-two of these had involved serious injuries, the others were other injury crashes. Only four of the crashes involved motorcycles. They were similar to the current crash in that they all involved violation of the motorcyclists right of way by another road user.



Figure 5: Case study 2 - Scooter involved

Contributing factors

The panel reviewing the case felt that the principal factor leading to the occurrence of the crash was the failure of the other road user to yield right of way to the scooter rider. They agreed with the scooter rider that the most likely cause for this was that the other road user had failed to look and/or see the rider. However, they also felt that the rider's inexperience, or lack of skills currency (though a former police motorcyclist, he had not ridden for thirty-three years until a few weeks before the crash) was also probably a contributing factor because of the way that he had positioned the scooter on the road. The panel also felt that the complexity of the road layout contributed to the crash's occurrence and that the nature of the rider's lower body clothing contributed to the severity of his injuries.

Actions proposed

The panel proposed a number of possible infrastructural improvements at the site, principally in relation to location of turn chutes in the median. The representative from the

authority responsible (VicRoads Metro South East region) advised that the location is subject to an ongoing evaluation and that the panel's findings would be fed into this⁴.

The other main issue arising from consideration of the case related to the apparent poor uptake of protective clothing by purchasers of scooters. The panel felt that scooter riders were a different demographic from the traditional motorcycling community. As in the present case, the panel felt that scooter riders' motivation for adopting two-wheelers was more to do with mobility in congested inner urban areas and rising fuel costs rather than an interest in two-wheelers *per se*. Hence, scooter riders might actively avoid personal protective equipment (PPE) which they saw as too motorcycle orientated. The panel were concerned about a perceived lack of PPE designed specifically for the scooter market.

⁴ Findings of the evaluation will be provided to the Victorian Motorcycle Advisory Council once completed.

4. AGGREGATED CONTRIBUTORY FACTORS DATA

Collectively, the case review panels reviewed twenty-five crashes and identified a total of ninety-six factors which they felt had either contributed to their occurrence or influenced their severity (an average of three point eight factors per crash). Contributory factors are normally classified by whether they relate to vehicle(s) involved, the infrastructure and roadside environment, or the behaviour of the road user(s) involved in the crash.

Only one vehicular factor, *per se*, was identified by the review panels; the inconspicuousness of motorcycles in general traffic was judged to be a factor in eleven crashes. The choice of an inappropriate motorcycle was identified as a factor in five of the crashes involving novice or returning riders, but as this related to the behaviour of the rider it was included in that field.

Twenty-one of the contributory factors identified by the review panels related to infrastructure and the roadside environment. Only in one case was the factor motorcycle specific (the case involved a sign which was located on a median strip adjacent to a right turn chute which appeared to have obscured the approach of a motorcycle to a right turning motorist).

The remaining sixty-four factors identified by the panels were behavioural: forty-eight related to behaviour by the rider and the remaining sixteen to behaviour by the other road user in the multi-vehicle crashes. The latter were exclusively concerned with failure of the other road user to yield right of way to the motorcyclist and were generally considered to be the precipitating factors in the crashes concerned, i.e. the factor without which the crash would not have occurred.

Tables 5, 6, and 7 show analyses of the frequency with which individual factors occurred in relation to infrastructure and the environment, rider behaviour, and other road user behaviour, respectively.

Table 5: Frequency of occurrence of contributory factors relating to *infrastructure and the environment* identified by the review panels across the twenty-five crashes.

Factor	Frequency	%
Poor sightlines	9	43
Complexity of road layout	6	29
Poor road surface condition	2	10
Rain	1	5
Proximity/nature of roadside furniture (injury severity)	1	5
Native animal collided with motorcycle	1	5
Inadequate warning signage (roadworks)	1	5
TOTAL	21	100

Table 6: Frequency of occurrence of contributory factors relating to *rider behaviour* identified by the review panels across the twenty-five crashes.

Factor	Frequency	%
Low skills currency	7	14.6
Inexperience	7	14.6
Inappropriate speed ^{5, 6}	7	14.6
Inadequate personal protective equipment (PPE) (injury severity; principally in relation to the lower limbs)	7	14.6
Fatigue	5	10.4
Inappropriate vehicle	5	10.4
Excessive speed ^{2, 3}	5	10.4
Following too close	3	6.3
Failed to yield right of way	1	2.1
Medical impairment	1	2.1
TOTAL	48	100.0

Table 7: Frequency of occurrence of contributory factors relating to *other road user behaviour* identified by the panels across the sixteen multi-vehicle crashes.

Factor	Frequency	%
Failed to look/see	8	50
Failed to stop at red signal/to yield right of way	3	19
Misjudged gap	3	19
Failed to provide adequate signals to other road users	1	6
Inattention	1	6
TOTAL	16	100

⁵ The term *excessive speed* is used here to describe travelling above the speed limit; the term *inappropriate speed* is used to describe travelling at an inappropriate speed for the prevailing conditions.

⁶ Limited data on pre-impact speed was available other than that derived from the riders' statements. There were two reasons for this. Firstly, methods of estimating delta-v from damage to a motorcycle have limited applicability. Secondly, as a retrospective investigation protocol was used, estimation methods based on quantities such as throw distances were also generally precluded.

5. RE-OCCURRING ISSUES

Consideration of the aggregated contributory factors data presented in the preceding section shows that a number of factors re-occurred in several of the cases reviewed. The factors which occurred most frequently related to the following four issues:

- The failure of other road users to detect motorcycles in traffic (and the issue of the inconspicuousness of motorcycles in general traffic).
- The non-use of adequate PPE by a significant proportion of the riders in the sample (particularly in relation to the lower body, and particularly in urban crashes).
- Low levels of skills currency amongst some of the riders in the sample who had held full motorcycle licences for many years but were effectively re-beginners due to a significant gap in riding experience (or who rode very infrequently).
- Inexperience or lack of skills amongst the majority of the riders in the sample who were riding on Learner's permits or Probationary licences.
- Inappropriate or excessive speed.

In the majority of cases, the panels felt that inappropriate speed (i.e. travelling at a speed which was inappropriate for the prevailing conditions) was a function of inexperience or low skills currency. The panels did not propose any new countermeasures in relation to excessive speed.

The remaining four issues will be briefly discussed, in the context of the cases reviewed by the case review panels through the Enhanced Motorcycle Crash Investigation (EMCI) project, together with the countermeasures and actions they proposed.

5.1 FAILURE OF OTHER ROAD USERS TO DETECT MOTORCYCLES IN TRAFFIC

As mentioned in the previous section, the failure of the other road user to yield right of way to the motorcyclist was judged by the review panels to have been a factor in all sixteen of the crashes that involved multiple vehicles. In all cases, the panels felt that the other road user had either failed to detect the motorcycle, or failed to judge its distance and approach speed correctly. This is not a new finding and many overseas studies have suggested that this issue is the major cause of motorcycle crashes.

Actions proposed by the panels included:

- Research into effective methods of promoting awareness amongst drivers of the issues faced by motorcycle riders.
- Conducting a comprehensive, scientific study of the issue of motorcycle inconspicuousness in general traffic and its role in crash and injury risk.

- Development of training materials for novice riders on issues of motorcycle inconspicuousness in general traffic, particularly with respect to speed and distance perception by other road users.
- Making the use of headlights mandatory (in relation to older motorcycles without hard-wired headlights).

5.2 THE NON-USE OF ADEQUATE PERSONAL PROTECTIVE EQUIPMENT (PPE)

Inadequate PPE was determined by the review panels to have been a factor which adversely influenced the severity of the injury outcome in seven of the cases reviewed. All seven of these crashes occurred on urban roads and six of them occurred on roads zoned at 50 or 60 km/h. The average Injury Severity Score (ISS) for the seven cases was fourteen (range ten to twenty-four). The average ISS for the remaining cases (which included all of the cases on rural roads and those zoned at 100km/h) was ten (range four to thirty-six). Even without correcting for crash severity, it is clear that the injury outcome was worse amongst riders who were not using adequate protective clothing.

Actions proposed by the panels included:

- Development of educational materials for novice riders regarding the need for adequate PPE, and the selection and correct use of PPE.
- Development of a star rating system, or Standard, for motorcycle PPE.
- Promotion and further development of PPE specifically designed for scooter riders.
- Introduction of a motorcycle Safety Levy funded rebate against the purchase of high quality PPE.

5.3 LOW LEVELS OF SKILLS CURRENCY AMONGST RETURNING AND INFREQUENT RIDERS

Four of the crashes reviewed involved riders who had recently returned to riding (within two to three months of the crash occurring) after a gap in riding experience of between seven and thirty-three years. Three of the four had held a full motorcycle endorsement throughout this period; the fourth had emigrated from the UK during the period and had not renewed his motorcycle endorsement when converting his UK licence to a Victorian licence. A further three of the crashes reviewed involved riders who said they rode very infrequently (once or twice a year).

Actions proposed by the panels included:

- Development of incentive based methods of improving uptake of training/re-training programs (e.g. through rebate of the motorcycle safety levy on completion of accredited programs).

- Improvement of the availability of training and re-training programs in country Victoria (according to panellists at the Western region panel, no refresher training programs are available in the region and returning riders from the region wishing to update their skills have to travel to Melbourne in order to do so).
- Mandating retraining and/or retesting at the time of licence renewal.

5.4 INEXPERIENCE AND LACK OF SKILLS AMONGST NOVICE RIDERS

The review panels felt that inexperience was a factor in four of the seven crashes involving Learner and Probationary riders. The panels also felt that four of the seven were riding inappropriate motorcycles for their experience and skills. Two of these motorcycles had an engine capacity of greater than two hundred and sixty cubic centimetres and so by riding them the riders were violating the restrictions of their licence/permit. The other two motorcycles, while having an engine capacity of less than two hundred and sixty cubic centimetres, would not satisfy the specific power requirements of the Learner Approved Motorcycle Scheme introduced to Victoria in July 2008.

Actions proposed by the panels included:

- Investigation of the options to improve the scope of rider training and testing (e.g. by incorporating on-road observed rides).
- Reviewing overseas practice in relation to restrictions placed on learner and novice riders.
- Development of a system to link vehicle registration with a check on licence status (to prevent Learner and Probationary riders registering motorcycles which they are restricted from using under the terms of their permit/licence).
- Review of the penalty tariff associated with breaking the restrictions of a Learner permit or Probationary licence (currently riding a restricted motorcycle carries only a fine and not any demerit points).

5.5 OTHER ISSUES

Two other issues which re-occurred in a number of the cases reviewed relate to long distance recreational rides and trail riding.

Five of the crashes reviewed occurred during long distance recreational group rides (typically involving an overnight stop or several days duration). In the majority of cases the panels felt that issues such as fatigue, insufficient rest and refreshment breaks, and dehydration might have contributed to the occurrence of the crash but it was not generally possible to confirm this. Several of the panels recommended the development of better guidelines for groups organising such rides, particularly in relation to route planning, rest

breaks, and contact numbers for checking the conditions on the planned route (in relation to road works, etc).

A couple of the crashes reviewed involved trail and enduro motorcycles and occurred on dirt roads (in the former case the road on which the crash occurred, while a public road, was essentially a forest track). The panels reviewing these cases proposed a couple of actions which are worth mentioning here. Firstly, they suggested that VicRoads review the potential benefits of introducing separate licence and registration categories for road and off-road riding and motorcycles. Secondly, they suggested that the Department of Sustainability and the Environment, and large private forestry operators, be encouraged to set a trail route rating systems (with respect to difficulty) for tracks and roadways on land in their control. Preventing access to such tracks using barriers, etc, was considered not practical as riders merely incorporate the obstacle as part of the challenge of the ride.

6. CONCLUSIONS

The EMCI project involved the review of twenty-five motorcycle crashes by eight case review panels. The cases reviewed were drawn from a pool of thirty-three crashes which had been the subject of in-depth investigations involving interviews with the rider and forensic examination of the vehicle(s) involved and crash scene. Thirteen of the investigations were conducted during the original ECI project and a further twenty new investigations were conducted for the EMCI project. Cases were chosen for panel review from this pool by the project manager at VicRoads Road Safety Department. The main selection criteria were the completeness of the cases and that, overall, the sample should reflect a range of the most common crash types.

Given the small number of crashes, recruitment of a structured sample was not part of the study protocol. Comparison of the twenty-five crashes reviewed with all police reported serious injury motorcycle crashes for 2005 (source CrashStats) indicated that the EMCI sample was reasonably representative (given its small size), save for two areas. Firstly, a greater proportion of the EMCI crashes (sixty percent) occurred on roads with a speed limit of eighty kilometres per hour or above compared with forty-two percent of the police reported crashes. Secondly, the EMCI sample contained a higher proportion of traffic type crashes involving more than one vehicle. Only thirty-two percent of the EMCI crashes were single vehicle loss of control crashes compared with forty-six percent of the police reported crashes. One possible effect of this may have been to reduce the incidence of excessive/inappropriate speed in the aggregated contributory factors data, as speed is often a factor in loss of control crashes.

The review panels identified the violation of the rider's right of way by another road user as the main factor in all of the multi-vehicle crashes reviewed. In all sixteen multi-vehicle crashes the review panels were of the opinion that the other road user had either failed to detect the presence of the motorcyclist or failed to correctly judge his distance and approach speed. In the nine crashes reviewed which involved only the motorcyclist, the panels judged the main factors to be inexperience (amongst learner and novice riders) and low skills currency (amongst those returning to riding after a gap in experience and those riding very infrequently). In a smaller number of this subset deliberate risk taking behaviour, such as speeding⁷, was also noted by the panels as a factor.

The other main issue apparent from the panel review of the EMCI cases relates to the non-use by some riders of appropriate protective clothing. The panels felt that inadequate protection had adversely affected the severity of the injuries sustained by the riders in seven of the crashes. All of these crashes occurred on urban roads (six on roads with speed limits of 50 or 60km/h) and all of them during journeys of relatively short intended duration (less than an hour).

On a more general point, the panels universally acknowledged the importance of on-going programs for the collection of in-depth crash data to improve understanding of motorcycle crash causation and, hence, inform the development of effective countermeasures.

⁷ Limited data on pre-impact speed was available other than that derived from the rider's statements. There were two reasons for this. Firstly, methods of estimating delta-v from damage to a motorcycle have limited applicability. Secondly, as a retrospective investigation protocol was used, estimation methods based on quantities such as throw distances were also generally precluded.

APPENDIX A – DATA COLLECTION PROCESS

Identification and Recruitment of Potential Participants

Potential participants are identified through regular screening of the admissions database in participating hospitals. The manner in which the screening is accomplished depends largely on the location of the hospital. In the five metropolitan hospitals currently associated with the study MUARC research nurses carry out screening. In rural hospitals, a member of the hospital's staff carries out the screening.

The mechanics of the recruitment process are also largely dictated by the location of the hospital. In the five metropolitan hospitals MUARC nurses will generally approach potential participants while they are still in-patients, having first sought approval from the supervising medical staff. Where the individual agrees to participate, the nurses will generally then conduct the medical interview straight away. In the case of the rural hospitals, recruitment is generally conducted post-discharge by telephone and post or fax.

Medical Interview

The medical interview is structured and usually takes between twenty and forty minutes depending on the individual and the nature of their vehicle. The interview questions cover *inter alia*: the location of the crash, prevailing weather conditions, the participant's recollection of events pre, during, and post crash, details of the motorcycle ridden, details of the clothing and helmet worn, details of the participants riding experience, details of the trip, and their perceptions of the causes of the crash and their physical and psychological well-being immediately prior to the crash. The participant's medical records are then accessed and the injuries they sustained are coded using international coding tools.

Inspection of Motorcycles

A range of vehicle and crash-related data are collected during the motorcycle inspection. Details, such as the exact make and model, year of manufacture, odometer reading are recorded. In addition, a detailed inventory of the damage to the motorcycle is collected (although methods of estimating delta-v from damage to a motorcycle have limited applicability, a detailed inventory of the damage is needed to determine the general kinematics of the motorcycle in the pre-crash and post-crash phases). The pre-crash roadworthiness of the motorcycle is also determined, to the extent possible, from an external visual inspection. Photographs depicting the damage sustained by the vehicle are taken during the inspection.

Crash Scene Inspections

The objectives of the scene inspection are to verify information that has already been obtained from other sources (e.g. the participant interview, local council road asset management databases, etc) and collect data that would not otherwise be available for reconstruction of the crash and determination of its causation factors. Data collected includes such items as road characteristics (eg; road type, speed limit, road cross-section, curvature, superelevation, surface condition and roughness), the road environment (hilly or flat terrain, presence of trees or other potential hazards, fencing, sight distance, etc) and road and traffic engineering standards (presence of barriers and abutments, level of delineation, shoulder sealing, etc). A detailed photographic record of the site is also made along with a drive-through video of the scene

Crash Reconstruction and Crash Scene Previous Crash History

Once the medical, vehicle, and scene data have been collected, the crash is reconstructed using the modelling software package PC Crash. Depending on the crash circumstances, these models can then sometimes be used to estimate, or verify, details such as the approach speeds of the vehicle(s) involved in the crash. They are also used to produce animated computer graphics which depict the pre-crash, crash and post-crash kinematics of the vehicle(s) which can help to determine, or to verify, how the participant(s) sustained their injuries.

The other main stage of post collection analysis involves researching the previous crash history of the crash scene. This is done using VicRoads' crash database, Crashstats, which contains records of all crashes in Victoria since 1987 at which the police attended. It is hoped that through conducting this background research local problems in infrastructure and design can be identified and corrected in cases where crashes at a particular location display a consistent pattern.