

FATIGUE: PROBLEMS AND COUNTERMEASURES

KEN SMITH, FACRS
SMITHWORKS CONSULTING

CROSS BORDER ROAD SAFETY INITIATIVES SEMINAR
THURSDAY 12 MAY 2005

© Smithworks Consulting 2005

INTRODUCTION

I will start this discussion with the premise that because of the kind of travel we are discussing today there is a strong chance that fatigue is involved in a number of the crashes we've heard some outline information about. I'll go further and say that there is a very good chance that up to one in five crashes and perhaps more can be expected to involve some element of fatigue. So we are talking about a real problem with some real consequences in terms of road trauma.

What is fatigue? Most people seem to think they know but there are a few misconceptions and certainly some important facts that many people don't know.

So let's start with some definitions.

DEFINING FATIGUE

Fatigue needs to be defined so that its character and effects can be distinguished from other forms of impairment, such as impairment from the use of prescription and non prescription drugs, cannabinoids and other 'recreational' substances and alcohol.

While use of alcohol and other drugs (and some associated behaviours) can lead to fatigue and give rise to much the same psychophysiological impairment as fatigue, a person can of course be impaired by fatigue without use of drugs and alcohol.

This requires a definition that relates specifically to fatigue, even if some of the impairment outcomes are common to other contributory factors. For the purposes of driving impairment, this does not matter.

Much of the research on fatigue in Australia has been in relation to the road transport industry. The outcome of this research is relevant to all drivers and riders. Most research has tended to use operational definitions of fatigue, focussing on psychophysiological outcomes and linking them to sleep deprivation⁽¹⁾. The report of the Neville Inquiry⁽²⁾ summed up various definitions and concluded:

"fatigue is the result of inadequate rest over a period of time and leads to physical and mental impairment".

A Fatigue Expert Group convened by the Australian Transport Safety Bureau, the Land Transport Safety Authority New Zealand and the National Road Transport Commission⁽³⁾ suggested a combination of symptoms and contributory factors:

"The symptoms or effects associated with fatigue include impaired performance (loss of attentiveness, slower reaction times, impaired judgement, poorer performance on skilled control tasks and increasing probability of falling asleep) and subjective feelings of drowsiness or tiredness;

Contributory factors include long periods awake, inadequate amount or quality of sleep over an extended period, sustained mental or physical effort, disruption of circadian rhythms, inadequate rest breaks and environmental stresses (heat, noise and vibration)".

Job and Dalziel⁽⁴⁾ noted that a definition of fatigue should identify fatigue as a construct or state of the person, not a performance or a behavioural outcome; it should identify the cause of the state of the person, to distinguish from other things producing the same performance outcomes, and should reflect, as far as possible, the meaning ascribed to the term by the general population. On these criteria they define fatigue as follows:

"Fatigue refers to the state of an organism's muscles, viscera or central nervous system, in which prior physical activity and/or mental processing, in the absence of

sufficient rest, results in insufficient cellular capacity or systemwide energy to maintain the original level of activity and/or processing using normal resources.”

Any of these definitions is suitable. It will be obvious that even where formulated for heavy vehicle drivers these definitions apply in every respect to all drivers and riders, whether professional or private and whether working or on personal affairs. Although as noted it is probably most generally associated with long distance driving, impairment caused by fatigue can affect short trips as well, as discussed a little later.

FATIGUE AND CRASHES

Certain kinds of crashes are said to be fatigue related or characteristic. At present there are three ways in which fatigue can be identified as a cause or major contributing factor to a crash. The first is by indirect evidence or by inference from investigation of the crash⁽¹⁾. The second is an admission by the driver or rider that fatigue played a part in loss of control. The third is through the evidence of a witness that the driver or rider was too tired to operate the vehicle safely, either through physical signs of fatigue or through the evidence of long hours of work or wakefulness.

The second and third ways are less frequently available to investigators either because the driver does not survive or is unwilling to admit that his or her driving was impaired by fatigue, or because there are no witnesses.

Many fatigue related crashes are fatal, and unlike drugs or alcohol, fatigue cannot be detected in a post mortem. Therefore investigators have to infer fatigue as a contributing factor through the circumstances of the crashes that occur. This is very important for determining whether fatigue played a part in the crash, and in relation to the limitations of the data we have available to us.

Criteria used for identifying fatigue related crashes

The criteria used for identifying fatigue related crashes become a matter of best judgement on the crash circumstances that can most reliably be associated with driving impaired by fatigue. These are commonly held to be:

- severe crashes
- crashes where the driver is the only occupant
- crashes involving running off the road or colliding with another vehicle or object, especially where there is no evidence of braking or swerving; or
- crashes occurring at the high risk times of mid afternoon, late at night or in the early hours of the morning, corresponding to the circadian rhythm low points⁽⁵⁾.

The times of day commonly used (2-4pm and 10pm or midnight to 6am) only represent those hours in which circadian rhythms are at a ‘low’ point and there is greater propensity to sleep. These periods are somewhat arbitrary in any case. A person who is seriously sleep deprived may fall asleep or be impaired by fatigue at any time.

There is great uncertainty about the number or proportion of crashes that can reliably be identified as fatigue related. It is likely, and is frequently acknowledged, that the numbers commonly cited represent an underestimate rather than an overestimate, even if they include crashes that might have been ascribed to fatigue because there is no other identifiable cause. Figures of 4-30% have been cited. Dobbie⁽⁶⁾ estimated that 16.6% of fatal crashes were caused by fatigue, on a very restricted definition. One study of crashes in NSW expressed the

view that up to 60% of the crashes investigated could have involved some element of fatigue⁽⁷⁾.

But even that does not account for all factors. Swann⁽⁸⁾ in an Austroads paper that has not been noticed very much, has suggested that crashes identified as fatigue related might only be those that result from the driver falling asleep, since the core characteristic of these crashes is that the driver is no longer in control. But there might be significant impairment at levels well below the point of falling asleep that also contributes to crashes. Swann thinks there are levels of sleepiness in which

‘...drivers have significant withdrawal of attention from road and traffic demands which can be both general, impairing vehicle control and collision avoidance ability, and can also be selective, impairing collision avoidance ability but leaving vehicle control intact. At these impaired levels of information processing drivers may not detect critical events, such as stop signs and red lights and may fail to appreciate high accident risk situations.’

If Swann is correct, it is probable that only crashes involving greater levels of sleepiness are reliably identified as fatigue related, and that crashes arising from lesser (but still present) fatigue impairment are incorrectly ascribed to other causes such as inattention or ‘negligent driving’ or sundry breaches of the road rules.

Without firm indication that a driver or rider was impaired in these crashes, or admission by the driver or rider that he or she was fatigued and therefore failed, it is unfortunately not possible to include such crashes in any definition of a fatigue related crash.

Does this amount of underestimation matter? On these and all available figures, it is clear that fatigue related crashes are a significant portion of the total and warrant action to reduce them. In fact effective action on driver fatigue could have a significant impact on a stagnating road toll, and the more so since available figures underestimate the true number. No greater precision than is now available would be required to justify investment in measures to reduce the number of crashes and resulting trauma that have fatigue as a major contributing factor.

MISUNDERSTOOD AND UNERESTIMATED

So why is fatigue such a widespread phenomenon and apparently so little understood?

One view is that people misunderstand the nature of fatigue. It is widely considered to be a problem in long distance driving. In this workshop we are concerned about crashes that occur in the region surrounding the ACT, and typically that is when people are heading off (or coming home from) holidays or a weekend in Sydney, or the like. Canberra people typically have their roots or their relatives somewhere else, so they are great travellers. And then of course there is the coast and other recreational pursuits. This means that on exposure grounds alone Canberra people are probably at considerable risk. And I think by now the dangers of, say, getting into the car to drive to wherever on a Friday night after work are relatively well understood even if not very well observed.

One of the phenomena of the last few years is that although there has been a considerable amount of research on fatigue it has been a bit one sided. It began with research into heavy vehicle driver fatigue and all that goes along with that, and from that research and a considerable amount of background literature came the realisation that circadian rhythm effects and loss of sleep time were if anything more important than the number of hours worked and time on task. There are issues related to you and me that I will come to later on. But there is more than one phenomenon that is thought of when people think about fatigue. Some writers and researchers draw a distinction between *fatigue resulting in measurable impairment* and *subjective feelings of sleepiness or tiredness*^(1,2,8). This is also referred to as

hypovigilance. For some recent thinking on this subject you might like to look up a workshop on hypovigilance that was held at CARRS-Q late last year⁽⁹⁾. These feelings are related to boredom or lack of stimulation and rapidly dissipate on arousal. Unaroused states can be just as dangerous as sleep deprivation or work induced fatigue if they mean loss of attention and consequent failure to perceive hazards and slowness to react. Phillip Swann in the paper referred to earlier talked about the effect of sleepiness as a phenomenon in its own right, without referring to sleep deprivation or other cause⁽⁸⁾. These feelings of boredom or sleepiness are relieved by taking periodic rest breaks and a snack, following the usual advice.

The layman understands very well that one can get drowsy because of boredom and lack of stimulation. And that is very easy these days, with much better roads, quiet and easy to drive cars, cruise control and automatic transmissions and the like. The human brain habituates very easily and without continual stimulation will, essentially, start to shut down the bits it doesn't need to continue functioning. We have all noticed the phenomenon: every so often we realise we've driven such a distance and suddenly found ourselves *here* without being conscious of having driven to that point. But how quickly that situation changes when we come up behind a bit of traffic that we have to negotiate, or a change in the road conditions. Instantly we are on full alert again.

Note that physiologically this is the same phenomenon as sleepiness from – well, let's call it fatigue from insufficient sleep, or too long awake since the last sleep. And in safety terms it is just as dangerous.

An important issue in fatigue

One of the factors in fatigue impairment is that fatigue, like alcohol, affects cognition^(1,p.50). This means that the fact that a person is becoming impaired by fatigue is itself masked in the same way as impairment from alcohol consumption. Perception, attention and judgement are impaired⁽⁸⁾. Therefore, as with alcohol a person's own judgement as to whether they are impaired by fatigue may not be able to be trusted, and in the interests of safety probably should not be. To put this in perspective, it should be recalled that in 1999 28% of drivers and riders killed in Australia had a blood alcohol concentration over 0.05%^(5, p.119).

Can I remind you again of the research by Dawson and Reid⁽¹⁰⁾ and Feyer and Williamson⁽¹¹⁾ which found that 17-19 hours continuous wakefulness brings a decrement in performance equivalent to being at 0.05, and that 27 hours or so is equivalent to being at a BAC of 0.10. We are talking serious levels of incapacity.

PERCEPTIONS ABOUT FATIGUE

I think there is still a widespread perception that fatigue is only a problem on long distance driving. Without firm survey evidence to substantiate the view, it is possible that the public has little understanding of the impact of insufficient sleep and sustained wakefulness, together with stressful or physically and mentally demanding work, time on task, rest breaks and so on, and the consequent danger of falling asleep or being significantly impaired even on short urban journeys. These issues have been canvassed in the road transport industry but not to a great extent outside it.

I think especially there is very little knowledge of the specific, impairment related reasons why behaviour should change. A well developed survey would be required to determine the reasons and influences, but it is reasonable to suggest that they would include

- insufficient understanding of how much fatigue can impair driving,
- insufficient self-awareness of growing loss of alertness and concentration (but with at the same time a perception that impairment could be identified when it begins)

- a desire to press on and complete the journey or to meet a time or stage
- not enough good, safe, convenient places to stop
- transient effects such as weather which lead to reluctance to stop and get out of the vehicle.

Attitudes need to change. We need to think in terms of the turnaround that came about in relation to drink driving.

RACV⁽¹²⁾ conducted market surveys and focus groups in Victoria to determine peoples' attitudes to rest breaks and rest areas, with some significant findings. Drivers 18-25 years of age were less likely to take rest breaks than older drivers, as were people who undertook long trips more frequently and rural residents than people who lived in urban areas. Significantly, inattention or inexperience (ranked third) were ranked higher than fatigue (fifth) as contributors to crashes. About rest areas and rest taking, respondents 'totally agreed' with the following statements:

On long driving trips I want to get where I'm going as quickly as possible (48%)
When I do stop it's only for petrol or a toilet break rather than a rest (41%)
There is not enough advertising warning drivers about fatigue (31%)
I only stop driving when I've nearly fallen asleep at the wheel (9%)
Breaking a drive to have a rest is just wasting time (7%)

Another survey conducted by Bartlett et al⁽¹³⁾ found sometimes confused and sometimes insufficient knowledge by 17-25 year olds compared with older drivers on the amount of sleep needed by young people compared with older people, on whether raising the volume of the radio would help a driver keep awake, and on whether younger people were more likely to fall asleep at the wheel than older people.

The RACV and Bartlett studies seem to suggest that urban residents who take long country journeys relatively infrequently are more likely to take rest breaks than rural residents who habitually take longer journeys. But on other evidence suggesting that fatigue related crashes often happen at holiday periods and weekends it is clear that many also just want to get to their destination as quickly as possible, as the RACV survey also suggests, and it is a reasonable supposition that many of those will be fatigued when they begin and be less inclined to take rest breaks.

These findings are by no means comprehensive but indicate that there is scope for deeper and more extensive public education about fatigue. In the same way as for alcohol, for example, such public education should be directed towards changing public perceptions and encouraging behaviour change.

RISK FACTORS

So what are the risk factors and what do we know about them? For starters, we are all at risk; obviously some are more at risk than others, but not always for the reasons we think.

The risks in long distance holiday driving have been well documented. But leisure activities may reduce sleep time and impair driving. The RACV survey⁽¹²⁾ noted that young people are less likely to take rest breaks than older drivers, to have less knowledge about the amount of

sleep they need and what should be done (and what is ineffective) when fatigue symptoms are detected.

Some medical conditions may lead to fatigue, whether through sleep loss or for some other reason. Researchers like Grunstein have pointed to the risks arising from various kinds of sleep disorder.

Here are some basic fatigue risk factors.

Work

There is little in the literature that covers the effect of work on driving. Work that is stressful and mentally or physically demanding means that a tired worker on his or her way home will have impaired driving capacity. The journey home from work is typically undertaken under the most difficult, crowded and stressful driving conditions.

Shift work brings a great many more problems. There is a broad literature on shift work. Anecdotally, shifts of eight, ten or twelve hours are worked in different industries, and the trend appears now for there to be relatively short periods on any one shift to prevent the body's habituation to one regime and to provide more periods for rest at night.

Shift work is at high risk for fatigue. The body is governed by inbuilt biological rhythms attuned closely if not precisely to the cycles of day and night. Work is best performed during the day when the bodily system is (other things being equal) awake and alert; the best sleep is obtained at night when there is a strong propensity to sleep^{(1), p.50}. By definition, shift work includes periods of work at night during the low points of the circadian rhythm, and that work is more fatiguing than work during the day. Further, in shift work rest and sleep are often taken at times of the day when sleep is less 'efficient' than at night: it may be shorter because of disturbances and interruptions and may be less restorative. The Fatigue Expert Group has suggested in relation to long distance road transport that there should be a limit of 18 hours night work (the period midnight to 6am) and that after this two nights' unrestricted sleep should be available^{(3; also in (1), p.52)}. This probably applies equally to shift work.

There is a strong possibility that people on shift work are permanently fatigued to a greater or lesser degree. In turn, shift workers' driving capacity is also likely to be impaired, the more so since some driving to and from work is likely to be at the most risky time of the day, ie at low periods in the body's circadian rhythm.

Young people

Evidence on crash risks for young drivers late at night and in the early hours of the morning suggests that they are at high risk^(5, p.227). Of course there are many reasons for this but sleepiness is one of them. Young people may also be at risk at other times if they are sleep deprived because of leisure activities, the more so because of a less than accurate perception of how much sleep they need⁽¹²⁾.

You and me

If these are some identifiable high risk groups – and there are others – it is clear that most of us are at some degree of risk at some time or other, some frequently or habitually for occupational or lifestyle reasons, and some only at intervals. Let us remember that the risk factors are sleep loss or deprivation, continuous periods awake, the effect of work or leisure activities and others. Then there is sleep apnoea and other kinds of sleep disorders.

Clearly, many are at risk more than they think they are. Harrison⁽¹⁴⁾ conducted surveys and discussion groups to assess the impact of ordinary day to day activities and found these often very significant in terms of general fatigue and consequently on driving. Parenting responsibilities, social activities and work were main contributors to fatigue while driving,

and respondents also pointed out that because of those activities driving could not be avoided: the option to postpone or avoid it altogether was simply not available.

WHERE DO WE GO FROM HERE?

Education

Clearly there is a strong case to be made for significantly more and better education on the characteristics and driving risks associated with fatigue than we have at present. As we have already noted, the number of crashes in which fatigue probably plays a part, even at the most conservative estimate, warrants action. Information on fatigue, its various ramifications and risks needs to be much more comprehensive and much more widely available than it is at present. Such education needs to cover more areas (for example issues relating to shift work and normal daily activities), and there is probably need to determine the extent and depth of public knowledge so that public education is directed most effectively.

‘Soft’ activities such as Driver Reviver stations during holiday periods are valuable and should be continued, although I am not aware of any research on their use and acceptance. But even for those who do not use them they serve a purpose in raising traveller awareness.

It is worth looking back to see the amount and depth of education and public information that went into informing the public about drink driving. A vast amount of that relates to enforcement but there has also been a significant component devoted to telling people about ‘knowledge’ matters such as standard drinks and so on. That effort is continuing with present education focussing on such things as morning after effects.

You might think that comparing fatigue with alcohol is a bit strong – but when we began with alcohol there was probably little better understanding of the dangers of alcohol than there is now about, for example, sleep deprivation. And yes, alcohol was a much bigger killer when we began seriously on that in the 1960s than fatigue is now. But we do not really know how many crashes we can reliably attribute to fatigue. And in a time when we are struggling to make real inroads to further reduce road trauma, here is a very significant contributor on which our efforts are only just beginning.

ENFORCEMENT: MEASURING AND IDENTIFYING FATIGUE

A corollary to education and another element that it is necessary to consider is enforcement.

This requires several prior things to be considered.

Firstly, impairment has to be reliably detected and measured.

In the case of alcohol the subjective judgement about whether driving is impaired or not, and the issue of whether a person ‘holds’ their alcohol well or not (and is accordingly fit to drive or not) has been bypassed by the advent of ‘per se’ laws which make just having the prescribed concentration of alcohol in the bloodstream an offence. A screening breath test and an evidentiary blood test provide the grounds for prosecution.

No test is yet available for fatigue, at least in a usable form. Perhaps the existence of two pieces of research which have compared impairment from fatigue with impairment from alcohol (Dawson & Reid⁽¹⁰⁾ and Williamson, Feyer et al⁽¹¹⁾) provide some clues to the way ahead. There first has to be a measure of impairment which in turn paves the way for the development of driving performance monitoring devices which can measure impairment and therefore warn the driver that their performance is degraded, and may provide the basis for enforcement.

Most of the work in this area has been done on measuring and monitoring truck driver fatigue, and this is not the place to review that work. But in brief, Feyer, Williamson et al⁽¹⁵⁾ assessed truck driver fatigue on long distance single driver and two-up operations using a range of measures including an on-road auditory response task administered at intervals while driving, and off-road visual processing, reaction time, vigilance and tracking tests

administered during breaks. Involuntary measures taken during the journey included speed variability, steering and tracking variability. These measures showed some evidence of change with fatigue. ARRB Transport Research Ltd⁽¹⁶⁾ developed a 'Pro-active fatigue management system' used in heavy haulage operations in open cut coal mines. The system requires the driver to respond to a reaction time test and provides feedback and warning if response time is too slow.

Systems requiring the driver to respond to vigilance or decision making tasks while driving are probably only suitable in specialised applications and could not be recommended for general use. But the existence of the on-road vehicle operation parameter measurement technology appears to offer hope, the more since the work reported by Feyer et al⁽¹⁵⁾ is now a decade old and computer-based technologies are both further advanced and much cheaper. Some on-board monitoring technology has already been developed in the MUARC/TAC SafeCar Project⁽¹⁷⁾. This includes headway and speed monitoring. MUARC has assessed driver reaction to several in-vehicle intelligent transport systems with high safety potential⁽¹⁸⁾. These included fatigue monitoring and warning (type of measure unstated) and lane departure warning. Participants in the study were receptive to both although concerned about reliability of the fatigue monitoring system, and did not favour a system that did more than warn the driver.

In 2001 Regan and colleagues⁽¹⁹⁾ reviewed a range of Intelligent Transport Systems (ITS) technologies, including driver vigilance monitoring systems. These systems are intended to detect that a driver is drowsy (or probably more correctly, to detect that performance has deteriorated), to warn the driver and, in some systems, to take control of the vehicle if the driver does not respond to warnings. Systems examined in the review were based on monitoring vehicle behaviour and monitoring the physiological state of the driver. Vehicle-based systems included rate of change in steering wheel angle, lane deviations and yaw, and headway keeping, speed variability and control of the accelerator pedal. Of these, steering wheel movements were said to be the most common indicator of fatigue and the most researched. Some steering movement and/or lane departure warning systems are in use in some heavy vehicles in the USA.

The most common driver physiology warning is eyeblink or eyelid closure using a camera aimed at the driver's face. Eyeblink or eyelid closure systems are limited because they may not give warning until a driver is at an advanced state of drowsiness. Various systems are under development or in use in passenger and commercial vehicles.

Other systems reviewed are steering wheel grip pressure, driver's head angle and seat movements.

Warning systems that have been tried include buzzers, release of a fragrance, dashboard displays, seat vibration and external warnings such as flashing the vehicle's hazard warning. Control systems include cutting off fuel supply, braking and the vehicle steering itself.

Probably the most comprehensive system is the European SAVE project intended to deal with drivers whose performance has deteriorated due to fatigue, drowsiness, alcohol or drug abuse, sudden illness or prolonged inattention⁽¹⁹⁾. No recent information appears to be available on further development or validation of the system, described in 1998.

The use of different forms of measurement in combination is attractive because if one measure fails to detect drowsiness or low arousal, another measure might. However no analytical, simulator based or on-road studies were identified by Regan et al to allow judgements to be made about the potential safety benefits of vigilance monitoring systems.

ISSUES

There are several significant issues that have to be resolved before driver vigilance monitoring or fatigue impairment detection systems can be considered for general implementation.

Validity and reliability

The first is that impairment warning systems have to reflect valid measures of impairment. Systems need to be reliable without giving false warnings that lead to the driver ignoring or disabling the system because of annoyance. They also have to provide warning early enough to truly reflect growing impairment without being so late in order to avoid false alarms that the driver is already significantly impaired and in danger of crashing. This is apparently a problem with many of the systems already tested. A good system needs to be sensitive enough but not activated by spurious effects such as road geometry changes.

Use of systems

Hartley et al (in Regan⁽¹⁹⁾ and elsewhere) note that monitoring and warning systems can be used not only as real-time safety systems but also in the commercial world as a management tool, as part of a system that manages work schedules, driver rest periods and so on. The potential for abuse is obvious, and Hartley et al warn that fatigue warning systems should never be used on their own: if they have value as part of driver work and rest management systems it should be in conjunction with other management tools. There may be a place for systems of this kind as a protection for the driver against management abuse, particularly if the system includes a recording mechanism.

Cairney⁽²⁰⁾ has reviewed fatigue warning and monitoring systems and notes the risk that over time drivers will come to rely on the system and cease planning journeys to avoid driving while fatigued, and pay less attention to monitoring their own degree of tiredness.

But there are a number of practical difficulties to be overcome before driving capacity impairment or vigilance monitoring systems could be considered. An effective system would require the driving performance measures selected (eg tracking and lane keeping, steering and speed variability and direct driver physiological measures) to be shown to reliably indicate normal and degraded driving performance. It is possible that technology has moved forward significantly since the systems reviewed by Regan et al⁽¹⁸⁾ were developed (witness the advent and increasing use in the last five years or so of vehicle stability control systems) allowing more sensitive systems than those described. It is also possible that a well developed system could be personalised so as to identify the baseline performance characteristics of each driver and warn when that performance is departed from. This allows for individual differences in driving style.

What we need is an appropriately sensitive, valid and reliable system, probably including both vehicle operation parameter and driver physiology measures. The signal virtue of a good system is that it monitors and warns of impaired driving directly. The question of whether a driver is impaired by fatigue, alcohol, illness, medication or recreational drugs becomes irrelevant.

Enforcement Issues

How and by what means enforcement could be applied through such systems remains to be seen. Although it is tempting and perhaps even justified by the risks there is no call for further legislative measures at this time than now exist to deal with driving impaired by fatigue. Perhaps definitions of existing traffic offences such as 'careless driving' could be broadened to include a presumption of careless driving if the driver is sleep deprived (see the work on comparing the impairment from sleep deprivation with alcohol consumption).

The first requirement for further legislation would be the creation of an offence of, for example, driving while impaired by fatigue, and it is likely that much firmer means of

detecting fatigue and determining that fatigue contributed to the occurrence would be required, than is now available. If it were to prove feasible to develop the kind of impaired performance monitoring and warning technology described above, and if the output had sufficient validity and reliability to be of evidentiary quality, then it might be possible to create an offence of 'impaired driving' which could be treated in a similar way to alcohol offences, although with perhaps less severity.

Whether governments should proceed in this direction and penalise people who drive when impaired by fatigue is another matter. There are probably stronger grounds for prosecution where there is an element of deliberate choice to drive knowing the risks, like driving while impaired by alcohol or recreational and other drugs. There are equity concerns if a person is to be prosecuted when work and other pressures result in their being too tired to perform safely and there is no realistic alternative. And yet impaired drivers are a danger to themselves and other road users regardless of intent or lack of alternative. The whole issue requires careful consideration.

On the other hand, the prevalence and seriousness of crashes involving fatigue and their impact on road trauma mean that there is a need for much more definite action than at present. Perhaps a way forward is to commence with improving public awareness and the usual persuasive means of attempting behaviour change, before moving on to legislative and enforcement measures.

ENGINEERING MEASURES

Audible edge lines, centreline raised markers in combination with painted centrelines, wide paved shoulders, unobstructed runoff areas and a more forgiving roadside environment generally have been shown to reduce both excursions from the travelling lane and mitigate the impact of excursions. These should be continued and extended where resources permit.

In at least one State in the USA much more aggressive audible edge lines or rumble strips are used at the lane edge marking and along unbroken painted centrelines, giving a much more powerful warning that the vehicle is straying (personal communication, Dr Raphael Grzbieta, 2004). The potential for use of similar edge and centre marking might be considered on sections of roads where excursions are frequent.

Roadside rest areas at suitable intervals also are important in providing a place and some incentive for drivers to break their journey periodically in accordance with safety messages and good practice. I understand that rest areas form part of warrants for highway development and upgrading, and further that standards exist for siting, intervals between, minimum facilities, and so on.

CONCLUSIONS

Fatigue is a widespread and serious road safety problem. Research evidence and inference based on the available evidence indicates that fatigue is probably more pervasive, and its effect in terms of driving impairment worse, than is commonly believed.

All sectors and groups in the community are affected at least at intervals, and some groups such as shift workers severely and predictably so, even if their problems are not often generally known. But survey evidence also highlights the severe fatigue impacts of normal, day to day activities of people leading ordinary lives, often with no relief and perhaps no

alternative to driving. Much improved public education and information is probably required to highlight the dangers.

Legislation and enforcement is a difficult issue. At present there is no known offence of 'driving while impaired by fatigue' and it is unlikely that this could change until there is reliable means of identifying, detecting and measuring impairment, which in turn would allow creation of an offence and the related penalty structures.

What is clear is that society's effort in dealing with driver fatigue is only just commencing. Much more work is needed to create awareness of the degree to which a person can be impaired by fatigue and its effect on performance, and that fatigue is as much a concern in ordinary, day to day activities as it is in holiday travel. Fatigue is everyone's problem.

REFERENCES

- (1) NRTC and Smithworks Consulting (2001), *Heavy vehicle driver fatigue: review of regulatory approach. Discussion paper*, NRTC, September
- (2) House of Representatives Standing Committee on Transport Communications and the Arts (2000), *Beyond the midnight oil an inquiry into managing fatigue in transport*, Parliament of Australia, Canberra, October
- (3) Fatigue Expert Group (2000) *Options for regulatory approach to fatigue in drivers of heavy vehicles in Australia and New Zealand*, ATSB Consultant Report CR 202, February
- (4) Job RFS and Dalziell J (1998), Are we confusing driver habituation, adaptation and boredom with fatigue in *Proceedings*, 7th Biennial Australasian Traffic Education Conference, Armidale, pp.91-96
- (5) ATSB (2004) *Road Safety in Australia A publication commemorating World Health Day 2004*, Canberra, p.132
- (6) Dobbie K (2002) *Fatigue-related crashes: An analysis of fatigue-related crashes on Australian roads using an operational definition of fatigue*, ATSB Report OR23
- (7) Sweatman PF, Ogden KJ, Haworth N, Vulcan AP and Pearson RA (1990) *NSW heavy vehicle crash study final technical report*, FORS Consultant Report CR 180, August
- (8) Swann P (2000) *Heavy vehicle driver health and sleep disorders AP-148/00*, Austroads, Sydney
- (9) CARRS-Q (2004) Workshop on hypovigilance, at <http://www.carrsq.qut.edu.au/> and contact Dr Andriy Rakotonirainy at r.andry@qut.edu.au for access to the workshop slides
- (10) Dawson D and Reid K (1997) *Equating the performance impairment associated with sustained wakefulness and alcohol intoxication*, Centre for Sleep Research, University of South Australia
- (11) Williamson A, Feyer A-M, Friswell R and Finlay-Brown S (2000) *Development of measures of fatigue: using an alcohol comparison to validate the effects of fatigue on performance*, Consultant Report CR189, Australian Transport Safety Bureau, Canberra
- (12) Gunatillake T, Daly T and Anderson N (2003), *Fatigue and rest taking – a snapshot of Victorian motorist's perceptions*, Road Safety Research, Policing and Education Conference, Sydney, September
- (13) Bartlett D J, Werner J B, Williams A, Grunstein R and Grunstein R R (2003) *Sleep behaviour and driver safety knowledge in young and older drivers in NSW*, Road Safety Research, Policing and Education Conference, Sydney, September
- (14) Harrison WA (2002) *Fatigued driving in urban areas: the role of daily activities in Proceedings*, Research, Policing and Education Conference RS2002, Adelaide, pp.79-84
- (15) Feyer, A-M, Williamson A and Friswell R (1995) *Strategies to combat fatigue in the long distance road transport industry Stage 2: Evaluation of Two-up Operations* Consultant Report CR158, Federal Office of Road Safety, Canberra
- (16) Mabbott, N (2002) ARRB pro-active fatigue management system in *Proceedings*, Research, Policing and Education Conference RS2002, Adelaide, pp.157-162
- (17) Regan MA, Mitsopoulos E, Triggs TJ, Tomasevic N, Young K, Healy D, Tierney P and Connolly K (2002) *Evaluating in-vehicle intelligent transport systems: a case study*

in *Proceedings*, Research, Policing and Education Conference RS2002, Adelaide, pp.215-220

- (18) Mitsopoulos E, Regan MA and Haworth N (2002) Acceptability of in-vehicle intelligent transport systems to Victorian car drivers in *Proceedings*, Research, Policing and Education Conference RS2002, Adelaide, pp.163-168
- (19) Regan MA, Oxley SA Godley ST and Tingvall C (2001) *Intelligent transport systems: safety and human factors issues* RACV Report 01/01, Melbourne
- (20) Cairney P (2003), *Implications of intelligent transport systems for high risk road users and high risk situations*, AP-R236/03 Austroads, Sydney