27th Australasian Transport Research Forum, Adelaide, 29 September – 1 October 2004

Paper title: **Intelligent Vehicle Safety research at the Monash University Accident Research Centre**

Author(s) name(s): M.A. Regan, K. Young, T.J. Triggs, T. Horberry, E. Mitsopoulos, N., Tomasevic, I. Johnston

Organisation(s): Monash University Accident Research Centre

Contact details:

Postal address: Monash University Accident Research Centre
PO Box 70A
Monash University, Victoria 3800, Australia

Telephone: (03) 9905 1838
Facsimile: (03) 9905 4363
email: michael.regan@general.monash.edu.au

Abstract (200 words):

The Monash University Accident Research Centre (MUARC) is Australia's leading Centre for research into safety and human factors issues associated with the design, deployment and evaluation of in-vehicle Intelligent Transport Systems (ITS). The Centre's activities in this area span the domains of road, aviation, occupational and rail safety. The aims of this paper are twofold: firstly, to outline some of the key human factors issues that critically determine the safety effectiveness of intelligent vehicle technologies; and, secondly, to outline some of the key research projects that have been undertaken by MUARC to address some knowledge gaps in this area. Notable is that none of the research described in this paper directly derives from any Australian national ITS strategy. There is an urgent need in Australia for a national strategy which provides a strategic plan for research into the design, deployment, development and evaluation of intelligent vehicle technologies with high safety potential.

Introduction

It is estimated that Intelligent Transport Systems (ITS), particularly in-vehicle systems, have significant potential to enhance the safety of drivers and other road users (Regan, Oxley, Godley and Tingvall, 2001; Rumar, Fleury, Kildebogaard, Lind, Mauro, Carsten, Heijer, Kulmala, Macheta and Zackor, 1999). The term, "Intelligent Transport Systems" refers to the application of advanced electronics, communication and computing technologies to the transport sector to improve safety and efficiency, reduce congestion and minimise harm to the environment (Regan, 2004a). These systems are at various stages of development – some exist in production vehicles, others exist as advanced prototypes and others are currently being developed.

Those ITS which have been developed primarily to enhance safety are usually referred to as Advanced Driver Assistance Systems, or ADAS. Such systems are applicable to all stages of a crash: some are designed to prevent crashes from occurring (eg, Forward Collision Warning systems), some are designed to minimize trauma to occupants in the event of a crash (eg, Seat Belt Reminder Systems), and others are designed to further reduce trauma after the crash (eg, Automatic Crash Notification systems; see Regan, et al (2001), for a review). These systems can be configured in different ways to solve specific safety problems. *Autonomous* systems, like In-Vehicle Navigation Systems (IVNS), can be self-contained within the vehicle. *Cooperative* systems, such as intersection collision warning systems, rely on roadside sensors – such as cameras and radars – to detect vehicles approaching an intersection and transmit this information, via receivers and in-car displays, to each of the drivers on a collision course. Alternatively, each car can be equipped with transmitters, Global Positioning Systems and receivers that enable each car to signal to the other, via on-board displays, that they are on a collision course. Finally, ITS services capable of enhancing safety can be accessed whilst driving through a *portable* device, such as a mobile telephone or a Personal Digital Assistant (PDA). In Australia, it is now possible to use a PDA as a portable IVNS, which provides turn-by-turn visual and auditory instructions on how to navigate to a chosen destination.

These existing and emerging ITS technologies will have a significant impact on the driving task (Regan, 2004c): navigation technologies will make it easier to find one's way; Lane Departure Warning systems will help to prevent drivers from straying off the roadway; Intelligent Speed Adaptation systems will obviate the need to monitor speed limits; collision avoidance is likely to be easier, with the advent of collision warning systems and the migration into the vehicle of real-time warning information, some of which is currently found on signs outside the vehicle (Regan, 2004a); and in-car displays will remind drivers of traffic rules. Ultimately, such systems will be capable of automating the driving task. There are already systems on the market, such as Adaptive Cruise Control, which automatically control vehicle cruise speed and inter-vehicle following distances. Whilst these systems, at least in theory, have tremendous safety potential, the actual safety benefits to be derived from them are largely unknown. This is because ITS technologies in vehicles are yet to be deployed on a large enough scale over a long enough period of time in traffic to yield crash numbers which can be used to evaluate changes in safety (Rumar et al, 1999). In addition, very little is known about how drivers adapt to these systems over time, and how this is affected by the design of the systems and a range of other human factors.

Whilst there are large-scale research programs in Europe, North America and Japan concerned with human factors and safety issues relevant to the design, deployment and evaluation of intelligent vehicle technologies, very little research of this kind is being conducted in Australia. The Monash University Accident Research Centre (MUARC), in Melbourne, is recognised internationally as Australia's leading organization into research on this topic. The aims of this paper are twofold: firstly, to outline some of the key human factors issues that underpin the safety effectiveness of intelligent vehicle technologies; and, secondly, to outline some of the key projects that have been undertaken by MUARC to address some of the knowledge gaps in this area.

Human Factors And Safety Issues

To be effective in enhancing safety, human factors knowledge and principles must be incorporated into the design, deployment and evaluation of ITS for vehicles (Reganet al, 2001). The human factors issues relevant here are many and varied. Some of the more salient issues are briefly discussed below.

Human-Machine Interface (HMI) Design

The HMI through which the driver interacts with the system must be designed in accordance with best ergonomic practice. Many international ergonomics standards and guidelines are now available to guide this process (Rupp, 2004). Emerging technologies will make it easier for drivers to personalize and customize the manner in which traffic and other information is displayed and responded to. Giving the driver access to information from ITS technologies when they want it, for as long as they want it, as often as they want it, and in whatever sensory modality they want it, may be counterproductive, however, if they choose to do so in a manner that increases distraction, confusion and information overload (see below).

Driver Distraction

There is converging evidence that emerging communication and entertainment systems are distracting, and that this distraction degrades primary driving performance and compromises safety. The mobile phone is one such example. If the warnings from intelligent transport systems take drivers' eyes off the road, take their attention away from the driving task or mask their ability to hear other safety-critical information, then they will induce distraction and degrade driving performance. Portable devices which provide ITS services are of particular concern from a human factors perspective. It is illegal in Australia to use a hand-held mobile phone to conduct a conversation while driving – but it is not, to the knowledge of the authors, illegal to use the same device as a route navigation system, the latter of which may be more distracting. The degree of regulation required for ITS-related services implemented on portable devices brought into the car is an important issue that needs to be addressed by road authorities.

Driver Workload

In future, drivers may receive traffic-related information from road signs, Variable Message Signs (VMS), Advanced Driver Assistance Systems, entertainment systems and communication systems – from inside and outside the vehicle - and from portable devices, such as mobile phones. If the amount and rate of information impinging on the driver exceeds his or her limited capacity to process it, overload will occur and performance will break down. Car manufacturers are aware of this. Some are already developing first generation "Driver Workload Estimators/Managers" which use available vehicle sensors to estimate driver workload in different driving conditions and temporarily suppress non-critical advisory and warning messages if driver workload is high, so that driving performance is not compromised (Regan, 2004b). These systems are similar functionally to "pilot associates" developed to support pilots in the aviation industry. To be truly effective in estimating and managing driver workload, however, it will be necessary for these devices to take into account all the various sources of information impinging on the driver - from inside and outside the vehicle.

Behavioural Adapation

At a higher level, drivers will adapt both positively and negatively to these new technologies. Negative behavioural adaptation, when it occurs, may take two forms. Drivers tend to set themselves a target level of driving difficulty. If you make a road safer, they drive faster. If they are bored, they engage in distracting secondary activities. This is known as Task Difficulty Homeostasis (Fuller, 2002). If future vehicles become highly automated, and drivers have less to do, they are likely to engage more in secondary activities that could compromise their safety. The other form of negative behavioural adaptation is more system-specific. People may go faster around a corner when they have an Intelligent Speed Adaptation system, because they wait for the system to warn them they are driving over the speed limit rather than driving to the prevailing conditions.

Awareness of System Limitations

It is critical that drivers understand the technological limitations of emerging systems. If their expectations of system performance are too high, they may expect the system to alert them to critical situations which the system is simply not capable of detecting. For example, they may crash into a pedestrian when reversing out of their driveway, in the false belief that their reverse collision warning system is capable of detecting pedestrians.

Over-Reliance

As drivers adapt over time to intelligent transport systems, they may become over-reliant on them. Driving with a Forward Collision Warning System, for example, may result in people scanning less actively for vehicles in front of them, knowing that the system is doing this for them. Over-reliance can also pose problems when transitioning from automatic to manual control of a vehicle. In one study, it was shown that when an Adaptive Cruise Control system was made to fail unexpectedly in a simulator, at least a quarter of drivers tested failed to take effective action and crashed (Stanton, Young and McCaulder, 1997).

Exposure

Little is known about the impact of emerging Advanced Driver Assistance systems on travel exposure. It is known, for example, that In-Vehicle Navigation Systems can reduce mental workload load and reduce unnecessary travel in unfamiliar locations. They may, however, encourage people to take more trips to locations they may previously not have traveled to, thus increasing their exposure to risk.

Automation

Increased automation of the vehicle can have several consequences. Drivers' danger avoidance skills and mechanisms, derived from the control of current generation vehicles, will be degraded if the vehicle itself becomes increasingly capable of scanning for, perceiving and responding automatically to traffic hazards. Automation of some driving tasks may lull the driver into a reduced state of attentiveness (Summala, 1997) and reduce their situational awareness of traffic events in time and space. It may further encourage drivers to use their spare capacity to engage in even more secondary tasks, distracting them and compromising their safety. These important issues remain to be resolved.

Driver Acceptance

Intelligent transport systems for vehicles are products. However, unlike most products, very little market research has been done in Australia or elsewhere to understand what people want in these systems and what barriers there might be to their widespread implementation. If user preferences are not well understood, the systems may be unacceptable to consumers and they will be difficult to market. If there is no demand for them, the potential safety benefits they offer will never be realized.

Individual Differences

Much is known about differences in the driving behaviour of novice, experienced and older drivers of current generation vehicles, and the implications of these differences for safety. Little is known, however, about the effects of age, experience and other individual difference variables on peoples' use of intelligent vehicle technologies.

In summary, there are many human factors issues that will intervene to determine whether an intelligent vehicle system is effective in achieving its intended safety benefit. It is important to identify and understand these prior to system deployment. Only the more salient issues have been noted here. For a more detailed coverage, the reader is referred to Barfield and Dingus (1998).

MUARC Research

The Monash University Accident Research Centre (MUARC), in Melbourne Australia, is one of the world's leading injury prevention research centres. Formed in 1987, it has over 80 research staff and undertakes applied, multidisciplinary, research for government and industry clients, locally and overseas. About two-thirds of this research is in transportation safety. In the last 5 years, the Centre has become recognised, locally and internationally, for its research into the impact of in-vehicle intelligent transport systems (ITS) on driver performance, behaviour and safety. Some of the key projects that underpin the MUARC research program, and which address several of the human factors issues discussed above, are described below.

Intelligent Transport Systems: Safety and Human Factors Issues

In 2001, MUARC prepared for the Royal Automobile Club of Victoria (RACV) a comprehensive report which reviews a large body of literature concerned with the safety and human factors issues relevant to the design, deployment and evaluation of ITS technologies (Regan et al, 2001). The report reviews both in-vehicle and out-of-vehicle ITS that have the potential to prevent crashes, reduce crash trauma, and enhance post-crash trauma management, although the primary focus is on intelligent vehicle technologies. The report is the first in Australia to address safety and human factors issues relevant to the design and deployment of ITS for high risk road users, such as young drivers, older drivers and motorcyclists. The report, much of which is still current, has spawned several ITS research programs, locally and overseas, and contains recommendations for further research in this area.

TAC SafeCar Project

The TAC SafeCar project, which commenced in 1999, is a unique collaborative research, development and evaluation project involving as key partners the Victorian Transport Accident Commission (TAC), Ford Australia and MUARC (Regan, Mitsopoulos, Triggs, Tomasevic, Healy, Tierney and Connelly, 2003). It is the centrepiece of MUARC's intelligent vehicle research activities. Nearly 15 local and international industry and government supporting partners are involved. The aim of the project is to stimulate demand in Australia for in-vehicle ITS technologies that are estimated to have significant potential to reduce the incidence and severity of road trauma. Each of 15 Ford passenger cars has been equipped with Intelligent Speed Adaptation (ISA), Following Distance Warning, Seat Belt Reminder and Reverse Collision Warning technologies. MUARC is evaluating behavioural adaptation to, technical operation of, and user acceptance of the technologies. Up to thirty company fleet drivers will each drive one of the vehicles for almost 17,000km. Twenty-three have already commenced driving. The systems turn on and off automatically at pre-set times during this period and an on-board data logger records (up to 5 times a second) vehicle speed, time headway and other safety-related parameters – before, during and after exposure to each system. Ten of the drivers will serve as Control Drivers and the rest as Treatment drivers. The study, which is well known internationally, will conclude early in 2005.

Preliminary findings from the study (see Regan, Young, Triggs, Mitsopoulos and Tomasevic, 2004, for details) are promising. Whilst the data are yet to be analysed statistically, several trends in the data for the 8 Treatment drivers who have so far completed the study are discernible. For the Intelligent Speed Adaptation System, these are: a reduction in mean speed; greater reductions in mean speed when the ISA and Following Distance Warning systems operate simultaneously; mean speeds after ISA is turned off which are slightly lower than before it is turned on; less variable travel speeds; an increase in time spent at or below the speed limit; a decrease in time spent driving above the speed limit; and only a marginal increase in mean trip times. For the Following Distance Warning system, drivers appear to spend less time driving at headways less than 1.0 second and more time at headways above 1.0 second (the system issues visual warnings at headways less than 2 seconds and an audio warning at headways less than 1.1 second). Interestingly, there is evidence that the Intelligent Speed Adaptation System, when operating on its own, also encourages drivers (albeit to a lesser extent) to adopt longer following distances. The Seat Belt Reminder System appears to promote safe belt wearing behaviours. The percentage of trips undertaken whilst unbuckled and the percentage of travel time where a seatbelt is unbuckled both decrease substantially, as does the average time taken to buckle up from the onset of the warnings when the system is activated. With the large number of data points yielded for each subject (in the tens of thousands), it is probable that most of these effects will be statistically significant.

Community Acceptance of In-Vehicle ITS Technologies

Market research is routinely undertaken to make consumers aware of new products and to identify their needs in relation to these, well before the products have been developed. Surprisingly, little such research has been undertaken in relation to in-vehicle ITS technologies. In 2002, MUARC carried out research for the RACV to assess the acceptability to a sample of Victorian car drivers of seven ITS technologies with significant safety potential: Forward Collision Warning; Intelligent Speed Adaptation; Automatic Crash Notification; Electronic Licence; Alcohol Interlock; Fatigue Monitoring; and Lane Departure Warning (Regan, Mitsopoulos, Haworth and Young, 2002). Factors that are likely to deter drivers from voluntarily purchasing and using these systems were identified. Estimates were also made of the annual savings in crash numbers and costs associated with the deployment in Victoria of these systems. The systems estimated as most likely to reduce crash numbers and costs in Victoria were, in descending order, the Alcohol Interlock (preventing 906 crashes and saving about $263 million per annum), Electronic Licence (preventing 603 crashes and saving about $134 million per annum) and Intelligent Speed Adaptation systems (preventing 331 crashes and saving about $155 million per annum). Paradoxically, the systems with the greatest potential safety benefit were perceived as least acceptable to consumers.

Similar research was conducted by MUARC in 2003 for the Motor Accidents Authority of NSW (MAA). This involved the identification of several ITS technologies most likely to enhance the safety of young novice driver sub-groups in NSW, and focus group testing to measure their level of acceptance of these technologies (Young, Regan and Mitsopoulos, 2004). The systems examined were: Intelligent Speed Adaptation; Forward Collision Warning; Following Distance Warning; Lane Departure Warning; Fatigue Warning; Alcohol Interlock and Sniffer Systems; Drink Driver Performance Test; Seat Belt Reminder; and Electronic Licence. Barriers that may prevent these technologies from being purchased and used by young novice drivers were identified, many of these being similar to those identified in the above-mentioned study. These included: any lack of information on the use and limitations of the system; any lack of system multi-functionality; concern that systems may make drivers over-reliant on technology; any lack of infrastructure support; any lack of system reliability; a high false or nuisance alarm rate; any perceived danger in drivers using the system; any system not perceived as useful; any system that cannot be overridden; a system that is not compact and non-intrusive in design; any system that can be easily tampered with or circumvented; any system that allows “Big Brother” to monitor driving activities; any system that automatically takes away vehicle control; the system costs more than about AUD $200; and there is no hard evidence that the system is effective.

Intelligent Speed Adaptation and Heavy Vehicles

Many heavy vehicles regularly exceed the speed limit. The aim of this 3-stage project, funded by Austroads, is to evaluate the effectiveness of Intelligent Speed Adaptation in reducing heavy vehicle speeding in Australia. In Stage 1, MUARC reviewed the international literature on intelligent speed adaptation for both light and heavy vehicles (Regan, Young and Haworth, 2003). The report describes these technologies, the infrastructure required to support them, their likely effectiveness, the costs and benefits of implementing them in Australia, and possible approaches for deploying them in Australia. In Stage 2, MUARC developed a research and logistics plan for conducting Phase 3 of the study (Regan, Connelly, Young, Haworth, Mitsopoulos, Tomasevic, Triggs and Hjalmdahl, 2003). Phase 3 is expected to comprise a field study in which a fleet of heavy vehicles is equipped with ISA systems. Phase 3 is expected to form part of the Austroads-funded Intelligent Access Project (IAP). It is not known who will undertake the Phase 3 research.

Driver Distraction

Emerging in-vehicle communication, entertainment, telematics and ADAS have the potential to overload and distract drivers if not ergonomically designed. MUARC is assisting Holden to design and evaluate HMI design concepts for future Holden cockpits which minimise driver distraction and workload. MUARC has the most advanced human-in-the loop driving simulator and eye tracking system (the Seeing Machines FaceLab) in the Southern Hemisphere and will use these systems during the study. The first Phase of the project involved a review of international literature on driver distraction (Young, Regan and Hammer, 2003). The next phase of the study will involve the conduct of a simulator study to evaluate some HMI design concepts for future Holden vehicle cockpits. Another related research project recently undertaken for the NRMA investigated, in the MUARC advanced driving simulator, the effects on driving performance of distraction induced by interacting with in-car CD players, radios and mobile telephones (Horberry, Anderson, Regan, Triggs, and Brown, 2003).

ITS and Aviation Safety

Accidents and incidents on the tarmac area surrounding airport terminals (the “ramp” area) is an issue of growing concern to the aviation community. In 2003, MUARC conducted research on how intelligent vehicle technologies could be used to improve ramp safety. The project identified problems in ramp traffic management, operations and logistics, and how ramp accidents occur. This led to the identification of potential ITS solutions that address the highest priority safety concerns in ramp operations (Horberry, Regan and Toukhsati, 2004). The research was supported by the Australian Airports Association and funded by the Strategic Monash University Research Fund.

ITS and Forklift Safety

A project recently undertaken by MUARC investigated the use of ITS for forklift trucks (Horberry, Larsson, Johnston and Lambert, 2004). Two different ITS devices were installed and evaluated on forklifts at a major manufacturing site: a speed limiting/load sensing device, and an intelligent seatbelt interlock system. Both were designed to address known forklift safety problems. A related project with a major steel manufacturer is currently being undertaken by MUARC.

Other Projects

Other intelligent vehicle-related MUARC research projects, recently completed or currently underway, include:

- a human factors and safety assessment of mobile data terminals in Metropolitan Ambulance Victoria (MAS) ambulances;
- a human factors and safety assessment of mobile data terminals in Victoria Police pursuit vehicles;
- development of a methodology for defining and specifying ITS solutions to road safety problems;
- a cost-benefit analysis of the safety potential of Seat Belt Reminder systems (Fildes, Fitzharris, Koppel and Vulcan, 2001);
- analysis of scanning patterns used by older versus younger drivers when interacting with in-vehicle ITS;
- research on how ITS can be used to assist young novice drivers to calibrate their driving skills;
- a simulator study concerned with the effects of driver experience and type of Intelligent Speed Adaptation system (advisory versus advisory plus tactile warnings delivered through the accelerator pedal) on driver performance and safety;
- a simulator evaluation of a newly-developed fatigue monitoring device;
- research on the potential of intelligent vehicle systems for enhancing safety in transport and logistics operations;
- a simulator evaluation of an ITS device for warning drivers of approaching trains at railway level crossings; and
- a simulator evaluation of a system that warns drivers when an emergency vehicle is approaching an intersection, long before the emergency vehicle can be seen or heard.

In summary, MUARC has completed, or is presently undertaking, more than 20 projects on the general topic of intelligent vehicles and injury prevention. Most of the referenced documents in this paper form the basis of manuscripts which have been submitted to local and international journals for peer review.

Conclusions

The aims of this paper were twofold: firstly, to outline some of the key human factors issues that critically determine the effectiveness of intelligent vehicle technologies in enhancing safety; and, secondly, to outline some of the key projects that have been undertaken by MUARC to address knowledge gaps in this area. The overview of human factors issues and individual research projects has necessarily been brief, and the reader is referred to the referenced source documents for further detail. Those published by MUARC contain recommendations for future research that is, in the opinion of the authors, needed in Australia. Many of these documents can be found on MUARC's website (http://www.general.monash.edu.au/muarc).

Notable here is the fact that none of the research described in this paper directly derives from any Australian national ITS strategy, although it supports the general aims of the existing Australian national ITS Strategy, e-Transport. There is an urgent need in Australia for a national strategy, similar to the European e-Safety strategy and the US Intelligent Vehicle Initiative (IVI), which provides a strategic plan for the design, deployment, development and evaluation of intelligent vehicle technologies with high safety potential, including enabling research priorities. MUARC is currently working with ITS Australia, the peak body which promotes ITS technologies and services in Australia, to develop consultative mechanisms that will facilitate a more strategic approach to the definition and conduct of intelligent vehicle safety research in this country.

References

Barfield, W and Dingus, T (Eds.) (1998) *Human Factors in Intelligent Transportation Systems,* pp 359-396 Mahwah: Lawrence Erlbaum

Fildes, B Fitzharris, M Koppel, S and Vulcan, P *Benefits of Seat Belt Reminder Systems*, Australian Transport Safety Bureau Report CR 211 Canberra: ATSB

Fuller, R (2002) Psychology and the highway engineer, pp 1-10 of Fuller, R and Santos, J A (Eds) (2002) *Human Factors for Highway Engineers* England: Elsevier Science Ltd

Horberry, T Regan, M A and Toukhsati, S R (2004) *Airport Ramp safety and Intelligent Transport Systems* Monash University Accident Research Centre Client Report prepared for the Strategic Monash University Research Fund (SMURF)

Horberry, T Larsson, T Johnston, I and Lambert, J (2004) Forklift Safety, Traffic Engineering and Intelligent Transport Systems: a Case Study ***Applied Ergonomics*** (In Press)

Horberry, T Anderson, J Regan, M A Triggs, T J and Brown, J (2003) Driver distraction and fatigue: A simulator experiment. In the *proceedings of the 5th International Conference on Fatigue and Transportation* "Coping with the 24 Hour Society". Freemantle March.

Regan, M A (2004a) A sign of the future I: Intelligent Transport Systems, pp 213-224 of Castro, C and Horberry, T (2004) *The Human Factors of Transport Signs* London: CRC Press()

Regan, M A (2004b) A sign of the future II: Human Factors. pp 225-238 of Castro, C and Horberry, T (2004) *The Human Factors of Transport Signs* London: CRC Press ()

Regan, M A (2004c) New technologies in cars: human factors and safety issues *Ergonomics Australia* 18 (3) (In Press)

Regan, M A Young, K Triggs, T J Mitsopoulos, E and Tomasevic, N (2004) Effects on driving performance of prolonged exposure to multiple in-vehicle intelligent transport systems: preliminary findings from the Australian TAC SafeCar project In the *proceedings of the 11th World Congress on Intelligent Transport Systems* Nagoya 18-22 October (In press)

Regan, M A Mitsopoulos, E Triggs, T J Tomasevic, N Healy, D Tierney, P and Connelly, K (2003) Multiple in-vehicle intelligent transport systems: Update on the Australian TAC SafeCar Project In the *proceedings of the 10th World Congress on Intelligent Transport Systems*. Madrid16 – 19 November

Regan, M A Mitsopoulos, E Haworth, N and Young, K (2002) *Acceptability of vehicle intelligent transport systems to Victorian car drivers,* RACV Public Policy Report 02/02 November 2002 Melbourne: Royal Automobile Club of Victoria

Regan, M A Young, K and Haworth, N (2003) *Intelligent Speed Adaptation for light and heavy vehicles* Austroads Report AP-R237 Sydney: Austroads

Regan, M A Connelly, K Young, K Haworth, N Mitsopoulos, E Tomasevic, N Triggs, T and Hjalmdahl, M (2003) *Intelligent Speed Adaptation for heavy vehicles Stage 2: Evaluation framework and action plan* Austroads Report Sydney: Austroads (In Press)

Regan, M A Oxley, J A Godley, S T and Tingvall, C (2001) *Intelligent transport systems: safety and human factors issues* Royal Automobile Club of Victoria Research Report 01/01 Melbourne: RACV

Rumar, K Fleury, D Kildebogaard, J Lind, G Mauro, V Carsten, O Heijer, T Kulmala, R Macheta, K and Zackor, I H (1999) *Intelligent transportation systems and road safety* Brussels: European Transportation Safety Council

Rupp, G (2004) Ergonomics in the driving seat, In *ISO Focus: the magazine of the International Organisation for Standardization* 1(3), March, 11-15

Stanton, N A Young, M and McCaulder, B (1997) Drive-by-wire: the case of driver workload and reclaiming control with adaptive cruise control *Safety Science* 27, 149-159

Summala, H (1997) Ergonomics of road transport *IATSS Research* 21(2),49-57

Young, K Regan, M A and Mitsopoulos, E (2004) Acceptability of in-vehicle Intelligent Transport Systems to young drivers *Road and Transport Research* (In Press)

Young, K Regan, M A and Hammer, M (2003) *Driver Distraction: A Review of the Literature* Monash University Accident Research Centre Report 206 Melbourne: MUARC