INVESTING IN NEW TECHNOLOGY TO REDUCE ACCIDENTS AND IMPROVE SAFETY IN TRANSPORT

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BACKGROUND

Rapid advances in computing power, telecommunications technologies and internet-based products are transforming the way in which our society undertakes commercial, recreational and educational pursuits. Within the business sector, both “new” and “old economy” companies are seeking to harness these developments to promote new services and products, enhance personalised customer service and secure market share globally.

Within the transport sector, parallel developments under the banner of Intelligent Transport Systems (ITS) are underway through electronic tolling involving private/ public sector partnerships, transport logistics and in-vehicle features that promote convenience and efficiency such as navigational aid systems.

At the international level, the major thrust of research and development within the ITS sphere has mainly targeted mobility, efficiency and convenience objectives. The objective of harnessing new technologies to advance safety in the transport system has been of relatively low priority. And yet all systems that modify the way in which the transport system operates have safety implications – in either a positive or negative way. The European Transport Safety Council (1) in a recent report noted that “ road safety has, until recently, been a mere by-product in ITS development and certainly not a central aspect of design……the development and application of ITS should not be left entirely to market forces, as the market does not necessarily select the alternative most beneficial to safety”.

Within Australia, a national ITS strategy known as “E-Transport” (2) was launched in December 1999 by the Australian government. The strategy brings a coordinated and strategic focus to the planning, application and assessment of ITS technologies in this country. While Australia has been progressive in developing and deploying Intelligent Transport Systems, to date there have been no research and demonstration projects here that establish the potential road safety and human performance benefits of in-vehicle ITS technologies.

Against this backdrop, the Transport Accident Commission (TAC), the provider of “no-fault” transport injury compensation in Victoria, established a partnership in June 1999 with the Monash University Accident Research Centre (MUARC) with a view to showcasing and assessing the potential of innovative, in-vehicle safety technologies.

This paper sets out to describe:

- The specific objectives of the project;
- The key phases of the project and progress made to date; and
- Specific technologies identified and the safety problems they target.

PROJECT AIMS

The Intelligent "SafeCar" Project was commissioned to achieve the following aims:

- To stimulate demand, initially by fleet owners and in the longer term by the broader community, for in-vehicle ITS features that have significant safety benefits;
- To trial and assess the technical operation of several currently available safety technologies;
- To assess driver attitudes towards, and acceptance of, these technologies – and
- To evaluate the impact of these technologies on driver performance and safety both on the road and in an advanced driving simulator.

DESIGN PHILOSOPHY

In-vehicle ITS technologies have several important roles to play in society: to calibrate drivers to use the road transport system within its limits; to reduce undesirable driver behaviours which are impossible to handle within a safe system; and to make safe driving easier and more comfortable. Within this project, the over-riding aim of the in-vehicle technologies is to provide guidance – not to wrest control from the driver. At all times, the driver is in control of the vehicle and must accept responsibility for his or her actions in accordance with the prevailing road rules and regulations. This responsibility cannot be relinquished on the assumption that the vehicle will assume control when high-risk situations arise.

Under normal driving conditions, the technologies should be totally "transparent" to the driver – it is only when the driver intentionally or inadvertently operates the vehicle outside the design criteria of the traffic management system that he or she will be warned or calibrated. This design philosophy has been central in guiding the choice and design of ITS technologies to be fitted to the vehicles in this project.

It is anticipated that adherence to this approach will promote:

- Sustainable change to safer forms of behaviour through a calibration process and, potentially, "transfer of effect" even when driving vehicles without these technologies;
- Increased driver acceptability of these technologies and the guidance they provide.

PROJECT OVERVIEW

At the outset, the project's viability was strengthened significantly when the Ford Motor Car Company of Australia agreed to lend its support by providing access to vehicles, technical expertise and workshop facilities. In the longer term, commitment by vehicle manufacturers such as Ford Australia is critical to securing a provider – consumer relationship for ITS in-vehicle safety features.

The "SafeCar" project is being conducted in four principal phases:

The key objective of <u>Phase 1</u>, completed in January 2000, was to identify several candidate ITS technologies for inclusion within later phases of the project. The identification process involved a review of relevant literature, extensive consultation with local and overseas ITS experts, suppliers and manufacturers and an analysis of Victorian crash data that led ultimately to the development of a model to estimate the potential safety benefits of each of the selected technologies. Final selection of systems entailed evaluating each technology against a set of key criteria including safety potential, cost, availability and so on.

Phase 2 of the project is current and entails fit-out of two demonstration vehicles with the technologies identified in Phase 1. ITS systems have been sourced from both local and international suppliers and, where required, additional developmental and integration work is being conducted locally. Ford Australia has actively contributed to all aspects of Phase 1 and 2 activities completed to date and played an important role in sourcing, selecting and supporting the development and installation locally of several technologies. Moreover, Ford is making available two Fairmont Ghia sedans to serve as the demonstration vehicles.

Upon completion of fit-out, Phase 2 also involves acceptance testing, establishment of operating procedures and, where appropriate, training requirements for drivers of these vehicles. Pilot testing of the demonstration vehicles will be conducted, including assessment of initial driver interactions with the technologies in readiness for the following project phases.

Phase 3 involves fit-out of a fleet of some 15 vehicles with the same (or similar) mix of ITS technologies featured in the demonstration vehicles. At the time that this paper was being prepared, issues such as the appropriate number of vehicles to be equipped, selection of candidate corporate fleet owners and the final configuration of systems to be incorporated into the vehicles were being considered. This phase will conclude early in 2001.

Phase 4 is the final stage of the project and will involve the conduct and evaluation of a major research study involving the fleet vehicles equipped with the safety technologies in Phase 3. The study will be conducted over 12 months and will entail the collection of data, both on-road and in an advanced driving simulator located at MUARC, to assess technical operation of the chosen systems, driver and community acceptance and the impact of the technologies on driving performance and safety.

While the overall design of the research study is yet to be finalised, it is envisaged that the design will involve an extended on-road study in which drivers are given time to adapt to the on-board technologies and in which they drive to meet their normal, on-going business and personal needs. Driving performance and behaviours will be measured to allow before, during and after comparisons through an in-vehicle data acquisition system. This system will sample multiple streams of data at regular, frequent intervals for subsequent down-loading and analysis.

CANDIDATE TECHNOLOGIES

Functional and human machine interface (HMI) specifications were developed for all of the ITS systems. These were prepared by a multi-disciplinary design team that included representatives of Ford, MUARC and the TAC. Systems purchased “off the shelf” were assessed for suitability against these specifications and systems configured locally were developed to these specifications. Wherever practicable, systems together with displays were designed to conform with draft ISO standards dealing with ITS technology deployment.

A description follows of significant road safety problems together with selected, key ITS technologies identified to assist in reducing these problems.

Speeding

Speeding remains a major contributor to trauma on Australia’s roads. Crash severity increases disproportionately with increasing impact speed. Reductions in both excessive and normal traffic speeds will significantly enhance safety for all road users.

MUARC estimates that an 11% reduction in travel speeds will reduce road deaths by 40% while the Road Accident Research Unit at the University of Adelaide (3) estimates that a 5 km/h decrease in average urban travel speeds will cut pedestrian deaths by 32%. Safety countermeasures that are capable of both curtailing excessive speeds and reducing, even by a small margin, average travel speeds can have a substantial impact on trauma levels.

Intelligent Speed Adaptation (ISA)

This system is designed to warn the driver when he or she is travelling, intentionally or inadvertently over the speed limit. A Global Positioning System (GPS) enables the operative speed limit to be registered by comparing the vehicle's location coordinate with an electronic database of the road network. An on-board computer then compares the speed limit at the car's location with the car's travel speed.

Two variants of the ISA system have been developed – an "informative" and an "actively supporting" system with easy switching between the two options at the touch of a button. The two systems are similar in most respects. While the vehicle is being driven at or below the posted speed limit, nothing is seen or heard. The driver does have the option, however, of viewing the posted speed limit on a visual display by depressing a control button.

If the driver exceeds the speed limit by a set amount (about 3 km/h) for longer than a specified time (about 5 secs), the system commences to present a series of graded warnings. For the "informative" system, the initial warning is visual only but, if speeding persists, is then accompanied by auditory tones that become more insistent if the travel speed is maintained beyond a preset period (about 10 secs). For the "actively supporting" variant, the auditory warnings are replaced by a light resistance fed through the accelerator pedal. This resistance is designed to remind the driver that he or she is currently exceeding the posted speed limit but can be over-ridden in emergency situations by simply pressing harder on the accelerator pedal.

Both these systems have been locally produced to support the research program with their relative effectiveness in reducing vehicle speeds after driver adaptation to be evaluated in the Phase 4 trial.

Non-use of Restraints

Australia can lay claim to having one of the highest seatbelt wearing rates of any jurisdiction world-wide. In Victoria, about 97% of drivers are restrained overall with front passengers having only slightly lower wearing rates. The corresponding rate for rear seat occupants stands at about 85%. The introduction of compulsory seatbelt legislation across Australia (commencing in Victoria in December 1970) has arguably been the single most important initiative in reducing death and injury on our roads.

Despite these achievements, at least one in every five vehicle occupants who die on our roads was unrestrained at the time of the crash. The low rate of unbelted occupants on-road is greatly magnified within the road trauma statistics. Technology can play a key role in enhancing safety by ensuring that all vehicle occupants can benefit from the protective value of seatbelts in the event of a crash.

Seat Belt Reminder System

This system is designed to remind the driver when at least one occupant in the vehicle is unrestrained. The system is being developed locally to a functional specification developed by the project team, but is similar functionally to a prototype system already developed in Sweden. Physically, the technology comprises three sensors in each of the five seating positions – a pressure sensor under the seat fabric to detect seat occupancy, a sensor on the buckle to ensure that the belt is properly buckled and a sensor on the webbing retractor to ensure that the belt is extended sufficiently to wrap around the occupant.

If all occupants in the vehicle fasten their seat belts, no warnings are issued and the occupants are unaware that the system exists. However, if one or more occupants are unrestrained, a visual "unbuckled" icon appears until the vehicle speed reaches 15km/h. Between 15 and 24 km/h, the "unbuckled" icon flashes and a single audio chime is heard. Between 25 and 49 km/h, the chime sounds repeatedly at the same rate as the flashing icon. When the vehicle travels at 50 km/h or faster, the audio chime and the "unbuckled" icon repeat at an even faster rate. The system cannot be circumvented while the vehicle is in motion.

A recent study by MUARC on behalf of the Swedish National Road Administration (4) sheds light on the likely acceptability by the Australian community of intelligent seatbelt reminder systems. A telephone-based survey showed that "drivers with relatively low wearing rates were not opposed to seat belts but appeared not to have developed a seat belt wearing habit in some driving situations. Participants were generally positive about the likely introduction of seat belt reminder systems".

Rear-end Crashes

Rear-end crashes are among the most frequently occurring crash types on Australian roads, but with outcomes typically not as severe as crashes involving striking a fixed object or a head-on collision. Nevertheless, rear-end crashes are strongly linked with the incidence of chronic soft tissue injuries – a problematic and long-term type of disabling injury.

In Victoria, there were 3227 rear-end casualty crashes reported by police over the 12 months to June 2000. For this same period, 2464 claims were made against the TAC for compensation of injuries sustained in these crash types – giving rise to an estimated $8.2M in payments to date.

Technologies that are capable of both warning the driver of an imminent collision and moderating on-road behaviour such that he or she keeps a safe distance from the vehicle in front have an important role to play in reducing rear-end crashes.

Forward Collision Warning System (FCW)

The Forward Collision Warning (FCW) system is designed to warn the driver if he or she is in danger of colliding with an object or vehicle in front by activating visual and audible warnings. This system has been chosen for use in this study as a means of calibrating the driver to adopt larger headway distances to vehicles in front and, in this way, to reduce the risk of a rear-end crash occurring.

A commercially available system, the Eaton Vorad EVT-300, has been fitted to the two demonstration vehicles. The system uses transmitted and received radar signals to determine the distance and relative speed between the host vehicle and objects or vehicles in front. The system provides a visual alert when objects are within 350 feet in front of the vehicle and is intended to provide separate visual and auditory alerts when the vehicle is within two second, one second and a half second following intervals. Physically, the system comprises four components – an antenna assembly, a central processing unit, the driver display unit and an interconnecting harness.

Drink-driving

Drink-driving is a major contributor to trauma on Australia's roads. While the number of drink-drivers killed on Victorian roads has dropped significantly from the 114 deaths in 1989, the incidence of alcohol-related trauma remains unacceptably high. For the twelve months to July 2000, 55 drivers (26%) were killed with illegal blood alcohol levels across Victoria. Two-thirds of these drivers registered blood alcohol levels in excess of three times the legal limit. Moreover, independent research indicates that about one third of drink-drivers killed has recorded prior drink-driving convictions.

In-vehicle systems that are capable of dissuading intending drivers who have been drinking from taking the wheel of a car have significant potential in reducing the extent of alcohol-related trauma.

Breath Alcohol "Sniffer" System

The "sniffer" system is designed to deter people from driving a vehicle if they have been drinking alcohol. A prototype has now been received from a company in Sweden that developed the unit in accordance with a locally produced functional specification. The system consists of four main components: electronics, a passive "sniffer", an active breath alcohol testing device and a visual text display.

Unlike alcohol ignition interlock systems, which are designed primarily for repeat drink-drive offenders, the "sniffer" system is designed specifically to deter fleet drivers from driving while under the influence of alcohol. The system is designed to be more acceptable to drivers than conventional interlock systems.

The "sniffer" sub-system automatically detects the presence of alcohol vapour inside the cabin in the car. If no alcohol is detected, the system is silent and no call is made on the driver to undertake a test. If alcohol is detected, the unit issues an advisory message to the driver to blow into a mouthpiece to test his or her breath alcohol concentration. If the driver's alcohol concentration is above the pre-defined legal or corporate limit, the driver is advised to stop the car within two minutes. If the driver chooses not to do so and continues to drink-drive, this decision is automatically registered on an in-vehicle database for later down-loading and transmission to the fleet manager.

If the driver's alcohol concentration is positive but less than the limit set, the driver is required to take a breath test every 15 minutes until such time as the alcohol concentration is less than the previous reading. Refusal at any time to take a breath test will incur a registration if the driver fails to bring the vehicle to a stop within two minutes. Alternatively, drivers can elect to take a breath test up front rather than be passively monitored by the "sniffer" system.

Post-Crash Trauma Treatment

It is estimated that there is potential to prevent up to 11% of road fatalities with improved post-crash trauma management. Moreover, evidence suggests that the first hour after a crash is crucial to a person's survival or the extent of injury sustained. Minimising the delay between crash occurrence and the arrival of specialised medical assistance is a key way of ultimately reducing the severity of outcome of crashes occurring on Australia's roads.

"May Day" Emergency Response System

The "May Day" system is designed primarily to provide rapid notification to emergency services of vehicle location in the event of a serious crash or medical emergency. "Car Com" is the system fitted to the two demonstration vehicles and is an available product manufactured and supplied by Oz Trak and marketed locally by Intelematics, a joint venture of the RACV and the NRMA. The system, as presently configured, provides a number of services and contains four buttons – an SOS button which when depressed initiates a call to an emergency response centre, a road-side assistance button, a telephone button and an information button that provides access to a range of services including navigation assistance and remote vehicle immobilisation in the event of theft.

Potentially, the system can be modified such that activation of a sensor linked either to airbag deployment or to vehicle roll-over will result in automatic dial-up to an emergency response centre.

Other Technologies

The two demonstration vehicles have also been fitted out with the following technologies with a view to enhancing safety outcomes:

- A rear collision warning system that is sonar-based and provides an audible tone once the reversing vehicle comes within 1.2 metres of an object to its rear; the frequency of the tone increases, the nearer the vehicle approaches the object;

- Daytime running lamps that operate at 80% of normal low-beam luminance and are activated once the vehicle's ignition is turned on; international research indicates that this measure is capable of reducing the incidence of multi-vehicle daytime crashes;

- An in-car navigational aid system that, potentially, can limit exposure to crash risk through choice of the most direct route from starting point to destination.

DISCUSSION AND CONCLUSION

In-vehicle ITS technologies have several important roles to play in society – to calibrate drivers to use the road transport system within its limits, to reduce undesirable driver behaviours that are impossible to handle in a safe system, and to make safe driving easier and more comfortable.

The SafeCar Project has been initiated with the specific purpose of evaluating and showcasing available in-vehicle technologies that have the potential to significantly reduce the level of trauma on Australia's roads. Preliminary estimates indicate that these technologies can reduce trauma levels by at least 30%.

Central to the project has been a design philosophy that ensures that drivers need not be aware that they are driving an ITS-equipped vehicle under normal driving conditions. It is only when the driver intentionally or inadvertently operates the vehicle outside the design criteria of the traffic system that he or she is warned or calibrated. It is envisaged that this approach will promote both sustainable, safer behaviours and improved user acceptability. Moreover, this approach contrasts with some ITS solutions that may have the effect of encouraging drivers to drive to the limit imposed by the ITS system.

Several features of the SafeCar Project distinguish it from similar ITS projects around the world:

- The focus of the field trial is on fleet vehicles, as these represent over 60% of the new car market in Australia and will drive societal demand for in-vehicle ITS systems;
- The project has the support and involvement of a major vehicle manufacturer, the Ford Motor Car Company of Australia;
- The interactive effects of multiple ITS systems on human behaviour over an extended period of time will be assessed;
- Concurrent collection of information from both on-road experience and simulator trials will provide important data on the validity of simulator studies in ITS applications; and
- The choice of ITS systems has been guided by the central design philosophy noted above.

Ultimately, the worth of this project must be judged by the extent that it acts as a catalyst for the demand from within fleets initially, and by the broader community eventually, for in-vehicle ITS safety features such as those highlighted in this paper.

References

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