Introduction

Vision Zero is known for its emphasis on developing safer physical road environments to prevent fatalities and serious injuries. However, the environment, in the wider meaning of the term, also plays a strong role in Vision Zero as a concept and in the strategies arising from this policy. Road trauma, vehicle emissions and noise are all harmful effects of the road transport system on human health and as such all must be addressed.

The Swedish policy statements describing Vision Zero outline the parallels with environmental issues. The Swedish Ministry of Transport and Communications has stated that...

"Much of the work on road traffic safety and the environment within the road transport system is aimed at minimizing the negative impact of traffic on human health both today and in the future. The purpose of the work on road traffic safety is to prevent people from being killed or injured in traffic accidents while that of the work on the environment is that people and the surroundings should not suffer from vehicle emissions and the noise emanating from traffic" (Ministry of Transport and Communications, 1997, p.12).

The limiting criteria in environmental standards are related to human tolerance for exposure to particular energies or materials. Vision Zero applies the analogous criteria of critical load limit and biomechanical tolerance, to the safety of the road traffic system (Tingvall, 1998).

Vision Zero states that "safety is a more important area than other issues in the road transport system (*except for health related environmental issues*)" (Tingvall, 1998, our emphasis). In much of the planning and implementation guided by Vision Zero in Sweden, the effects on both safety and the environment of particular measures are being considered.

This paper discusses two facets of Vision Zero where both the safety and environmental effects have been investigated: travel speeds and work-related travel. It then discusses possible benefits of linking safety and the environment in Australian road safety strategies.

Speed

The Vision Zero adopted by the Swedish Government is that *eventually no one will be killed or seriously injured within the road transport system* (Ministry of Transport and Communications, 1997). While a safe road transport system can be achieved by eliminating all accidents, Vision Zero recognises that this is not likely to happen, even with advanced ITS techniques. Therefore, the system must rely on a balance between travel speeds and the inherent safety of the physical road environment and of vehicles to ensure that those crashes which occur do not result in death or serious injury (Haworth, 1999).

Vision Zero proposes that design and investment decisions for the physical road environment should aim to control speed where there is a potential for conflict with other vehicles and should provide a better interface between the passive safety of the car and the physical road environment when a car leaves the intended direction of travel. More specifically, investments should mainly be directed to interventions reducing speeds below the threshold for serious injury or to avoiding high-speed crashes by building grade-separated intersections on high-speed main roads.

Other investments should be directed towards more forgiving roadsides and large separation between opposing vehicles where speeds exceed, say, 60-70 km/h. For pedestrian safety, vehicle speeds must be restricted to 30 km/h where conflicts between vehicles and pedestrians exist, or alternatively cars and pedestrians should be physically separated.

Speed and crashes

There is overwhelming international evidence that lower speeds result in fewer collisions of lesser severity. In general, the faster the average traffic speed, the more collisions there are. Accident frequency rises approximately with the square of the *average* traffic speed (Taylor, Lynam and Baruya, 2000).

A model has been developed based on experiments with different speed limits in Sweden which states that the probability of a fatal accident is related to the fourth power of the speed (Andersson and Nilsson, 1997). This means that a 10% reduction of mean speed results in a reduction of the number of fatalities of approximately 40%. Figure 1 in Appendix A shows the predicted outcome of a change in mean speed on the number of accidents, fatal and serious injury accidents and fatal accidents.

Research undertaken in the USA after the raising of the interstate speed limits (cited in Finch, Kompfner, Lockwood and Maycock, 1994) has shown that an increase in mean speed of 2-4 miles/h (approximately 3-6 km/h) resulted in an increase of the number of fatalities of 19-34%. This translates roughly to a 8 to 9 per cent increase in fatalities on USA interstate highways for every 1 mile/h change in mean speed.

Recent work on speed and accidents has indicated that the relationship derived by Finch et al in 1994 holds for the general case: i.e. every 1 km/h reduction in speed across the network leads to a 3 percent drop in accidents (Taylor, Lynam and Baruya, 2000). However, greater accident reductions per 1 km/h reduction in speed are achieved on residential and town centre roads, and lower reductions are achieved on higher-quality suburban and rural roads.

Recent Australian research has generated new evidence on the increases in crash risk with increasing travel speed. For example, a study in metropolitan Adelaide reported that travelling at 5 km/h over the speed limit doubles crash risk, the same effect as BAC of 0.05 (Kloeden, McLean, Moore and Ponte, 1997). For pedestrian crashes, McLean, Anderson, Farmer, Lee and Brooks (1994) reported a strong relationship between impact speed and injury severity. Vehicle speeds affect pedestrian safety in a number of other ways as well: "lower vehicle speeds increase the time available to a

driver to detect and react to risky or inappropriate pedestrian behaviour, lower vehicle speeds provide for shorter braking distances to minimise or eliminate the risk of collision with pedestrians, and lower vehicle speeds allow more time for a pedestrian to detect and react to the presence of the vehicle on the roadway" (Gibson and Faulks, 1998).

Several studies have shown that the risk of a pedestrian receiving fatal injuries at an impact speed of 50 km/h is approximately 10 times higher than at an impact speed of 30 km/h. The power functions are even steeper for pedestrians than for vehicle occupants. About 90 percent of pedestrians struck at 65 km/h will be killed in comparison to about 10 percent for those struck at speeds at or below 35 km/h (Ashton and Mackay, 1979). The change from mainly survivable injuries to predominantly fatal ones takes place between 50 and 60 km/h.

Many residential areas in Australia have recently been assigned a speed limit of 50 km/h – a reduction from the long term limit of 60 km/h. Over the period 1998-2000, Meers (2001) concluded that this factor alone saved 19 fatal crashes each year in south-east Queensland alone (a decrease of 15% in fatal crashes). In New South Wales, the initiative led to a 25% reduction in crash risk on streets zoned at 50 km/h. This represented 262 fewer crashes and a cost saving to the community of $6.5 million (RTA, 2000).

In summary, reducing speed is probably the most powerful instrument to overcome a system in which drivers drive faster than the design of the road will allow with safety. Even very small reductions in mean travel speed have a substantial impact on injuries and a greater effect on fatalities. Reducing speed is therefore often a very cost-effective measure to reduce the incidence and severity of crashes.

Speed and environmental impacts

While there is interest in Australian in the safety and environmental effects of reductions in urban speed limits from 60 km/h to 50 km/h, most of the Swedish research has focussed on reductions from the widespread urban speed limit of 50 km/h to a new limit of 30 km/h for some areas. The environmental effects at these lower speeds are more complicated. Swedish research has shown that at a constant speed, the fuel consumption in cars with modern motors is higher at 30 km/h than at 50 km/h. On the other hand, a speed of 30 km/h entails less fuel consumption when stopping and accelerating. Hydrocarbons, carbon monoxide and nitrogen dioxide are greatly affected by changes in speed. It has been calculated that of the total emissions in the year 2000 there will be 4% less hydrocarbons, 7% less carbon monoxide, 8% less nitrogen dioxide and just under 1% less carbon dioxide at speeds of 30 km/h compared with 50 km/h. It has also been calculated that fuel consumption will decrease by a little less than 1% (Ministry of Transport and Communications, 1997).

Work-related driving

The operational strategy of Vision Zero includes a move to public authorities applying quality assurance principles to work-related travel. These quality assurance principles include both safety and environmental outcomes.

"The operational strategy of Vision Zero means that public authorities should, for example, take considerably greater responsibility for the quality assurance of their road transports, official business trips, and trips to and from work, so-called work-related trips from a road safety and environmental point of view. If this is done in an organized way throughout society, there will be significant impact on the road traffic safety within the country" (Ministry of Transport and Communications, 1997, p.40).

Quality assurance of transport aims to ensure that people and goods arrive at the right place, at the right time and in the right way (i.e. without danger of serious injury or damage to the goods or the environment in connection with the transport). Quality assurance from a road safety and environmental point of view involves:

- influencing the need for road transport
- influencing how road transport is implemented
- influencing the choice of vehicle, equipment and fuel.

According to the Ministry of Transport and Communications (1997), management is responsible for setting up goals and establishing policy for quality assurance, providing organisational and financial backing for the work and ensuring that the outcomes are monitored.

Quality of transport could be followed up with performance indicators, such as choice of vehicles, fuel consumption, etc. Fuel consumption and emissions are related to each other, as well as to safety (in terms of speed and non-aggressive driving). Therefore fuel consumption can be used as a performance indicator for transport operations (Haworth, 1999).

The following section gives some examples of implementation of these policies in Sweden (from Haworth, Tingvall and Kowadlo, 2000).

Swedish National Road Administration Travel Policy

The travel policy of the Swedish National Road Administration (SNRA) was introduced in January 1998. This policy relates to fleet cars and rental cars used by the employees. The safety specification relates to frontal and side protection, weight of the vehicle and ABS brakes. The use of the vehicle in terms of safety has also been specified. The main environmental requirement relates to fuel consumption. Several agencies and corporations have followed the example, and it is expected that the Swedish government will decide that all state agencies should have a similar travel policy. This will include outsourced vehicles and transport as well as transport made within the organisation.

Purchasing safe transport services, Borlänge local government

In 1997, Borlänge Municipality in Sweden commenced a program to purchase transport services in which safety is one of the key elements. Providers of transport have to deliver the transport service in a way that is safe in terms of vehicle used, drivers used and the way the vehicle is driven. In the contracts between the local government and the providers, it is specified that the provider must have a quality system in place to be able to guarantee that the standard is followed. A local non-govermental traffic safety organisation was contracted to do some of the audits to ensure that safety systems were in place.

A trial of electronic speed monitoring is being undertaken by the Borlänge Municipality and the Swedish Association of Local Authorities. The purpose of the trial is to test and develop technical solutions for vehicle-based speed control of publicly procured road transport. The work involves a number of transport firms. GIS/GPS systems have been installed in vehicles for quality assurance of speed. When a vehicle exceeds the speed limit, and the driver does not slow down, the speeding is recorded and dealt with within the quality management system of the supplier. This is gradually developing, not only in Borlänge.

Taxi company safety and environmental policy in Sodertalje

A taxi company in Sodertalje, a city with many large companies, has developed and implemented a safety and environmental policy in order to provide especially large clients with a safe and environmentally sound transport service. The policy is seen to create a better market position, and the taxi company claims they have more clients than before. It is also seen as positive from some of their very large clients.

The policy relates mainly to driving, requiring that speed limits should be adhered to and that special consideration should be paid to unprotected road users.

Purchasing of taxi and tram transport in Gothenburg

Local government in Gothenburg purchases bus and tram services from a corporation. Specific requirements in terms of speed etc. are built into the contract. The speeds mentioned go beyond the speed limits in terms of lower speeds in certain areas. If speed limits are exceeded, the contract is used to negotiate the consequenses. This is an example where actual road user legislation is combined with contracts. While road user regulation is used in the relationship between the driver and enforcement, the contract deals with the relationship between the two parties signing the contract.

Guidelines for vehicle policy, YNNOR

A major consulting company in Sweden, YNNOR, specialising in helping corporations to develop vehicle policies, has recently started to integrate safety and environmental issues in their policies. In an attempt to combine safety, environment and economy, the policies relate mainly to vehicle fleets, and the use of them. A book has been produced, and YNNOR is helping a large number of corporations to develop new policies. A number of specific suggestions are mentioned and the book is continuously being revised. SNRA has been involved in part to fund the production of

the book, but the consulting company is independent and considered to be the most prominent consultant in the area.

Folksam Insurance – Environmental and Safety Requirements

In Sweden, insurance companies are responsible for approximately half of the rental car market (Folksam Research, 1999). Most of this demand is to provide replacement cars for cars which are being repaired. As part of a move to influence safety development, Folksam has developed environmental and safety requirements that must be met by the rental car companies with which it forms agreements.

The safety requirements are presented in the box below:

> The cars which meet with our approval must firstly meet the requirements of alternative I below. If the car in question is not represented in our ranking list, it should meet the requirements of alternative II. If the car is not listed in Euro NCAP's research results, alternative III will apply.
>
> I At least 20 percent safer than the average car (safety class green or blue)
> II Safety classified with three or four stars, in accordance with Euro NCAP's crash test results
> III Meets European requirements for head-on and side-impact collisions (96/79/EEG and 96/27/EEG)
>
> Folksam Research, 1999, p.6

The environmental requirements are as follows:

> Our environmental requirements apply to fuel consumption, and the values are based on national targets for average fuel consumption in the year 2000.
>
> | | 1999 model | 2000 model |
> |---|---|---|
> | Small cars and small family cars | 7.7 | 7.5 |
> | Family cars | 8.5 | 8.3 |
> | Large family cars | 9.6 | 9.4 |
>
> Cars certified in environmental class 1 in Sweden, are exempt from fuel consumption requirements. Diesel is not recommended.
> Folksam Research, 1999, p.6

Based on the Swedish National Road Administration and Folksam policies, the Monash University Accident Research Centre has developed a Policy for Purchase and Use of Vehicles at MUARC. This policy incorporates best practice elements from a number of guidelines (Monash University Accident Research Centre, 2000).

Proposed meeting on safe and environmentally-sound technology

Sweden will host a high-level meeting on new technology for safe and environmentally-sound road transport in June 2001 (Swedish National Road Administration, 2000). The Swedish National Road Administration is arranging the

meeting at the request of the Swedish Government. The meeting is included in the calendar of events for the Swedish EU Presidency. The meeting will present new technology based on research which should be possible to implement within three to five years. Concrete applications will be demonstrated within three main subject areas: vehicles of the future, the infrastructure of the future, and safe and environmentally-sound traffic behaviour in the future.

The benefits of linking road safety and environmental goals

Linking road safety and environmental goals may serve to increase support for both types of goals. In addition, concepts and implementation processes used in the environmental movement may have the potential to provide models for road safety planning and implementation. For example, environmentalists appear to have been more successful in making the point that the environment is paramount, than road safety agencies have been in stating that safety is paramount.

In the environmental area, it has been possible to achieve a global insight into the problems, and that the problems cannot be reduced simply by individuals behaving better. Instead, environmentalists have been successful in showing that the major changes must be made on the systems level, including states and private industry. Nature and individuals have been seen as the victims of poor environment rather than the states being victims. This is very different from safety in road transport, where the road user has traditionally been seen as the agent and the state is the victim. Furthermore, in the environmental area, critical load limits have been set up for humans and nature (e.g. permissible levels of noxious chemicals). These are viewed as limits that cannot be exceeded in the sustainable development of a society, while in road safety, life and health have been balanced against other benefits, primarily mobility.

There are a number of reasons why governments should try to combine road safety and environmental issues. There are true areas of mutual benefit, such as reduced energy consumption which is related to both pollution, carbon dioxide emissions and speed, which is related to safety. A more even distribution of vehicles, with less power, is also beneficial, as is the redesign of built-up areas. Given the strong role of the environmental agencies, this could mean that there is more and stronger support for safety issues.

The Swedish Ministry of Transport and Communication has concluded that:

“Through the focus on environmental issues, there has been a greater understanding of the causes and effects of environmental problems on the part of decision-makers and citizens. There is, at present a widespread debate throughout all levels of society as to what must be foregone to be able to convert our resource intensive society into an ecologically sustainable society. A similar broad debate including grass-roots commitment is also required on the subject of road traffic safety so that the present-day focus can eventually result in a society with safe road traffic.

It is highly essential that the work on road traffic safety be co-ordinated, as far as possible, with the overall work on environmental issues and the work on other closely related areas of activity (such as the work environment, health and welfare promotion, crime prevention etc.). This is partially due to the fact that this work is largely based on grass-roots commitment and partially because of the common ambition to prevent health impairment and crime both today and tomorrow" (1997, p.13).

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Appendix A

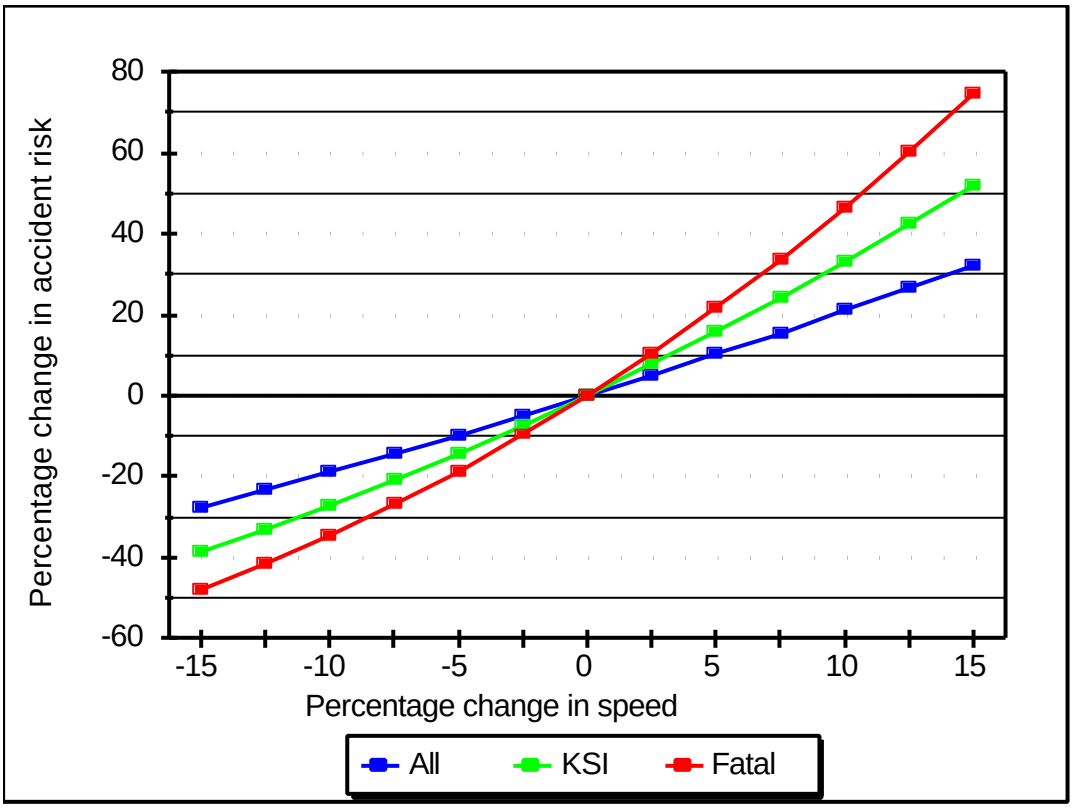

Figure 1. **The percentage change in all accidents, killed and serious injury (KSI) accidents and fatal accidents (y-axis) as a function of percentage changes in mean speeds (x-axis). The steepness of the curve increases with accident severity. Based on Andersson and Nilsson (1997)**

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