Vision Zero - An ethical approach to safety and mobility

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Paper presented to the 6th ITE International Conference Road Safety & Traffic Enforcement: Beyond 2000, Melbourne, 6-7 September 1999.

ABSTRACT

Vision Zero is a philosophy of road safety that eventually no one will be killed or seriously injured within the road transport system. This paper describes Vision Zero and its view that safety cannot be traded for mobility. The applicability of Vision Zero to Victoria in the short- and long-term is discussed.

THE VISION ZERO

In October 1997, the Road Traffic Safety Bill founded on Vision Zero was passed by a large majority in the Swedish parliament. The Vision Zero is that *eventually no one will be killed or seriously injured within the road transport system* (Ministry of Transport and Communications, 1997). The Vision is an expression of the ethical imperative that

It can never be ethically acceptable that people are killed or seriously injured when moving within the road transport system.

Vision Zero addresses fatalities and those injuries where the victim does not physically recover within a certain period of time. This means that common, but not long-term disabling injuries, and non-injury accidents are more or less outside the scope of the Vision.

Vision Zero provides a vision of a safe road transport system which can be used to guide the selection of strategies and then the setting of goals and targets. Zero is not a target to be achieved by a certain date. It is a change from an emphasis on current problems and possible ways of reducing these to being guided by what the optimum state of the road transport system should be.

Vision Zero also changes the emphasis in responsibility for road traffic safety. In all current road transport systems, the road user has almost total responsibility for safety. In most countries, there are general rules that the road user should behave in such a way that accidents are avoided. If an accident occurs, at least one road user has, by definition, broken the general rule and the legal system can therefore act.

In contrast, Vision Zero explicitly states that the responsibility is shared by the system designers and the road user:

"1. The designers of the system are always ultimately responsible for the design, operation and use of the road transport system and thereby responsible for the level of safety within the entire system.

2. Road users are responsible for following the rules for using the road transport system set by the system designers.

3. If road users fail to obey these rules due to lack of knowledge, acceptance or ability, or if injuries occur, the system designers are required to take necessary further steps to counteract people being killed or seriously injured."

‘Ethical rules’ have been proposed to guide the system designers. Two of these are:

> "Life and health can never be exchanged for other benefits within the society"
>
> "Whenever someone is killed or seriously injured, necessary steps must be taken to avoid a similar event".

SAFETY AND MOBILITY

Vision Zero states that the loss of human life and health is unacceptable and therefore the road transport system should be designed in a way that such events do not occur. This means that safety is a more important area than other issues in the road transport system (except for health-related environmental issues). Mobility therefore should follow from safety and cannot be obtained at the expense of safety.

Since safety and mobility cannot be traded against each other, then mobility becomes a function of safety, not vice versa. The safer the road infrastructure, the greater mobility is afforded. In Vision Zero, speed is often used as an operational definition of mobility. Thus, Vision Zero states that speed must be limited to a level commensurate with the inherent safety of the road system. This is a true paradigm shift and contrasts to the more general principle, where human life, mobility and other benefits and problems are weighted against each other.

In the background paper to the Swedish parliament written by the government, the following sentence is probably the most important: "…the speed limits within the road transport system should be determined by the technical standard of vehicles and roads so as not to exceed the level of violence that the human body can tolerate. The safer the roads and vehicles, the higher the speed that can be accepted."

FROM VISION TO STRATEGY

The most important part of the vision and the meaning of ‘Vision Zero’ is that "no foreseeable accident should be more severe than the tolerance of the human in order not to receive an injury that causes long term health loss". If a virtually safe system is going to be designed, either the harmful event must be eliminated, or it should not reach the limit of the human tolerance. In the Vision Zero concept, it is assumed that accidents cannot be totally avoided, hence the basis for this concept is built around the human tolerance for mechanical forces.

The risk of an injury can be seen as a dose-response function, where injury is a result of mechanical forces. Accidents involve more or less mechanical force, often described as the accident severity exposure. If the accident exposure, or the mechanical forces, could be kept below the threshold for a serious injury, we have a virtually safe system. To keep the exposure under the threshold, we can either eliminate all accidents over the limit, or increase the ability to withstand forces. These are elements known as accident prevention and injury prevention.

There is always one parameter that can be used to dramatically increase safety: that is to reduce mobility, either for some road user categories, or to reduce speeds down to a level where accidents do not cause serious injuries. The correlation between speed and safety is one of the best-known relationships in the road safety area, both theoretically as well as empirically. If nothing is done to the inherent safety of the system, mobility can be reduced to such levels where almost no accident causes serious injury.

Accident prevention and injury prevention become somewhat blurred when traffic safety is modelled in this way. The reduction in exposure to mechanical force can be

achieved not only by avoiding accidents, but also by modifying it to fit into the human tolerance, sometimes filtered by protective systems. A safe intersection for cars is not an intersection without accidents, but an intersection where no possible accident will lead to a serious health loss. In fact, a safe intersection might be one where there are more accidents than occur in a less safe solution.

It is quite obvious though that the focus must be set on the interface between the different components of the system (speeds, roads, vehicles). The safe intersection might only be safe for occupants that are properly restrained in a vehicle with a certain level of crashworthiness. At the same time, it might be unrealistic to develop a safe road for unbelted occupants. The interfaces must therefore be defined, but only to such a degree that they will be realised. This definition will make it quite clear what the limitation of a car is, as well as the road. The car will probably never be able to protect its occupants in head on collisions with trucks over a certain velocity, even if the front end of the truck is deformable. In this sense, the automotive industry and the infrastructure designers that will largely set the future speed limits.

Vision Zero has many parallels to approaches to environmental issues, both setting criteria related to what the human being can tolerate. The Swedish Ministry of Transport and Communications has stated that "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" (Ministry of Transport and Communications, 1997, p.13).

IMPLICATIONS FOR SPEED MANAGEMENT

Vision Zero describes the end product of a safe road transport system. While such a system can be achieved by eliminating all accidents, 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 infrastructure and vehicles. By assuming a certain level of vehicle safety, long term guidelines for maximum actual speed related to the infrastructure can be set. These guidelines form the basis for sustainable investments into the infrastructure, and can be used as options in redesigning the infrastructure.

For example, the human tolerance for a pedestrian hit by a well-designed car will be exceeded if the vehicle is travelling at over approximately 30 km/h. If a higher speed in urban areas is desired, the option is to separate pedestrian crossings from the traffic. If not, pedestrian crossings, or zones (or vehicles), must be designed to generate speeds of a maximum of 30 km/h.

The same arguments could be used for infrastructure where only cars can collide. While the inherent safety of well-designed cars can be anticipated to be a maximum of 70 km/h in frontal impacts, and 50 km/h in side impacts, higher speeds can be tolerated if the interface between the vehicle and the infrastructure is well designed. Speeds over 100 km/h can be tolerated in the future. It can be assumed that every step in the direction to fulfil these guidelines will be positive in terms of reducing the road toll.

While Table 1 shows the end product of an inherently safe system, not producing serious or fatal injuries, which should be the goal of speed management. The key issue is that such a strategy is sustainable and allows substantial investments that

will not be obsolete over any foreseeable time frame. It must be noted that the success of such a strategy is based on a certain development of vehicles and restraint use in order to give maximum benefit. It is also based on the assumption that the road user is encouraged or forced to use the system in the intended way.

Table 1. Possible long term maximum travel speeds related to the infrastructure, given best practice in vehicle design and 100% restraint use.

Type of infrastructure and traffic	Possible travel speed (km/h)
Locations with possible conflicts between pedestrians and cars	30
Intersections with possible side impacts between cars	50
Roads with possible frontal impacts between cars	70
Roads with no possibility of a side impact or frontal impact (only impact with the infrastructure)	100+

APPLYING VISION ZERO IN VICTORIA

The traffic safety strategy in Victoria has been mainly focused on high-profile measures directed at the road user and progressive improvements to the road system. Speeding and drink driving measures seem to be the main areas that have created the success in reducing the number of fatalities and injuries in the beginning of the 1990s.

Vision Zero focuses on the inherent safety of the road transport system, as well as safe use of the system. Given no change to the inherent safety of the system, the only radical way to drop the road toll is to reduce travel speeds. If this does not seem acceptable, especially as speeds would have to be dropped substantially, the alternative is to invest to improve the inherent safety of the system, with a more or less given mobility. These investments will be mainly directed towards the infrastructure.

As the main design factor in Vision Zero is the biomechanical tolerance of the human in the case that a potentially harmful event occurs, the main investments into the infrastructure should aim to control speed where there is a potential for conflict with other vehicles and to provide a better interface between the passive safety of the car and the infrastructure when a car leaves the intended direction. More specifically, investments should mainly be directed to interventions creating speeds below the threshold or grade-separated intersections.

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

To increase the inherent safety of the road transport system based on Vision Zero is not in conflict with general investment in the road system. A more system-oriented approach must be developed in co-ordination with the automotive industry. In order to improve the interface between vehicles and the infrastructure, the interface must be defined and developed. The vehicle must be able to guarantee seat belt use, a

sober driver and limitation of speed. The infrastructure must be developed to cope with a variety of vehicle types.

Vision Zero is a long-term vision which can guide the development of strategies but it does not prescribe the content of strategies. There are no obvious conflicts between other strategies and Vision Zero, other than those strategies which rely on fewer errors made by the road user. The general recommendation from Vision Zero is that strategies should incorporate linking speed to the technical standard of the system.

In the short term, the implication of Vision Zero in Victoria would be to invest differently into road traffic infrastructure. In order to make a substantial change to safety within a reasonable time, large investments would be needed, mostly related to traffic calming, improved intersections and well designed barriers on high-speed roads. Speed limits would need to be reduced in areas where improving the infrastructure is not an option.

An operational strategy

While it is desirable to have political commitment to the sustainable development of a safe road transport system, it is not necessary in the short term. Therefore, an operational strategy can be outlined and some important steps can be taken fairly soon. It must be stressed though, that some of the components of the strategy will not give an immediate effect. While these components will eliminate a certain problem in the long run, they must be complemented with more short-term strategies. Seat belt interlocks, as an example, will only have a very limited effect in the beginning, probably not addressing non-use of seat belts within five years, but then gradually have a substantial effect later. Non-wearing of seat belts must therefore be addressed with other methods in the short term. The three areas below address the inherent safety of the system as well as a safe way of using it.

The most important steps in an operational strategy are:

A. Gradually aligning vehicle speed to the inherent safety of the system

A first step would be to "rate" the infrastructure-speed in terms of safety and compare the end product with the current situation. This will give a good picture of where it is most effective to either reduce speed or modify the infrastructure. Generally, four aspects should be considered in a rating system. All of these aspects contribute to determining the safe travel speed:

Roadsides

Lane separation

Intersections

Unprotected road users

A road receives a top ranking if it fulfils the requirements in Table 1, but it is important to describe the intermediate steps, so that even small modifications are recognised. The amount of traffic can be a parameter showing the importance of modifying the system. This is an alternative to using accidents as a way to identify problems, and will make it clear what actions must be taken at each spot or road, in order to eliminate the role of the infrastructure in producing harm.

The ranking will produce an end product that can be used for long-term planning and for demonstrating the options in producing an inherently safe system. The ranking

system can also be seen as a performance indicator of the inherent safety of the system.

B. Improving vehicles to address driver behaviour issues

At least two, possibly three, major steps, can be taken in terms of vehicle safety:

Seat belt interlocks

Alcohol interlocks

Intelligent speed limiters

While there are problems in relying on the market to stimulate the demand for these devices, it is nevertheless very important that these devices will in the long term have a substantial impact, especially within a safer infrastructure.

The implementation process can be designed in many different ways, allowing both regulation and market demand. One way of promoting the development of such systems is to form an alliance of fleet buyers of cars that will gradually start to demand vehicles with the devices. The role of insurance companies should not be underestimated, as well as building partnerships with the automotive industry. The phasing out of older cars should also be considered in a market-oriented approach.

C. Stimulating the community to use the system in a safer way

The role of corporate behaviour can be used to build quality systems within organised use of the road transport system. By demanding professional users of the system to focus on issues like speed, fatigue, purchase of cars etc, a large proportion of the traffic can be influenced. It is important to see this as a demand-driven process rather than regulatory in the short run. State and local government could start this process, being major users of the road transport system. Producing a safe system of transportation would both affect transport within the organisation as well as transport provided by others (taxis, rental cars etc).

Quality of transport within a corporate behaviour strategy would benefit from finding synergies with economy and environmental issues. 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). It is recommended that fuel consumption be used as a performance indicator for all transport operations.

In the short term, a "safe" way of using the road transport system should be defined, in order to help the market, preferably in a way that suits modern quality management systems, such as ISO 9000 and 14000.

CONCLUSIONS

Vision Zero is a long-term strategy in which the system and its use are gradually integrated and where the responsibility for safety gradually becomes shared by the designer and the user of the system. Such a system that is built on tolerating human error leads sooner or later to a changed pattern of responsibility within the automotive industry, road engineers and traffic planners.

"In a broad sense, the decision [to adopt Vision Zero] stimulates innovations and investments into the road transport system, and gives a new perspective as to how the society can handle different actors in a complicated world. If mobility is what society wants, it can only reach that by an increased inherent safety. If safety is what

society wants, it can be reached in two ways – reduce mobility or invest in safety." (Tingvall, 1998, p.8)

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