SWOV Fact sheet

Sustainable Safety: principles, misconceptions, and relations with other visions

Summary
In the early 1990s the Sustainable Safety vision was launched in the Netherlands. This vision, which was implemented during the following years and was updated in 2005, proved to be a success. The Sustainable Safety vision aims to prevent (serious) crashes from occurring and if this cannot be done, to prevent severe injury. Sustainable Safety is a pro-active approach. This means that the weak spots in the traffic system are dealt with generically. Since 1998, the introduction of all the measures that are based on the Sustainable Safety vision had in 2007 decreased the number of road deaths by approximately 30% compared to a scenario in which policy and crash and fatality rates would have remained unchanged. These measures turned out to be socially profitable.

Background and content
Road traffic is inherently unsafe. Our traffic system is designed in such a way that it does not (sufficiently) prevent crashes and severe injuries. The main hazards in traffic are the large differences in speed and mass that the human being has to deal with. The human being is not only physically vulnerable, but also makes errors and commits offences. Each year, this results in hundreds of road deaths and many thousands of severely injured in the Netherlands.

The idea that traffic is inherently unsafe should be a starting point in improving road safety (Koornstra et al., 1992). This insight was inspired by developments in other sectors, such as aviation and the process industry. The Bruntland report on sustainable development was the inspiration for choosing the term 'sustainable' for this road safety vision. ‘Sustainable’ refers to a development that answers to the needs of the present generation without harming future generations’ possibilities to answer to their own needs.

This fact sheet presents the current principles of Sustainable Safety. It will discuss the goals, the ‘human measure’, the integral approach to the elements factors ’man’, ‘vehicle’ and ‘road’, the proactive character, and the five principles on which the vision is based: functionality, homogeneity, predictability, forgivingness, and state awareness. Some misconceptions about Sustainable Safety will be addressed and, finally, Sustainable Safety will be compared with the Swedish Vision Zero and with Shared Space, a traffic concept within spatial planning.

How has the vision developed since 1997?
During the last few decades, the main approach used to tackle high-risk locations was a reactive method. High-risk locations, also called black spots, are locations where many crashes have occurred within a short period of time (see also SWOV Fact sheet *The high risk location approach*). Sustainable Safety proposed a proactive approach which involves a mainly generic approach to the weaker spots in the traffic system. The weak spots are determined based on the potential hazards due to possible conflict situations and the conditions under which these occur. The launch of the Sustainable Safety vision found political support, which resulted in a number of demonstration projects in 1995, and, finally, in the Sustainable Safety Start-up Programme in 1997. Striking elements were the large-scale implementation of urban 30 km/h zones and of residential 60 km/h zones in rural areas. This gave Sustainable Safety a strongly infrastructural character, even though measures in other areas, such as education and enforcement, are also essential components of the vision. These elements also developed strongly within the Start-up Programme, but were somewhat less in the in the spotlights.

More than a decade after the introduction of Sustainable Safety, the time had come to evaluate the vision and the direction it had taken. This was to give the vision a new impulse and to make it possible to respond to new developments. The evaluation resulted in the updated vision entitled *Advancing Sustainable Safety* (Wegman & Aarts, 2006).

The updated vision:
– promotes continuing the successful infrastructural measures of the past;
– puts more emphasis on education, regulations, and enforcement;
– emphasizes technological developments;
– argues the necessity of a system for quality assurance;
– argues the necessity of an integrated approach to measures, safety principles, and policy areas;
– points out the importance of integration of road safety with other policy areas, innovation of policy implementation, research and development, and of knowledge dissemination.

What is the essence of the vision?
Sustainable Safety aims to prevent (serious) crashes, and where this is not possible, to eliminate the risk of severe injury as much as possible. The notion *Man as the measure of all things* was adopted to achieve this goal. The 'human measure' is determined by physical vulnerability as well as by psychological characteristics: human beings, irrespective of background, education and motivation, do make errors and do not always abide by the rules; this makes the human being an important cause of crashes.

Sustainable Safety aims to prevent these errors and offences as much as possible or to mitigate their consequences by designing the traffic system according to the 'human measure'. First of all, the surroundings, such as the *road* and the *vehicle*, should be tuned to man's capabilities and should offer assistance and protection. In addition, information and education must prepare the road user for his traffic task, and, finally, his traffic behaviour must be checked for safety.

What are the Sustainable Safety principles?
In order to achieve a sustainably safe road traffic, five guiding principles were defined (see *Table 1*). The current principles are all based on scientific theories and research (see also SWOV Factsheet *Background of the five Sustainable Safety principles*).

Sustainable Safety principle	Description
Functionality of roads	Monofunctionality of roads as either through roads, distributor roads, or access roads in a hierarchically structured road network
Homogeneity of mass and/or speed and direction	Equality of speed, direction, and mass at moderate and high speeds
Predictability of road course and road user behaviour by a recognizable road design	Road environment and road user behaviour that support road user expectations through consistency and continuity of road design
Forgivingness of the environment and of road users	Injury limitation through a forgiving road environment and anticipation of road user behaviour
State awareness by the road user	Ability to assess one's capability to handle the driving task

Table 1. *The five Sustainable Safety principles.*

What do we know about the effects of the Sustainable Safety measures?
When the *Sustainable Safety Start-up Programme* was introduced, a beginning was made with large scale implementation of Sustainable Safety measures. The categorization of the road network, the construction of increasing numbers of 30 km/h and 60 km/h zones, and 'Moped in the Carriageway' legislation, were the most important road safety measures in the *Start-up Programme*. Some of the developments, such as the construction of 30 km/h zones, had already begun earlier. The construction of roundabouts and the construction of safe shoulders were not part of the *Start-up Programme*, but do fit the Sustainable Safety ideas extremely well. The same is true for the application of 'essential predictability characteristics', mainly on rural roads, which was only started in 2004. Based on current knowledge, we have estimated that the complete package of infrastructural Sustainable Safety measures that was introduced has resulted in a reduction of about 6% of all fatalities and serious road injuries in the Netherlands during the 1997-2002 period (Wegman et al., 2006).

Traffic education, enforcement, and vehicle technology also are essential parts of a sustainably safe traffic system. At present, there are many developments in these areas. Of course, it is important to know to what extent these developments affect road safety. In a recent evaluation of *traffic education projects*, a (small) effect on self-reported behaviour relevant for safe traffic participation was measured in just over half the studied projects (Twisk et al., 2007).

In the late 1990s, regional enforcement teams were set up for a more efficient and effective *traffic enforcement* in five specific areas: helmet wearing, seatbelt use, red light running, drink-driving, and speeding. This approach has in all probability been effective (Weijermars & Van Schagen, 2009), especially for seatbelt use, and the use of alcohol on weekend nights.

For many decades, there have been worldwide developments in *vehicle technology*, which aim at preventing injury, and, increasingly, at preventing crashes. Usually these are initiated at European level or influenced by various international parties, yet they perfectly fit within the Sustainable Safety vision. Especially the implementation of electronic stability control (ESC), airbags and seat belt reminders have improved traffic safety. A British study reports that the introduction of vehicle measures, excluding compulsory seatbelt use, resulted in an annual reduction of injury crashes by about 1% during the 1983-1998 period (Broughton et al., 2000).

The introduction of all these measures based on the Sustainable Safety vision, resulted in an estimated total reduction of the number of fatalities of more than 30% in 2007. This was calculated in comparison with the scenario in which policy and crash and fatality rates would have remained unchanged (Weijermars & Van Schagen, 2009). The measures were particularly effective in the prevention of severe injury in crashes involving a motor vehicle. The measures were socially cost-beneficial. See *Table 2* for an overview of the estimated effects per category of measures.

Category of measures	Minimal effect known	Maximal effect known	Unknown effect
Infrastructure	120	150	+++
Enforcement+education	65	120	+
Vehicle safety	40	95	+++

Table 2. *Estimated number of fatalities prevented in 2007 due to the various measures that fit in with the Sustainable Safety vision, per category of measures and as opposed to the scenario in which policy and crash and fatality rates would have remained unchanged since 1998 (Weijermars & Van Schagen, 2009).*

Recently, SWOV has looked into the question of what Sustainable Safety should look like in order to reduce the number of serious road injuries. Their number has been developing a lot less favourably than the number of road fatalities, especially when it comes to crashes not involving motor vehicles (mainly bicycle crashes). For this purpose, Weijermars et al. (2013) have further elaborated on the Sustainable Safety principles for bicycle crashes not involving motor vehicles. They have formulated a number of research questions for further elaboration in practice. The current guidelines for bicycle infrastructure design already contain elements that fit in with the Sustainable Safety principle of forgivingness. Among other things, these elements aim at reducing the number of bicycle-only crashes. Despite that, the majority of cyclists get injured in a bicycle-only crash, and infrastructure plays a role in around half of these crashes (Schepers, 2008). The causes of this have not yet been studied.

What are the misconceptions about Sustainable Safety?

Misconception 1: man is the cause, therefore education is the solution

Man has a central position in traffic. This means that traffic has to deal with human abilities and limitations. People make errors, even if they are well-trained and motivated: this is a universal human shortcoming crucial for traffic safety which is confirmed by crash analyses. This means that beside defects of the vehicle and roads, the human being is the most important cause of crashes. A commonly heard argument is that, consequently, most effort should be put into education, since infrastructure and vehicle are a lesser contribution to the problem. However, this line of thought fails to allow for the notion that the design or layout of the road environment can contribute to the prevention of errors, or limit the errors' consequences. Particularly man's surroundings greatly influence human behaviour. Clearly, education also has an important role, but has limited scope. Ultimately, it is important to know the effectiveness of various types of measures in relation with the human measure and to use this knowledge.

Misconception 2: Sustainable Safety is solely an infrastructural matter

The original Sustainable Safety vision is an integrated approach which combines the elements 'man', 'vehicle' and 'road'. However, initially the sustainably safe infrastructure was elaborated most

concretely and had a leading role within the *Sustainable Safety Start-up Programme*. This gave rise to the misconception that Sustainable Safety only refers to infrastructure. On the contrary, education, rules and regulations, enforcement, and vehicle technology are just as much part of a sustainably safe traffic system. This is especially the case where they fit in with the 'nudge theory', which means that they entice road users to make safer choices (see Thaler & Sunstein, 2008; Wegman, 2010). Of course it is true that by nature infrastructure has a more sustainable character: once it is there, its effects last for years. Measures such as education and enforcement are different in that they require continuous efforts if they are to have a lasting effect.

Misconception 3: Sustainable Safety (i.e. infrastructural) measures are expensive
An often-heard complaint is that particularly the infrastructural Sustainable Safety measures are expensive. Still, the 'high' costs can be put into perspective by also looking at the benefits: savings on medical costs, on the costs of production-loss, loss of the quality of life, property damage, and settlement costs (see SWOV Fact sheet *Road crash costs*). The returns of various Sustainable Safety measures vary, but the Netherlands Bureau for Economic Policy Analysis judged the measures in their entirety as 'robust' in terms of costs and benefits (CPB et al., 2002). Calculations show that the Sustainable Safety policy of the last few years has resulted in 2 to 4 times higher benefits than costs (see Weijermans & Van Schagen, 2009). Furthermore, SWOV has introduced the term 'avoidable crashes' (Wegman, 2001), which means that specific crashes can be prevented by taking measures that are effective and socially profitable as well as fitting within Sustainable Safety.

How does Sustainable Safety relate to other visions?

Vision Zero: striving for 0 severely injured
Starting point of the Swedish Vision Zero (e.g. Tingvall & Haworth, 1999) is that it is immoral not to do everything possible to prevent road deaths and injuries. Internationally, Vision Zero and Sustainable Safety are mentioned together as examples of a 'safe system approach'. This approach, in which 'the system' is designed safely in order to prevent serious crashes, has already been used for other modes of transport such as aviation and rail transport (see for example OECD/ITF, 2008).

Meanwhile, more and more regions in the Netherlands have made striving towards zero serious road injuries the motto for their policy. As in Vision Zero, the main principle is the immorality of accepting road deaths.

Vision Zero as put forward by Sweden shares the following similarities with Sustainable Safety:
- Both visions see man as the measure of all things.
- Both assume physical laws which influence the risk and severity of a crash.
- They use a proactive approach to tackle road safety.
- The system designer is considered responsible for a safe system design and for reduction of injury severity when the system is used unsafely.

Vision Zero differs from Sustainable Safety on the following points:
- Vision Zero assumes that road users obey the rules.
- Vision Zero focuses mainly on rules and regulations, enforcement and man's physical environment ('vehicle' and 'road'; see Vägverket, 2009). Public information and education are not at all, or hardly, regarded as system components or effective measures for the prevention of severe injury.
- Educational aspects of man in traffic and his moral and social actions (principles such as social forgivingness and state awareness) are not included in Vision Zero.

Shared Space: a spatial planning and road design vision
Another vision that is interesting to compare with Sustainable Safety is Shared Space (Monderman, 2004; CROW, 2011). This Dutch vision refers to the creation and design of residential areas – in fact only the access roads, although the idea is sometimes applied to other road types. Shared Space is based on the point of view that residential areas are 'shared areas'; shared by people who live there and road traffic. Traffic is a guest in these areas and the layout should clearly indicate that the primary function of the area is residential.

Similarities between Shared Space and Sustainable Safety are:
- Both visions give the often non-motorized vulnerable road user pride of place in residential areas.

- In both visions the road layout should support the road functionality; therefore the goal is in fact to create a credible road layout and speed limit.
- Both set a good road network as an important precondition to avoid rat running in residential areas. With a good flow network, no or less through-traffic moving from A to B will use the road network that is meant to safely mix road users, so that there is less resistance against driving more slowly.

Differences between Shared Space and Sustainable Safety are:
- In Shared Space, increasing credibility of a residential area should be done preferably by using natural and historical elements. Sustainable Safety does not exclude such solutions, as long as the layout leads to lower speeds, but also uses traditional traffic engineering measures (speed humps, raised junctions, road narrowings) that have proved to be effective in lowering speeds.
- One of the principles of Shared Space is that it is easier to solve conflicts by bringing uncertainty into the traffic situation (no traffic signs) so that people pay more attention and solve situations together using eye contact. This as opposed to the 'predictability' which is a starting point of Sustainable Safety, although this principle becomes more relevant as speeds are higher.

At the moment, well-performed research that can shed light on the road safety effects of Shared Space are still lacking. Further study is being made of the extent to which a layout according to the starting points of Shared Space is in line with Sustainable Safety elements, such as predictability and social forgivingness.

Conclusion
Just like the Swedish Vision Zero, Susainable Safety is a pro-active safe system approach which takes a human-centered design of the road traffic system as its starting point. The human being has been found to play an important part in crashes occurring. To - as much as possible - prevent the human factor causing crashes, a sustainably safe system does not only focus on education and enforcement of proper behaviour of the road user, but also on a safe layout of the infrastructure and safe vehicle design. All these elements are crucial for providing a safe place in traffic for man's physical vulnerability as well as his psychological characteristics. The principles of Sustainable Safety derive from various academic disciplines. In the course of decades, they have been elaborated, put into practice and appeared effective in the prevention of serious injuries. Measures fitting into the Sustainable Safety vision have also appeared to be cost effective. This places measures that initially seem to be expensive, especially those concerning the infrastructure, in a different light. Although there are a some differences, there are also similarities between Sustainable Safety and a number of other road safety visions, such as the Swedish Vision Zero and the Shared Space vision.

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(SWOV reports in Dutch have an English summary)

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