

Review of an initial concept of the manual 'Sustainably Safe Road Design'

Atze Dijkstra, Theo Janssen & Fred Wegman

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Report on request of the World Bank

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Summary

The World Bank has requested SWOV to review an initial concept of a manual written by DHV Environment and Transportation in the Netherlands, entitled *Sustainably Safe Road Design* (DHV, 2004). Drafting this report was funded by the World Bank in cooperation with the Dutch Ministry of Transport, Public Works and Water Management as part of their Partners for Roads programme.

More specifically, SWOV was asked to answer three questions:

1. Does the manual reflect and represent the Dutch 'Sustainable Safety Concept'?
2. Can this manual be used in other parts of the world? Is the manual too much focused on Central European countries and could it be made applicable to other regions in the world?
3. What is the added value of this manual compared to other (just released or to be released soon) manuals (PIARC, FHWA), what are the differences in approach between these manuals and how should we market this *Sustainably Safe Road Design* Manual?

It is SWOV's opinion that it is worthwhile placing the Sustainable Safety vision in a manual on road design that is suitable for use all over the world. In the first place it regards bringing out into the limelight a new way of thinking about road design. This could certainly contribute towards providing a high quality and really safe road design. The Sustainable Safety principles of course need being converted to functional and operational demands for road design. We recommend to let this happen in the countries themselves in close cooperation with the authors of this manual, based on the theory and working with concrete cases.

It is SWOV's opinion that the present draft of the *Sustainably Safe Road Design* Manual (December 2004) insufficiently reflects the Sustainable Safety vision in the Netherlands. We recommend making a number of improvements in two phases. First of all improvements that can be easily made in the draft with comparatively little effort. We recommend that the introduction of the (theoretical) backgrounds about Sustainable Safety must be strengthened considerably. SWOV also recommends starting preparations for a 2.0 version. The experiences of working in practice with the current 1.0 version can be processed and, simultaneously, a number of chapters that are not yet considered ripe for publication can be added. In particular, we mean a chapter on cost-benefit analysis and education.

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1. Introduction

The World Bank has requested SWOV to review an initial concept of a manual written by DHV Environment and Transportation in the Netherlands, entitled *Sustainably Safe Road Design* (DHV, 2004). Drafting this report was funded by the World Bank in cooperation with the Dutch Ministry of Transport, Public Works and Water Management as part of their Partners for Roads programme.

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3. What is the added value of this manual compared to other (just released or to be released soon) manuals (PIARC, FHWA), what are the differences in approach between these manuals and how should we market this *Sustainably Safe Road Design* Manual?

SWOV approached the answering of these three questions in the following way. Independently of each other, three of senior staff members of SWOV (Atze Dijkstra, Theo Janssen, and Fred Wegman) answered the first question. All three have, from the very beginning, been involved with the development of the Sustainable Safety vision. Since 1992 they have made all sorts of contributions to its further practical implementation, especially in the field of infrastructure. The three answers were written in a number of internal SWOV notes, which were then compared with each other. There was a great deal of agreement in the three assessments. *Chapter 2* contains the results.

We have answered the second question, seen from two points of view. Is the Sustainable Safety vision universally applicable? How practical is it to now work in the same way in all countries of the world? *Chapter 3* contains the answer.

Finally, what is the position of this manual compared with other manuals in circulation in the world? We examined three of them. The first was the guide for planners and engineers entitled *Towards Safer Roads in Developing Countries* by TRL (1991). The second was the very recent PIARC *Road Safety Manual* (PIARC, 2004), and the third was the *Highway Design and Traffic Safety Engineering Handbook* (Lamm et al., 1999).

What we did not look at were two American productions. The *Interactive Highway Safety Design Model* (IHSDM), drawn up by Turner-Fairbank Highway Research Centre of the Federal Highway Administration, and the *Highway Safety Manual*. This last manual is still being developed and some draft chapters are available. The IHSDM is only aimed at rural two-lane roads. It is expected that IHSDM will become part of the Highway Safety Manual. *Chapter 4* contains our view of the position of the DHV manual in relation to the PIARC manual, the TRL manual, and the book by Lamm et al. *Chapter 5* contains our conclusions and recommendations.

2. Does the manual reflect and represent the Dutch Sustainable Safety Concept?

The draft report of DHV contains 12 chapters (see *Appendix 1* for the complete list). We report the most important remarks by chapter.

2.1. Chapter 1 Introduction

The introduction to the manual is rather brief, perhaps it is too brief. We would expect that the manual's design would be explained, what the manual does and does not contain, how to use it, and what the relation is between the chapters. The main message of Sustainable Safety could be introduced here to justify the manual's title. There are useful publications available in English about this (anyway, SWOV and the Transport Research Centre AVV reported on this), and these could be added. It is recommended to introduce a 'new' chapter 2 presenting the theoretical background of Sustainable Safety. It can be decided to bring that as an Annex to the manual as well.

2.2. Chapter 2 Solving traffic safety problems: a strategy

We do not regard the proposed POGSE-approach as being suitable as an introduction to Sustainable Safety. A general introduction to the road safety problem is missing here. An introduction entitled "Vision of Sustainable Safety" could attempt to discuss the differences between this vision and the more traditional design manuals. This would also be a good place to introduce relevant items to consider how to apply the manual in other countries.

Typical road safety problems first should be ranked according to their Sustainable Safety vision. For example: finding the widespread mixture of traffic and residential functions more important than the layout of an intersection or road section. On page 7 where the POGSE-approach starts with: a problem is mainly related to a location (junction) or a road section, there is a reference to chapter 4 and it is briefly stated that there must be a consensus about the desired function. However, in the next step, black spot analyses are directly recommended. This structure does not fit in the Sustainable Safety approach. If wished, it is worth considering using the black spot approach in a later stage of this Manual when it comes to prioritizing of countermeasures.

The traffic and residential functions should most probably be formulated differently in other countries from how we have done for the Dutch situation. This certainly applies to the road types that have been derived from the traffic function. In the Netherlands, the three road types (flow road, distributor road, and access road) stem from the three functions of flow, distribution and access. This will require also being fixed as adapted to the circumstances in other countries, where they have other types of rural and urban surroundings, other vehicle types, and other residential functions, etc.

2.3. Chapter 3 Analysis of accidents

The MATAC, described as the in the meantime classic Dutch black spot method ('AVOC'), is regarded as step 2 in the POGSE approach (origin/ cause). The DOCTOR method is referred to (p. 26), but no explanation is given there. At the end of the chapter, MATAC is "flooded" with the observation that "prevention is better than cure". The sustainably safe system, as leading principle is announced here as alternative. We are of the opinion that MATAC does not fit in the Sustainable Safety approach. It is a completely different approach that can, perhaps, supplement this manual in the form of a course. SWOV recommends not to include this chapter in this manual.

2.4. Chapter 4 Sustainably safe road design: theory

First look at the remark about chapter 1 on the position of the theoretical background of Sustainable Safety. Our proposal is to briefly present Sustainable Safety in chapter 1 and then to expand on it in this chapter (which, according to us, becomes chapter 2).

Only a few sentences are devoted to the term 'functionality', whereas the countries aimed at having the most problems here. Figure 8 shows two systems that are not explained in the text.

2.5. Chapters 5, 6, and 7 Cross-sections, Junctions and Alignment

These chapters deal with a part of the road network (urban distributor roads), but the other parts are missing. If this limitation has to be leading for this Manual, it should be clearly stated right at the beginning of this Manual. Furthermore, the present chapters are more of a road design manual than a manual for a sustainably safe road design. We recommend a detailed transformation from the Sustainable Safety principles to these concrete chapters about road design. This is so essential that we recommend applying this check before officially publishing this manual.

Perhaps in a second phase there can be contributions from various other sources. Without being exhaustive we can name the following ones:

- *INTERSAFE: Technical Guide on Road Safety for Interurban Roads* (ERSF, 1996).
- *Road Safety Manual* (PIARC, 2004).
- *The Phare Multi-Country Road Safety Project* (Finnroad, ERSF & TRL, 1999).
- *Highway Design and Traffic Safety Engineering Handbook* (Lamm et al., 1999).
- *Manual for Safety in Road Design* (Ross Silcock, TRL & CRRRI, 1998).
- *Safety Standards for Road Design and Redesign SAFESTAR* (SWOV, 2002).
- *Integrated Strategies for Safety and Environment* (OECD, 1997).
- *Low-cost Road and Traffic Engineering Measures for Casualty Reduction* (ETSC, 1996).
- *Guidelines for the Safety Audit of Highways* (IHT, 1996).
- *Low-cost Engineering Measures to Improve Road Safety in Central and Eastern European Countries* (SWOV, 1993).
- etc.

2.6. **Chapters 8 and 9 Linear villages and pedestrian crossing**

Ribbon/linear villages and pedestrian crossing are good examples to illustrate how to work with the Sustainable Safety approach in practice. We strongly support the idea to include practical topics to 'explain' Sustainable Safety.

2.7. **Chapter 10 Cases in different countries**

This chapter with its relevant examples is very useful for this manual. We propose that a good example book with Sustainable Safety aspects (such as roundabouts and 30/60 km/h zones) is a supplement in this manual to the theoretical background about functionality, homogeneity, and recognition. It is important to really transfer the Sustainable Safety criteria into the road design and to indicate the consequences if the criteria are not followed.

2.8. **Chapters 11 and 12 Cost benefit analysis and education**

It is better not to deal with the subjects of cost-benefit analysis, education, enforcement, and public awareness campaigns so abstractly as now is the case. In addition, we note that the knowledge in this field has grown considerably since the publication of the Dutch black spot approach (AVOC), that is the basis of chapter 11. We recommend including these subjects in a second edition, but they should then be worked out more. If information about cost-benefit and cost-effectiveness analyses is already to be a part of this first edition, we recommend consulting recent literature about this subject.

2.9. **Appendices**

The checklist can be a good (educational) instrument, providing it gives sufficient background on it. We recommend converting the Dutch "Sustainable Safety Gauge" into a Sustainable Safety checklist for this manual.

3. Can this manual be used in other parts of the world?

The art of road design is united in various goals and preconditions. Goals are a matter of ensuring sufficient traffic flow, reducing the environmental pollution by traffic, and promoting road safety. There are many preconditions: as low as possible construction and maintenance costs, providing the requirements of public utilities, solving solutions within a limited area, and considerations about nature, urban development, etc. The design assignment is to try and achieve the goals optimally within fixed borders. These borders are sometimes determined by law, e.g. if there are laws about noise nuisance.

The application of the Sustainable Safety vision in the road design is, first of all, aimed at creating such circumstances that certain inherent dangerous traffic conflicts cannot happen (e.g. head-on collisions on motorways). Should such conflicts occur, the circumstances are such that no severe injuries can occur. Meeting these two preconditions goes further than daily practice of road design and traffic engineering. However, this is insufficient reason to not apply these principles. What we do recommend is to include them in the ultimate decision making, if the Sustainable Safety principles are converted into a concrete road design. The results of cost-benefit analysis and/or cost-effectiveness considerations can be helpful when coming to a final decision. However, we have to take into account all 'uniformity and design consistency' considerations!

In addition, it would be good to record and monitor the experiences with the road design according to the Sustainable Safety principles and the more traditional approach, in order to make it possible to compare them. It would then be clear, hopefully combined with research results, what the advantages and disadvantages of various designs are. The road safety audit is a suitable method of doing this.

We conclude that Sustainable Safety principles, and a manual based on these principles, could be applied in all countries of the world, however the practical design principles should be customized by local conditions in good cooperation with local experts.

4. What is the added value of this manual compared to other manuals?

As was mentioned in the Introduction, the DHV manual was compared with three other manuals:

- the bilingual *Road Safety Manual* of PIARC (2004) (*Appendix 2*),
- the guide for planners and engineers *Towards Safer Roads in Developing Countries* by TRL (1991) (*Appendix 3*),
- *Highway Design and Traffic Safety Engineering Handbook* (Lamm et al., 1999) (*Appendix 4*).

4.1. Sustainable Safety and other leading principles

The four manuals differ considerably. The DHV manual is the only one dealing with Sustainable Safety. In Lamm et al., the three well-known safety criteria for design consistency are central:

- the relation between design speed and operating speed,
- the longitudinal harmonization of operating speed,
- the driving dynamics (difference between assumed and required friction force).

This is anyway a strong point of the IHSDM approach. These approaches are preferable to others, such as those of TRL and PIARC. They consider the safety of 'isolated elements' of a road network and not their mutual coherence. From the road user's point of view, SWOV supports choosing a leading principle as starting point of design manuals. SWOV regards the design consistency approach as being slightly too limited and we, obviously, are in favour of the Sustainable Safety terms based on human error and human tolerance (man is the measure of all things): recognition, predictability, and speed homogeneity. TRL and PIARC do not have a recurrent theme; they choose a pragmatic approach based on crash data analysis and good design practice. To summarize: SWOV's opinion is that the systems approach, as attempted in the DHV manual and in the design consistency approach in Lamm et al. (and IHSDM), is preferable.

4.2. Crash data and analysis

As we have already stated, chapters 2 and 3 (about crash analysis and black spot approach) do not fit in the Sustainable Safety vision. In addition, this is dealt with in much more detail in the PIARC manual - three chapters and 176 pages. On its CD-rom, PIARC has also included a large number of calculation functions (with clear input and output screens) that make it possible to structure and analyse the crash data. There are also interesting developments going on in this field, but that is somewhat beyond the scope of this review. To summarize this: it is our opinion that there is some more up-to-date information available in this area than presented in this draft and it could be considered to introduce this to this manual.

4.3. Road design

The DHV chapters Cross-section, Junctions, and Alignment are, of course also included in Lamm et al. and PIARC. Lamm et al. limits itself to road

segments of rural single-carriageway roads; we have not found this limitation in other manuals. Vertical alignment is much more important in countries other than the Netherlands. That is why Lamm et al. and PIARC (with its calculation functions) pay a lot of attention to it. DHV reflects the slight interest in the Netherlands by only devoting a few pages to it. We consider this as too limited for an international manual. TRL's manual has developing countries as its target group. The way in which TRL deals with road design is still very useful: many examples, problem descriptions and analyses, pros and cons of solutions (expressed more as a guideline than as a handbook), and all aimed at the practical situations in developing countries. DHV seems to aim at more developed countries in its examples, except its chapter on cases in Poland, Latvia, and Estonia.

The advantage of the DHV manual is that the Sustainable Safety philosophy can be included, and, in this way give shape to the stricter requirements of road design that are necessary to substantially reduce the crash rates. In a next phase, SWOV also recommends linking the relation with the knowledge from *The Handbook Road Safety Measures* of Rune Elvik and Truls Vaa (2004) because, in this book, the estimated road safety effects of many infrastructural measures are presented.

4.4. Human factors

Lamm et al. and PIARC pay attention to human factors by discussing in detail the consequences for road design of human/driver limitations. TRL deals with human factors where it is necessary for some measures or problem descriptions. DHV, however, only gives thought to influencing the human/driver by education and public information. We recommend exploring human factors in two directions in a next phase. On the one hand, try to show more accurately what is meant exactly in the Sustainable Safety vision by "man is the measure of all things". On the other hand, it is interesting to work out further the subject of behavioural change via education, police enforcement, and communication; thereby using the international knowledge about this area.

4.5. Conclusions

The added value of the DHV manual lies exclusively in its conversion of the Sustainable Safety principles to concrete road design recommendations. SWOV considers this sufficient reason to be positive about the DHV manual. SWOV therefore recommends spreading the knowledge in the DHV manual worldwide. With regard to this aspect, other manuals are a lot less ambitious. DHV has produced a road design manual that is rather brief in comparison with other manuals. The TRL manual is (apparently) practical in its application in developing countries. The PIARC manual is practical because of its calculation facilities. Lamm et al. is outstanding in its systematic approach of design consistency (of rural single carriageway roads). However, we have thus indicated the limitations of these manuals. The DHV manual should not deal with topics such as crash analysis, which other manuals do better. This could be achieved by taking sections of existing manuals as starting point, and then outlining the Sustainable Safety approach when using these manuals.

5. Conclusions and recommendations

It is SWOV's opinion that it is worthwhile placing the Sustainable Safety vision in a manual on road design that is suitable for use all over the world. In the first place it regards bringing out into the limelight a new way of thinking about road design. This could certainly contribute towards providing a high quality and really safe road design. The Sustainable Safety principles of course need being converted to functional and operational demands for road design. We recommend to let this happen in the countries themselves in close cooperation with the authors of this manual, based on the theory and working with concrete cases.

It is SWOV's opinion that the present draft of the *Sustainably Safe Road Design* Manual (December 2004) insufficiently reflects the vision on Sustainable Safety in the Netherlands. We recommend making a number of improvements in two phases. First of all improvements that can be easily made in the draft with comparatively little effort. We recommend that the introduction of the (theoretical) backgrounds about Sustainable Safety must be strengthened considerably in which available English language documents in the Netherlands can be used. We recommend having the chapters about the actual road design reviewed by experienced road designers in the Netherlands who have experience with the sustainably safe road design. Finally, we recommend to exclude those chapters that do not fit in a manual about Sustainable Safety (i.e. 2 and 3).

SWOV also recommends starting preparations for a 2.0 version of Sustainable Safety. The experiences of working in practice with the current 1.0 version can be processed and, simultaneously, a number of chapters that are not yet considered ripe for publication can be added. In particular, we mean a chapter on cost-benefit analysis and education.

When preparing the 2.0 version, we recommend tuning the DHV manual to existing manuals, and to use them to the extent that is possible. It is recommended to consider establishing an international editorial board that will guarantee a high quality manual.

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World Bank

Initial concept



Sustainable safe road design

A practical manual

Dutch Ministry of Transport, Public
Works and Water Management

December 2004 / initial concept

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Road Safety Manual

Recommendations from the
World Road Association (PIARC)



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TOWARDS SAFER ROADS IN DEVELOPING COUNTRIES

**A Guide for
Planners and Engineers**

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**TRANSPORT AND ROAD RESEARCH
LABORATORY**



**OVERSEAS DEVELOPMENT
ADMINISTRATION**

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HIGHWAY DESIGN AND TRAFFIC SAFETY ENGINEERING HANDBOOK

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