

Recognizable road design

Summary

One of the Sustainable Safety principles is that a road should have a recognizable design and a predictable alignment. If this is the case, road users know how they are expected to behave and what they can expect from others. This would contribute to the prevention of crashes. What exactly do we mean by recognizability of roads and what is a recognizable road design? This fact sheet will discuss the theoretical background of the concept of recognizability, and describe how to put this into practice. The Dutch Essential Recognizability Characteristics guideline (CROW, 2004a) will be discussed and the most important results of our research into recognizability of roads will be presented.

Background

The Sustainable Safety vision has been an important starting basis for improving road safety for more than a decade (Koorstra et al., 1992; Wegman & Aarts, 2005). The goal is the prevention of serious crashes and, where this is not possible, to reduce the risk of severe injury. The principle of recognizability and predictability, known for short as the predictability principle, is one of Sustainable Safety's central principles (see also the SWOV fact sheets [Background of the five Sustainable Safety principles](#) and [Sustainable Safety: principles, misconceptions, and relations with other visions](#)).

The predictability principle builds on the Sustainable Safety principle of functionality. Roads can have different traffic functions. One function is 'traffic flow' on through roads and another function is 'allowing access to destinations' on access roads. In order to have a tidy transition between these two road categories, there is a third road type, known as distributor roads. Both figuratively and literally, these roads are the link between the other two road categories.

In a Sustainably Safe road system, each road category has its own characteristics for road design and speed limit, according to the homogeneity principle. This principle means that traffic with large differences in mass, speed, and direction should be physically separated from each other. Therefore, through roads, which have a flow function, are only intended for motor vehicles. Since this involves high speed traffic, the driving directions ideally are physically separated. At locations where fast traffic meets with vulnerable road users, the driving speed must be lowered to reduce the risk of severe injury.

For each road type, the principles of functionality and homogeneity determine its speed (high or low), types of road users (motorized vehicles only or a mixture of motorized traffic, cyclists, and pedestrians), and permitted manoeuvres (such as overtaking, joining, or crossing). In an ideal situation, the appropriate behaviour for each road type should be supported or evoked by the road image. That is how different road types are made recognizable.

How does the predictability principle work?

The principle of predictability is based on the idea that human errors, and the resulting crashes, can be prevented by providing a road environment that is both recognizable and predictable. The road features should tell the road user immediately what road type he is driving on, which driving behaviour is expected of him and other road users, and which other types of road user he can meet. In the ideal case, the road should be self-explaining as much as possible. This makes the traffic system more predictable and prevents indecisive behaviour and its resulting crashes.

Recognition is preceded by a process of mental categorization. This means that people recognize things by placing them in a certain category. Categorization, and consequently recognition, is easier the more the roads in the same category resemble each other. The differences between the categories should be as large as possible (Aarts et al., 2006; Theeuwes & Diks, 1995). This improves the distinctiveness of road categories.

In short we can state that for the recognizability of roads it is important that they:

- are distinguishable, and
- evoke and support correct expectations.

The whole chain as described above is shown schematically in *Figure 1*.

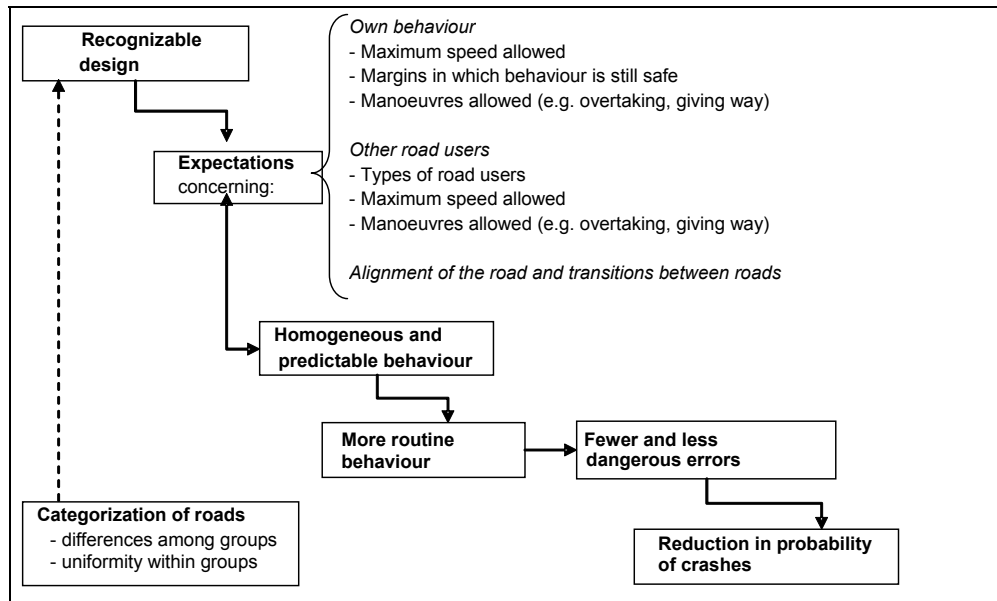


Figure 1. Chain of recognizable layout and predictable behaviour as suggested in Sustainable Safety.

What must be done to make roads recognizable?

Starting from the operational requirements that Sustainable Safety road categories should meet (CROW, 1997), only a limited number of characteristics can be used for distinguishing road categories (Van Schagen et al., 1999). These characteristics must be continuously perceivable, practical, and not disadvantageous for road safety. Research (Aarts et al., 2006) has shown that the following characteristics contribute to recognizability:

1. type of road surface;
2. design of the driving direction separation (axis markings or physical separation);
3. edge marking;
4. (anti) flow marking;¹
5. salient colour and shape of kerb marker posts;
6. urban road characteristics such as buildings, parking spaces, and exit roads;
7. (red) recommended cycle lanes on the carriageway.

We should mention here that these characteristics only refer to the design of road sections and, as such, do not contribute to the recognizability of intersections and transitions between road categories. Until now, research has only shown flow marking and red recommended cycle lanes to be effective, thus actually increasing the recognizability of road categories. What is more, red lanes evoke the correct expectations about the possible presence of moped riders and cyclists (Kaptein & Theeuwes, 1996).

What actually happens in practice?

In December 2003, the Dutch National Mobility Council earmarked two characteristics as being an 'Essential Recognizability Characteristic' (ERC) of sustainably safe roads: driving direction separation and edge marking. A combination of these characteristics would increase the distinction *among* road categories (Figure 2). By determining the ERC, feasibility, particularly because of its affordability, has played a very important role. This has resulted in only the alignment marking remaining as a recognizability characteristic: rural access roads, if sufficiently wide (>4.5 m), have a driving lane with broken edge marking; distributor roads have a broken edge marking plus double continuous axis lines; and regional through roads have a continuous edge marking and double continuous axis lines with a

¹ (Anti) narrow-illusion marking consists of diagonal stripes which partly cover the lane from the edge marking and/or axis marking. If the stripes are in the driving direction on one's own half of the road (/ \) it is a narrow-illusion marking; if the stripes are contraflow (\ /) it is (anti-) narrow-illusion marking (Van Schagen et al., 1999).

green marking in-between. Other characteristics such as bicycle facilities, physical driving direction separators, and different intersection designs per road category, have not been earmarked as ERC by the National Mobility Council.






Essential recognizability characteristics	Through road		Distributor road			Access road	
	SW120	SW100	GOW80	GOW70	GOW50	ETW60	ETW30
Zone sign	Motorway sign 	Trunk road sign 	Sign n.a. (general speed limit)	Speed limit sign 	Sign n.a. (general speed limit)	Zone sign 	Regulation or zone sign 
Edge marking	Continuous marking	Continuous marking	Broken marking	Broken marking or kerb	Broken marking or kerb	None or broken marking	None or broken line, or kerb
Driving direction separation	Vehicle barrier or wide median	Double axis line with green 'filling', barrier, or median	Double axis line or median	Double axis line or median	Double axis line or median	None	None

Figure 2. *Essential Recognizability Characteristics according to CROW guideline (2004a).*

Since 2004, road authorities have started to make their roads recognizable for road users within 15 years by using the Dutch Essential Recognizability Characteristics guideline (CROW, 2004a). However, the implementation of ERC does not complete the improvement of the Sustainable Safety quality of roads. The ERC are meant to be an intermediate step towards a sustainably safe road layout. Other Sustainable Safety characteristics like obstacle-free shoulders and roads, and horizontal alignment are also important for road safety (CROW, 1997). It was agreed that all roads would eventually be designed in accordance with the *Road Design Manual* (CROW, 2002) for rural roads and the *Recommendations for Urban Traffic Facilities* (CROW, 2004b) for urban roads. SWOV is in favour of aiming at a full Sustainable Safety quality when designing roads by using *Essential Characteristics* (see for example Wegman & Aarts, 2006) and not just recognizability characteristics.

The ERC guideline offers road designers the opportunity of applying various phasing solutions. If, for example, there is not enough space for a service road next to a distributor road, agricultural traffic can be allowed on the main carriageway. Permission to overtake can then be indicated by broken instead of continuous double axis marking. Also in situations where the road width is too narrow to apply the road profile as recommended in the *Road Design Manual*, the ERC guideline offers phasing solutions. In this case the guideline recommends prioritizing: first narrow the lane width, then narrow the width of the axis marking, then narrow the space between the double axis marking, and, finally, narrow the width of the hard strip to the narrowest width permitted. For such cases the ERC guideline permits smaller measures than the smallest required cross section in the general *Road Design Manual*.

How recognizable are roads for the road user at present?

We can conclude that the ERC are a first step towards making road categories distinguishable by using the differences *among* road types. There is, however, a lot of room for variation *within* road categories. This results in roads of the same category not looking very much alike, thus undermining their distinction and consequently the recognition of roads by road users. This is even aggravated by road authorities using their own variations, in spite of the possible phasing solutions that the ERC guideline offers (Aarts et al., 2006). As a consequence, the differences in road layout are made even bigger. In addition, many roads still have the traditional marking. Therefore, this mix of traditional and ERC markings will still exist during the coming years, because the implementation of ERC will continue until 2020. This raises the question whether the road layout is indeed recognizable for road users.

A SWOV study (Davidse et al., 2007) in which subjects were requested to sort photographs of roads, has shown that particularly distributor roads and regional through roads are often confused and not identified correctly. The only uniform element that distributor roads have according to ERC, the broken edge marking, was not noticed by the subjects. The characteristics they *did* notice, such as the possibility of overtaking and the road width, are precisely those that have more variations. This leads us to the conclusion that for a good recognizability by using distinguishing elements, it is not only important to introduce more uniformity in the design, but to accomplish this with precisely those elements that are important for road users; i.e. elements that they automatically notice.

Research has also shown that road users need information about the new markings. Apparently, these markings are not self-explaining and thus do not evoke the correct expectations. A road survey (Hendriks, 2004; 2006) and a photograph study (Arcadis, 2005) showed that it was by no means clear to everybody whether or not overtaking was permitted, what the double or green axis marking meant, which types of road users could be expected, and which speed limit matched which road design. Apparently, road users do not understand the new ERC markings very well and, for the time being, they evoke confusion rather than recognition. Perhaps it is necessary to provide road users with explicit information about what a road layout means.

The previously mentioned SWOV photograph sorting study (Davidse et al., 2007) showed that providing information about the various road categories can assist in recognizing differences between road types. Providing information satisfies a general information need, and can also make those road types that are insufficiently distinguishable for road users more recognizable.

It should be mentioned here that information about road categories, certainly initially, especially appeals to active memory. This is especially the case if the link between road characteristics and their meaning is rather abstract (e.g. green axis marking as a code for a 100 km/h speed limit), and is not an extension of a coding system that road users already know (e.g. broken edge marking) has a different meaning than broken axis marking. The Sustainable Safety vision advocates a traffic system in which the layout of the environment supports desirable behaviour as much as possible. As it were, the environment continuously gives clues about the desired behaviour and evokes the correct expectations, and does not so much ask the road user to actively remember the desired behaviour (Wegman & Aarts, 2006).

A SWOV driving simulator study (Aarts et al., 2007) found no effect of information on driving behaviour. When asked about their expectations of which speed limits applied and the possible presence of other types of road users, the subjects were quite capable of estimating the speed limit correctly. The more elements the road layout contained indicating the presence of other types of road users (such as bicycle lanes indicating the presence of cyclists and physical driving direction separation indicating the possibility of agricultural vehicles using the road), the more correct the estimates were. The road layout also had a strong influence on desired driving behaviour, in terms of speed and position on the road.

The above results indicate that road users are insecure about the correct interpretation of the road layout, although their intuitive interpretation was usually correct. Further research is needed to determine what sort of information can bridge the gap between the current road design, the correct interpretation of ERC, and the road user's intuition. Evaluation of the ERC campaigns so far may provide answers to these questions. Initially, some Dutch provinces conducted their own campaigns. A national campaign ('Lines on the road') started in January 2009. This campaign makes use of leaflets, articles in regional and local newspapers and free local papers, and sometimes billboards at the roadside. It is an initiative of the Dutch Ministry of Transport, together with the provinces and the Royal Dutch Touring Club ANWB. For this national campaign it is a matter of concern how to formulate the message while there are still so many different road layouts and so many corresponding behaviour rules (Aarts et al., 2006). Whether or not the campaign 'Lines on the road' has been successful despite these difficulties remains to be seen. So far, no effects of the campaign on the road users' ERC knowledge and application have been measured.

If we ultimately want to achieve a real sustainably safe road design, more will need to be done than implementing ERC and communicating them. A more uniform and faster implementation is then needed. SWOV also advocates not to stop at recognizability characteristics, but to start from *Essential Characteristics* in order to realise a full sustainable safe road network quality.

Will there be a follow-up study?

The elaboration of the predictability principle in guidelines has up till now primarily aimed at the design of road sections. A recognizable layout of intersections and transitions between different road categories is as yet unexplored territory, whereas these are the locations where many crashes occur. Therefore, SWOV is carrying out follow-up research of recognizable layout of intersections and transitions of road category and road layout.

Conclusion

One of the principles of Sustainable Safety is the recognizability of roads and, consequently, the predictability of road course and traffic behaviour. The predictability principle assumes that their design makes roads so recognizable and, their alignment makes them so predictable that the correct expectations of both own and other road users' driving behaviour are evoked. For road recognizability, it is not only important that a distinction can be made *among* road categories, but also that there is uniformity *within* categories. The Essential Recognition Characteristics (ERC) agreed on in 2003 are a first elaboration of these requirements. However, various studies have shown that the roads in the Netherlands are not easily recognized. SWOV research indicates that this is due to too little uniformity within road categories. We can also conclude that it is not only important to introduce more uniformity in the design, but that this is particularly necessary for those elements that are important for road users.

Information can help to make those road categories which are as yet insufficiently distinguishable, more recognizable for road users. This also satisfies a general information need. Information is less suitable for obtaining the desired driving behaviour because this is very much influenced by the road layout.

Finally, we can conclude that the ERC are an initial elaboration of the idea of making roads recognizable. However, within the ERC guideline, a great deal of variation is allowed, and its spreaded implementation also gives problems with regard to recognizability for road users. Characteristics that can increase the recognizability of *intersections* and *transitions between road categories* are still lacking.

Recommendation

SWOV recommends not to limit road layout to the ERC but to start from *Essential Characteristics* and to use them within a yet to be developed quality assurance system for monitoring the complete Sustainable Safety road quality.

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