SWOV Fact sheet



Predictability by 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 other road users, so that crashes may be prevented. For roads to be recognizable, it is not only important to distinguish *between* road categories, but also to have uniformity *within* categories. The Dutch Essential Recognizability Characteristics (ERC) are used in practice. These ERCs - concerning longitudinal markings - appear not to contribute to recognizability consistently. Uniformity is often lacking within road categories and the uniform ERC applied - i.e. edge marking - often fails to be noticed or understood by road users. Characteristics that are meaningful for road users are centre line marking or driving direction separation. Moreover, the design of intersections at transitions serves to make roads more recognizable. Information may improve knowledge of the meaning of ERCs, but it shows in practice that driving behaviour basically derives intuitively from the entire road design, not only or particularly from the meaning of markings.

Background and content

From the early 1990s, the Sustainable Safety vision has been an important starting point for improving road safety in the Netherlands (Koornstra et al., 1992; Wegman & Aarts, 2005). The goal of Sustainable Safety 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 SWOV Fact sheets *Background of the five Sustainable Safety principles* and *Sustainable Safety: principles*, *misconceptions, and relations with other visions*).

Functionality of roads is the basis of a sustainably safe traffic system and also the basis of the predictability principle. Roads can have different traffic functions. One function is 'traffic flow', which is mainly served on through roads; the other function is 'allowing access to destinations' providing safe conditions for traffic to mix, which is mainly served 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. They have a flow function on road sections and safe mixture of traffic at intersections.

In a Sustainably Safe road system, each road category has its own characteristics for road design and speed limit, according to the homogeneity principle. On the one hand, this homogeneity principle means that traffic with large differences in mass, speed, and direction should be physically separated, and, on the other hand, speeds should be low when various types of traffic mix, so as to reduce the risk of serious injuries.

As stated, the characteristics of each type of road category relate to speed (high or low), but also to 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 category should be supported or evoked by the road image. That is how different road types are made recognizable.

This fact sheet will discuss the theoretical background of the concept of recognizability and the way it is put into practice. Moreover, this fact sheet will present the most important results of research into the recognizability of roads and the transition between roads: what is needed to make roads recognizable and to what extent are roads currently recognizable for road users? No follow-up research is presently carried out into the recognizability of roads.

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 predictable by means of a recognizable road design and predictable alignment. 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 indecisive behaviour and crashes as a result of that may be prevented.

Recognition is preceded by a process of mental categorization. This means that people recognize an image if it resembles an image that they have perceived earlier and which may, as such, belong to the same group or 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 road layout and predictable behaviour as suggested in Sustainable Safety.

What can roads make 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 1) continuously perceivable, 2) be practical, and 3) not be disadvantageous for road safety. Research (Aarts et al., 2006) has shown that the following characteristics can 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.

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 *between* 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:

- access roads (ETW): rural ETW should have a driving lane with intermitted edge marking if sufficiently wide (>4.5 m);
- distributor roads (GOW): rual GOW have an intermitted edge marking plus double continuous axis marking;
- through roads (SW): regional SW have a continuous edge marking and double continuous axis lines with a 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 (NMB).

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).

So far, research has shown that of these characteristics, only vehicle barriers, the green axis marking on regional through roads and recommended cycle lanes are effective and, subsequently, increase the recognizability of road categories in actual fact. Moreover, red cycle lanes appear to evoke the correct expectations of the possible presence of cyclists and moped riders (Kaptein & Theeuwes, *1996; Davidse et al., 2007)*.

¹ (Anti) narrow-illusion marking consists of diagonal stripes that 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).

Since 2004, road authorities have started to make their roads recognizable for road users by using the Dutch Essential Recognizability Characteristics guideline (CROW, 2004a) within 15 years. However, the implementation of ERC has not completed 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. A road authority questionnaire from 2008 showed that ERC have been implemented on 76% of the ETWs and on 40% of the GOWs in rural areas (Doumen & Weijermars, 2009).

Wegman & Aarts (2005), among others, are in favour of aiming at a full Sustainable Safety quality when designing roads by using *Essential Characteristics* rather than mere recognizability characteristics.

In 2010, as initiated by NMB, a plan was taken up to combine recognizability characteristics and other road safety characteristics in updating the valid guidelines for both urban and rural roads (Basic *road design characteristics; CROW 2012*). This manual explains which characteristics constitute a sustainably safe design and what the collective governments consider as the minimum road design variant. The objective of this guideline is to limit the variation of design variants and to alter specific minimum requirements by no means. However, it applies for both this guideline and the ERC, that far from all choices are evidence-based.

How recognizable are roads in the Netherlands now for the road user?

We can conclude that the current application of ERCs are a first step towards making road categories in the Netherlands distinguishable for road users by using different road layouts between road categories. 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. This may undermine their distinction and consequently the recognition of roads by road users (Aarts et al., 2006). Moreover, some roads - be it a decreasing number - still have the traditional marking. As the implementation of ERC will continue until 2015, it is to be expected that the road user will come across various types of marking on the road, at least until then. This raises the question whether the road layout is indeed recognizable for road users.

A study, in which subjects had to sort photographs of roads, showed that particularly GOWs and regional SWs are often confused and not identified correctly (Davidse et al., 2007). The subjects did not notice specifically the only uniform element between GOWs and ERC: the intermitted edge marking. The characteristics they *did* explicitly notice, such as the possibility of overtaking and the road width, are precisely those characteristics of GOWs that have more variations, and, as a result, this type of road is difficult to distinguish from other types of road. 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.

Evidence has also been found that expectations with respect to other road users are more correct when the road design includes elements that point to the presence or absence of these road users. Examples are bicycle lanes indicating the presence of cyclists and physical driving direction separation indicating the absence of agricultural vehicles (Davidse et al., 2007).

Furthermore, the desired driving behaviour (in terms of speed and road position) is influenced by the full road design and not mainly by the marking (alone) (Aarts et al., 2007). This illustrates the relation between recognizability and credibility (see SWOV fact sheet *Towards credible speed limits*): a recognizable design supports the expectations and the behaviour of road users through explicit knowledge and recognition of characteristics; a credible design supports road user behaviour intuitively and, this way, contributes to recognizability.

The recognizability of transitions between types of roads has also been subjected to research. Transitions can generally be made recognizable when:

- the type of road prior to the transition clearly differs from the type of road following the transition, or
- the transition itself clearly indicates that it is a transition from road type to another road type.

Photo research (Stelling-Konzcak et al., 2011), studying the effect of the design of road sections, showed that especially regional SWs and rural GOWs were more distinguishable because of the green centre line or a physical driving direction separation for SWs, instead of the edge marking that should, in principle, make these two types of road recognizable. The distinction between rural GOWs and rural ETWs appeared mainly to improve when rural ETWs were not fitted with markings. Film research also yielded these results (Mesken et al., 2010). Not only the difference in design of the road sections served in recognizing the transitions, but also the design of the transitions themselves: grade separated intersections between rural GOW and regional SW and priority intersections instead of roundabouts between rural GOW and rural ETW. However, these results do not in all cases support the physical road safety requirements demanded from sustainably safe infrastructure. Consequently, an integral consideration of interests remains necessary.

Does information serve to make roads more recognizable?

In summary, research shows that the ERC markings are not self-explaining - especially not at first instance - and do not automatically 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 in a number of situations, what the double or green axis marking meant, which types of road users could be expected, and which speed limit matched which road design. It can subsequently be questioned whether information about the various design characteristics serve to make roads more recognizable.

Research has shown that information meets a general information requirement and, moreover, serves to make types of road that are not yet sufficiently distinguishable more recognizable (see for a survey Mesken et al. 2010). Also, other studies gave evidence that information could help the recognizability of roads. Subjects grouped photos of roads more successfully when they had received information about road categories compared to subjects who had not been given this information (Davidse et al. 2007). In a driving simulator study by Aarts et al. (2007), with various design variants, ERC included, subjects who had not been given additional information turned out to be reasonably well capable of assessing the expected speed limit and whether other road users might be expected. This study concluded that road users are mainly *insecure* about the meaning of the road design. Information, in addition to familiarization with the new road design, might result in reducing road users' insecurity.

In the meantime, various ERC information campaigns have been carried out. Initially, some Dutch provinces conducted their own campaigns, with brochures, as well as billboards along the roads. Moreover, January 2009, the national campaign 'Lines on the road' was launched, instigated by the Dutch Ministry of Transport (nowadays Infrastructure and Environment) and the Royal Dutch Touring Club (ANWB). This information campaign consisted of a website, brochures, articles in regional and local newspapers, free locals papers and, occasionally, billboards along the roads. For all these campaigns, 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). Do road users manage to understand all this? So far, the effects of the campaigns on the road users' ERC knowledge and application have not been evaluated.

However, providing information about road design is not always effective: the driving simulator study by Aarts et al. (2007), mentioned above, could not detect an effect of information on *driving behaviour*. Moreover, information appeals to actively being reminded, rather than recognizing, and this can be problematic, especially at first sight. This is specifically important for road characteristics whose meaning is fairly abstract and not intuitively supported, such as the green centre line marking, indicating a 100 km/h speed limit.

Furthermore, the Sustainable Safety vision argues in favour of a traffic system in which the design of the environment evokes the desired behaviour intuitively 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). According to this vision, this not only requires the earlier mentioned 'Essential Characteristics' (instead of recognizability characteristics), but also a quality assurance system in order to guarantee the total Sustainable Safety quality of roads.

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 roads should be recognizable by their design and predictable by their alignment .This will evoke the correct expectations of both own and other road users' driving behaviour. 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 step into the direction of recognizability equally well: overall uniformity is lacking, and those characteristics that are uniform (i.e. edge marking) are not always equally meaningful for road users. Recognizability can be improved by structurally applying meaningful characteristics for each road category in a more uniform way: centre line marking and driving direction separation and the design of intersections at transitions. Moreover, for a sustainably safe road system, these characteristics should also be physically meet safety standards (i.e. 'Essential Characteristics').

Information can be used to improve knowledge about the meaning of markings. This also can satisfy a general information need of road users. Information is less suitable for obtaining the desired driving behaviour because driving behaviour is mainly evoked intuitively by the road layout.

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