

# Road Markings and Signs in Road Safety

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Due to the dynamic nature and complexity of road traffic, road safety is one of the most demanding social challenges. Therefore, contemporary road safety strategies incorporate a multidisciplinary and comprehensive approaches to address this problem and improve the safety of each individual element, i.e., the human, vehicle, and road. Traffic control devices are an important part of road infrastructure, among which road markings and road signs play a significant role. In general, road markings and signs represent basic means of communication between the road authorities and road users and, as such, provide road users with necessary information about the rules, warnings, obligations, and other information related to the upcoming situations and road alignment. The aim of this entry is to briefly present the main functions and characteristics of road markings and signs, and their role in road safety. In addition, practical issues and future trends and directions regarding road markings and signs are discussed.

Keywords: road markings ; road signs ; road safety ; traffic control devices ; road infrastructure

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Road safety is still one of the major issues worldwide, given that annually approximately 1.3 million people die in road crashes, with an additional 20 to 50 million people injured <sup>[1]</sup>. In general, the state of road safety is considered to be the result of the interaction between three main factors: human, vehicle, and road. Given the propensity for error, humans have long been considered a major perpetrator of road crashes, although external factors typically contribute to human error. Roadway characteristics, as well as the vehicles themselves, can provoke human error and thus be primary causes of crashes. Accordingly, current road safety strategies (such as the Safe System Approach) clearly differentiate factors that cause road crashes—human, environmental, vehicle-related, etc. and focus on a more holistic approach for resolving the problem. This kind of approach is aimed at taking actions that improve the roads and their environments, vehicle safety systems, law enforcement, and the behavior of road users. There are many ways to influence road users and human behavior, such as safe driving training, public campaigns, and additional education in schools, i.e., road safety education <sup>[2]</sup>. Furthermore, the effects are improved when several preventive measures are combined <sup>[3]</sup>.

As one of the elements of road safety, the road consists of its entire infrastructure and surrounding environment. Therefore, traffic control devices, such as road markings, signs and signals, and other road safety elements, are an important part of road infrastructure.

Traffic control devices date back to the time of ancient civilizations, whereby roads were marked were in a primitive way, using trees or stones. The purpose of this practice was primarily navigational, and it can be said that trees and stones represented the first directional road signs. Technological progress, construction, the interconnectedness of evolving geographical areas, the need for faster transport, and the migration of people and goods led to the need to establish a legal framework for managing transportation networks. Moreover, the rise of international road transportation increased the need for rules that could be interculturably understandable.

Therefore, the first International Convention on Motor Traffic was held in Paris in 1909, and it addressed problems related to the construction of motor vehicles, international traffic, road signs, and lighting <sup>[4]</sup>. Among other things, the convention defined the basic shapes of road signs, e.g., danger signs were defined as equilateral triangles with the top facing upwards, mandatory signs as circles, and notice signs as rectangles. The Paris Convention was supplemented by two new conventions related to road and motor traffic (the International Convention relating to Road Traffic and the International Convention relating to Motor Traffic), the conclusions of which were adopted in Paris in 1926. However, the conclusions mentioned did not deal exhaustively with the issue of road signs and lighting, which is why a convention on the unification of road signals was held in Geneva in 1931. In 1949, the United Nations Economic and Social Council concluded that the current conventions from 1926 and 1931 were obsolete and organized a new conference in Geneva the same year. The outcome of the conference was the Convention on Road Traffic and the Protocol on Traffic Signs and Signals.

Several other conventions followed, but the most important was the one held in Vienna in 1968, when the Geneva Convention was revised and significantly expanded. The Vienna Convention <sup>[5]</sup>, officially called the Convention on Traffic

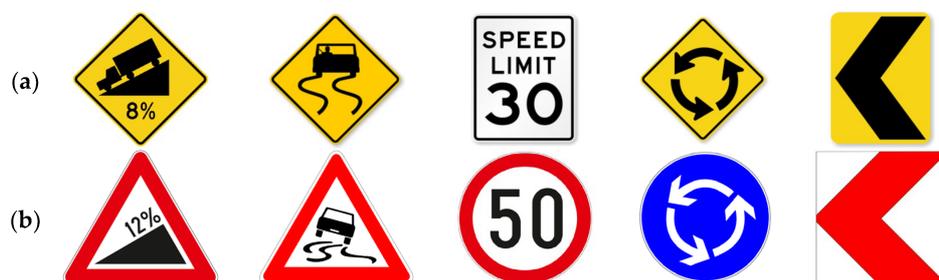
Signs and Signals, is a multilateral treaty aimed at increasing road safety and standardizing international road traffic, which is still the basis for regulations in most countries, especially European ones. The convention unified colors, shapes, and basic dimensions of road signs and defined the use of symbols instead of words to make the signs more understandable to people from different countries, and cultural and linguistic origins, and to illiterate people. In addition, the Vienna Convention defined some new specially shaped signs, such as the octagonal obligatory stop sign in place of the previous round sign with the delineated triangle.

Except road signs, the Vienna Convention also included and defined road markings. The first documented use of road markings dates to 1911 when the center line was painted on Trenton River Road in Wayne County, Michigan (USA) [6]. The originator of the idea was Edward N. Hines, chairman of the Wayne County Road Committee, who got the idea after seeing milk leaking from a milk truck on the road. Shortly after, center lines were painted on rural and state roads in Michigan, Oregon, and California. In Oregon, in April 1917, a yellow center line was painted on the Columbia River Highway, representing the first application of yellow markings. In Europe, the first road markings were applied in Great Britain in 1918, and as in the US, their use quickly spread through Europe; for example, in 1925, the roads in Berlin were already marked with white center and edge lines.

Relatively soon after their first application, it was found that during nighttime, road markings were neither visible nor effective. The solution to this problem was presented in the article Luminous Marking for Highways, which proposed the use of retroreflective glass beads in road markings [7]. Today, in addition to contrast, retroreflection is a basic qualitative characteristic of both road signs and markings.

The Vienna Convention was later updated with the Supplementing Agreement (1971) and Protocol on Road Markings (1973), and as such is used in 69 countries worldwide. However, the system based on the Vienna Convention is not the only system for signs and markings. In the United States, the system is based on the US Federal Highway Administration's Manual on Uniform Traffic Control Devices (MUTCD). The main difference between the MUTCD and Vienna Convention is related to road signs, i.e., their shape, colors, and the way the message is conveyed to the road user. For example, diamond-shaped yellow signs signify warnings, rectangular signs with a white background convey traffic regulations, while yellow circular signs warn of a railroad crossing, etc. Moreover, road signs in the MUTCD are often more text-oriented, though some signs do use pictograms as well. When comparing road marking standards, the main difference is that the MUTCD requires all center lines dividing opposing traffic on two-way roads to always be painted in yellow.

Today, the Vienna Convention and MUTCD are the two main systems and the basis for standards worldwide (**Figure 1**), e.g., Canadian and Australian systems are based on the MUTCD to a large extent, in Latin and Central America and in some Asian countries, the systems are based on a combination of the Vienna Convention and MUTCD, while in most African countries, European (the Vienna Convention) or the old British system is used. Regardless of the system, road markings and signs have to be properly designed and situated in order to provide timely and appropriate messages to road users in all weathers and traffic conditions, and thus positively affect overall road safety.



**Figure 1.** Comparison of road sign designs from (a) the United States (MUTCD system) and (b) Croatia (Vienna Convention-based system).

In the following chapters, the main functions and characteristics of road markings and signs, and their role in road safety are described, with an emphasis on conventional signaling. Moreover, practical issues and future trends and directions are discussed.

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