

# **A Proposed Method About the Design of Road Signs**

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## **1. Introduction**

The road sign can be defined as a communication to the users of the road. In fact, as stated by Crundall and Underwood (2001), the role of the road signs is to prepare the driver for a subsequent behavior, which is necessary according to the layout of the road ahead. Such communication can be an advice, an order, or, finally, a prohibition, and it is related to the driver's behavior that should be taken on the road. The core aim of these signs is to improve the safety of the traffic. For this reason, the road signs are designed paying a great importance to their ability to sensitize the driver to the hazards (Fisher, 1992). Such contents are principally expressed by pictures accompanied, very often, by texts, which sometimes result to be very long and complex.

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**Figure 1.** Examples of road signs with textual inscriptions in specific languages. It is easy to recognize the comprehension difficulty (and the consequent danger) for foreign road users that do not know the respective language.

In article 8, paragraph 3 of the Convention on Road Signs and Signals (Economic Commission for Europe: Inland Transport Committee, 1968), signed at Vienna on 8 November 1968, states that it does not

... prohibit the addition of an inscription in a rectangular panel below the sign or in a rectangular panel containing the sign; such an inscription may also be placed on the sign itself, if this does not make the sign more difficult to be understood for drivers who cannot understand the inscription.

If the length or the complexity of the inscription can be a problem, the fact that the text is written in the language of the country where the road sign is placed, as shown in Figure 1, can be considered much more as a problem. In fact, with the increase of foreign drivers travelling for business or tourism purposes, the problem of a poor understanding of the road signs, due to linguistic misunderstandings, cannot be overlooked.

Adding an inscription to the road sign can reduce its comprehension, as reported in many studies on graphic symbols and icons (Auer & Dick, 2007), and may require reading times incompatible with the traffic requirements. In fact, driving at 30 m/s (about 110 km/h), if there is a road sign at a distance of 60 m, it could be readable for 2 sec, that is the time necessary to travel that distance.

Aim of this article, therefore, is the proposal of a general method able to “translate” the texts written below the road signs in graphical form. The starting point of this idea is that the graphical language can be a universal communication form, able to overcome the language and the cultural differences.

## 2. Context

Earliest road signs were the milestones that served to provide the road users or the pedestrian with the information related to the distance and/or the direction to follow to reach a determined place, but only in the late 1800s we have the first example of signs aiming at warning the road users, who were the bicycle’s riders, of the potential hazards that could occur ahead (Cummins, 2003). These signal systems contributed to define the modern road signs, though the information provided was only expressed by textual inscription. The advent of the car encouraged the use of more complex signage systems. These systems have

required the use of notices based not only on the text. One of the first road sign systems was conceived by the Italian Touring Club in 1895 (Castro & Horberry, 2004), whereas the first effort to define a regulation of road signs were set at the International Road Congress, held in Paris in 1908 (Harris & Wakelam, 1909). The work on the road signs, which took place in Europe in the first half of the 20th century, led to the development of the European road signs system. The United Kingdom adopted a version of the European road signs in 1964; and, finally, over the past decades, the same symbols have begun to be used in the North American signage (McShane, 1999).

A great effort in the development of the road signage system was devoted to unify the pictorial content, including the colors, and the shape of the road signs (Economic Commission for Europe: Inland Transport Committee, 1968). The present perspective regards the effort to make the information obtained from road signs more conscious and explicit. In this direction much research has been conducted to evaluate the readability of the road signs under different driving conditions (Viganò et al., 2011; Zwahlen, 1994; Zwahlen & Schnell, 1998;) and the influence of the reflectivity and size of the traffic signs for their recognition (Cole & Hughes, 1984; Hughes & Cole, 1986; Paniati & Mace, 1993). Many studies were also devoted to define detection systems able to recognize road signs by means of vision apparatus (de la Escalera et al., 1997; Fu & Huang, 2010).

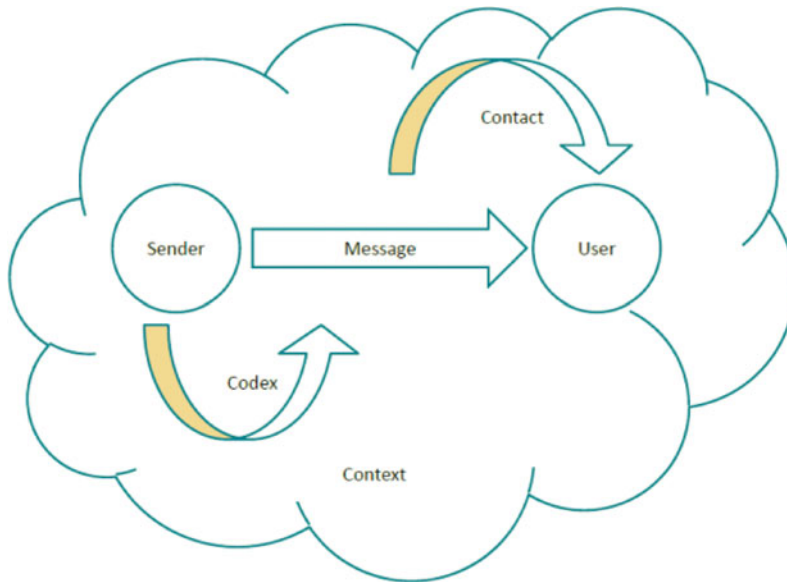
A rich technical literature and many books were devoted to the graphic signs (Arnell, 1963; Chisesi, 2000; Modley et al., 2011). They include a complete collection of schematic and simplified pictures adopted in many technical fields such as transports, factories, tourism, and so on. Research about the aspects and the components of the graphic communication was developed in the years, as showed in (Bowman, 1968). After some consideration on the visual perception, Bowman (1968) analyzed the communication issue in the terms of “what” (appearance, structure, organization), “how” (movement, system, process), “how much” (size, quantity, trend, division), and “where” (area, location, position) communicate. Other studies were devoted to road signs from the historical point of view (Baines & Dixon, 2003) and on the basis of their attributes, according to the human requirements (Castro & Horberry, 2004), such as visibility, conspicuity, readability, comprehensibility, unambiguity, precision, credibility, correctness, opportunity, and timeliness. Finally, studies have been conducted to collect and classify the road signs used in many countries of the world (Mustienes & Hilland, 2004). All these collections are very interesting, because they confirm the difficulty of interpretation of road signs when the information is transmitted by means of texts written in specific languages. The studies present many signs with the same meaning, so that their results can be used as a basis for the choice of the better sign among a certain number of given signs.

Despite the extent of the literature about road signs, no author approaches the problem of the comprehension of the texts included in the road signs and not one of them proposes a method to substitute the inscription by means of the use of pictures or symbols.

## ***2.1. Fundamental Concepts About the Communication***

Before analyzing the issue of the texts included into the road signs, it is necessary to consider the structure of the logical schema of the communication process adopted by the authors. This schema, shown in Figure 2, is the result of several studies conducted in the specific field of the technical communication (Biggioggero & Rovida, 1997).

From a general point of view, in a communication process the following elements are recognizable:



**Figure 2.** Logical schema of technical communication.

1. Sender: the organizer of the communication, who operates the association of the contents with the system of signs. The signs are the medium (the “vehicle”) of the communication.
2. User: the person or the group of people who receives the system of signs and reconstructs the information contents wanted by the sender.
3. Message: it is the information that, by following specific rules, “starts” from the sender and “reaches” the user.
4. Codex: it is the structured connection between contents and signs that “transfer” the information (the contents).
5. Contact: it is the sensorial channel (generally the sight and/or the hearing) that permits the reception of the message.
6. Context: it is the environment where what happens and that surrounds the communication.

The implementation of the above-mentioned considerations about the communication system to the matter of the road signs could be expressed as follows:

1. Sender: the authority responsible for the traffic safety.
2. Users: all the road users, whether they are driving a vehicle, such as drivers, riders, bikers, passengers, and pedestrians.
3. Message: the communication of the information, of the order or of the prohibition, with the aim of improving the safety and the regularity of the traffic.
4. Codex: the association between graphical signs and texts, supported by a road sign and directed to the road’s users.
5. Contact: principally the user sight and, more rarely (e.g., in the case of traffic lights with acoustic signal for blind people) the hearing, that are devoted to receive the message.

6. Context: the road and the environment (the weather, the rural, or the urban context, etc.) surrounding.

To design and perform a correct communication it is necessary to follow some rules, which permit the division of the communication issue into subproblems and the application of a methodical approach to it (Moore & Fitz, 1993). These subdivisions are devoted to clarify the communication requirements and can be expressed from the following four notions: the initial behavior, the terminal behavior, the structure of the concepts and the communication unit.

The term *initial behavior* is related to the behavior of the recipients, identifies the requirements to receive the communication, and can be expressed as the knowledge background required by the recipients before the act of the communication.

The terminal behavior is strictly related to the capacity of comprehension of the human being, identifies the objectives of the communication, and in analogy with the initial behavior, is expressed in terms of the knowledge that may be reached by the recipients after the act of the communication.

The structure of the concepts to be transmitted represents the complex of the information contents, which are the amount of knowledge between initial and terminal behavior. Those concepts have to be carefully determined and structured to reach the target of the communication.

The communication unit is the part of the communication devoted to the transmission of each concept. In general, each communication unit should be constituted by an informative part and by a critical applicative. In the didactic context, the informative part, which explains the definitions and information about the concept, is called “rule” or “RUL,” whereas the applicative part, which is devoted to the application of the concept, is called “example” or “EG.” (Gavini, 1965; Markle, 1969).

An application of these subdivision rules to the communication related to the traffic signage system is explained in Table 1. The case regards a prohibition signal with an inscription added in Italian language and placed below to the road sign. The prohibition regards the stop of the vehicles, whereas the meaning of the inscription is “except for the ascent and the descent of the passengers from buses.”

To guarantee the effectiveness of the communication, some further aspects are necessary. In particular, the immediate perception, the completeness, and the uniqueness of the information assume great importance for the quality of the communication.


In fact, it is firstly necessary to guarantee that the message transmitted requires a very short time between the perception and the mental reconstruction of the communication contents by the recipient. Secondly, it must ensure that all the contents, which have to reach the terminal behavior, are included in the message. Finally, the information transmitted must not contain different significance than that required by the communication. The latter statement results to be very crucial in the context of the traffic signage system.

## **2.2. General Analysis of a Road Sign**

The research conducted by the authors about the specific argument of the road signs (Ballardin et al., 2005) and, in general, about the technical communication (Rosa et al., 2007; Rovida & Viganò, 2006) have revealed that the message transmitted, even if based on a picture, can be considered as structured as a sentence. Those studies have permitted the acquisition of a great number of examples of road signs, with and without textual inscriptions. Any road sign has been analyzed in relation to the message transmitted by

**Table 1**

Application of the communication steps to a road sign

Road Sign	Communication Step	Explanation of the Step	Application to the Road Sign
	Initial behavior	Knowledge necessary to use the communication	<ul style="list-style-type: none"> <li>• No visual important defects</li> <li>• Knowledge of the Italian language</li> <li>• Driver's license</li> </ul>
	Terminal behavior	Knowledge to be reached by the user with the communication	<ul style="list-style-type: none"> <li>• No stop permitted by drivers of private vehicles</li> <li>• The bus drivers can stop only for the ascent and the descent of the passengers</li> </ul>
	Structure of the concepts	Parts of the communication individuated by the analysis of the terminal behavior	<ul style="list-style-type: none"> <li>• Stop for private vehicles not allowed</li> <li>• Stop allowed only for the ascent and the descent of the buses passengers</li> </ul>
	Communication unit	Association of the parts of the communication to the medium	<ul style="list-style-type: none"> <li>• Stop prohibited: picture</li> <li>• Exception for bus drivers: text</li> </ul>

means of it and, finally, it has been synthetized, for each road sign, the structure of the concepts used for the communication. The results obtained have permitted to consider the communication, used for the traffic signage system, as structured as a sentence and composed by the following parts: operation, complement, preposition, and complement linked to the preposition. An application of the subdivision proposed for the communication structure of some road signs is shown in the Table 2. This subdivision can be directly derived by the observation of the most common road signs, correlating their structure of the contents with the structure used for the sentences of the natural language. For example, considering the following common classes of signs:





- danger: "it is required to give attention";
- obligation: "it is required to do something";
- prohibition: "it is required do not do something".

They could be analyzed in relation to the syntax of their meaning:

- verb: to give, to do, do not do;
- object: attention, something.

**Table 2**

Examples of the communication sentence analysis applied to the road signs

		Example 1	Example 2	Example 3	Example 4
					
Textual message on the traffic sign	Italian	<i>in caso di nebbia</i>	<i>a semaforo lampeggiante</i>	<i>uscita autocarri</i>	<i>solo per autocarri</i>
	English	in case of fog	when the traffic lights are flashing or off	heavy vehicles	only for heavy vehicles
Components of the textual message	Operation	Drive	Give	Give	No turn
	Complement	No more speed 80 km/h	Way	Attention	Left
	Preposition linked to the complement	If Fog	If Traffic lights are flashing or off	Because Crossing of trucks	Only Trucks

The subdivision of the sign meaning is expressed by the graphical and the textual information. Here, the textual information expressed in the road sign is analyzed to translate the information into a graphic form with an equivalent meaning.

It is important to observe that usually the operation and the complement are expressed in graphical form. The complement linked to the preposition is explained by means of the textual notation of the road sign, while the preposition is often understood, if it is not explained in the inscription.

Using the subdivision proposed, it has been noticed that many prepositions are repeated in various road signs, so a list of those prepositions was realized. Subsequently, an analysis with the purpose of identifying the complements linked with the prepositions has been conducted. Table 3 shows the list of the prepositions obtained from the analysis, whereas in Table 4 it is reported the list of the complements linked with the prepositions.

**Table 3**  
Prepositions individuated in the road signs analyzed

Preposition
and
because
except
if
in
only
or
out
when
where

**2.3. Proposal of Translation with Known Graphical Signs**

After the identification of the prepositions and of the complements associated to them, it is necessary to define a set of symbols able to transmit the textual information so that they can substitute the inscription placed below the road sign. The choice of the symbols has

**Table 4**  
Complements linked to the prepositions individuated in road signs analyzed

Complement linked with preposition
Ascent and descent
Authorized people
Authorized vehicles
Both sides
Certain days of the week
Certain hours
Construction
Continue
Drive way
In case of frost
In the middle
In the tunnel
Level crossing
Loading/unloading
Marked fields
Permanent
Residents
Restricted traffic zone
To the sides
Traffic light off or flashing
Vehicles given mass
Vehicles given size



been oriented to obtain a set of simple pictures useful to be used alone or in combination among them, so that the relative meaning of any sign can be combined to define the global information content linked to the road sign. The first approach to the question can be faced by trying to replace the text with well-known symbols. Those symbols are defined known because they are already used in the road signage system. Also, because the known symbols are already applied to different contexts, the choice of using them to explain the content of the road sign is considered as the most suitable to ensure a better comprehension of the recipients. As for the road signs, the found known symbols have been identified according to the prepositions explained in Table 3; and, in this manner, they were used to replace the textual inscriptions. The selection of the most appropriate symbol to explain a specific preposition could be made in a heuristic manner: when the symbol is already used in a similar context, or by means of the use of a criterion based on a preferential classification that could be also made with the contribute of the road users. The last kind of selecting has the aim of selecting a symbol through a comparison among other symbols. These symbols, all identified through the same preposition, are usually applied in different contexts with respect to that of the inscription to be translated. If the symbol searched does not exist or it is not possible to choose the best one among the others, the definition of a new pictorial symbol becomes necessary. Table 5 presents some examples where the translation of the textual prepositions has been developed by means of well-known pictorial symbols.

The use of the graphical symbols to replace the text messages of the road signs allows great flexibility. It sometimes allows the use of pictures in contexts different from those where they are usually adopted, also with slightly different meaning. An example could be observed in the case of the symbol of the traffic lights that it is used to replace the preposition *except*.

Through the proposed subdivision of the information transmitted, it is possible to guarantee the translation of the message even in more complex cases. For example, in Figure 3 it is reported the proposed translation for the message that requires the reduction of the velocity of the vehicle, because there is a possible exit of people in the neighborhood. In this case, the image of the translation adopted is the combination of three simple pictures: "Exit," "Men," and "Slow drive." Note that the "slow drive" symbol used is also adopted in Italian horizontal signage system to indicate the need to slow down.

It is possible to notice that the translation of the message by means of a graphical picture can give more detailed information than the textual inscription. In fact, in the example shown in Figure 3, the graphical sign also includes the indication of the direction of the exit of the people with respect to the location of the road sign.











By the application of those criteria, it is possible to create an archive of symbols able to replace the most common prepositions and the complements associated to them.

#### ***2.4. Proposal of Translation with New Graphical Signs***

Despite the existence of a multitude of known graphic symbols, it is possible that none of them could be suitable to satisfy the translation of the content of the inscription associated with the road sign. In these cases, it is necessary to study and select new symbols able to guarantee a good comprehension of the message transmitted to the recipients.

The effective capacity of a specific graphical sign to perform its function, that is, to transmit the message, can be seen as the sum of many characteristics, such as the simplicity, the comprehensibility, and the unambiguity. A way to select the most suitable symbol among different ones could be derived from the approach used in the methodical design for the choice of the "best in class" constructive solution (Galli & Rovida, 1993;





**Table 5**  
Inscriptions translation of traffic signs by means of well-known symbols



Preposition	Textual Message on the Traffic Sign		Textual Example	Before	Proposal of Translation After
	Italian	English			
In	<i>in centro</i>	in the center	Circulation of trucks in the center of the town prohibited		
In	<i>in galleria</i>	in the tunnel	Speed limit of the vehicle applied in the tunnel		
Except	<i>eccetto</i>	except	Prohibition of transit for all vehicles except for motorcycles		
Because	<i>passo carrabile</i>	driveway	Entrance and exit of private vehicles (driveway)		
Because	<i>conversione mezzi operativi</i>	turn back of operative vehicles	Turn back of operative vehicles		

*(Continued on next page)*

**Table 5**

Inscriptions translation of traffic signs by means of well-known symbols (*Continued*)

Preposition	Textual Message on the Traffic Sign		Textual Example	Proposal of Translation	
	Italian	English		Before	After
And	<i>rallentare</i>	slow down	Slow drive		
With	<i>biciclette condotte a mano</i>	bicycles hand-guided	Bicycles admitted if hand-guided		

Textual Message on the Traffic Sign		Proposal of Translation	
Italian	English	Before	After
<i>uscita maestranze</i>	exit workers		
<i>rallentare</i>	slow down		

**Figure 3.** Proposal of graphical translation of the message: “slow drive, because there is exit of people in the neighborhood.”

Rovida et al., 2005), for a product or a technical system, able to perform a given function. The methodical design is a part of the “design science” focused on methods and tools to support in a systematic manner the development of industrial products able to perform the required functions. An important step, defined in the methodical design, is devoted to the procedure to the identification of the best solution among a set of proposed solutions, all able to perform a given function. Such choice can be made through a system of matrixes where the rows report the different solutions and the columns report the characteristics of the specific solution with regard to the function under analysis. The cells of the matrix include, finally, the evaluation of the behavior of the solution in relation to the specific characteristic (Biggioggero & Rovida, 1985). Following this method, all the symbols able to transmit the required message are compared on the basis of the selected characteristics, and the most suitable one reaches an evaluation greater than the others under analysis.

The practical application of the procedure to choose the more appropriate symbol, for the road sign message required, could be explained in math mode through the following steps. The behavior  $v_{ij}$  of the  $i$ -th symbol is evaluated for any  $j$ -th characteristic obtaining an evaluation matrix where the symbols are reported along the rows and the characteristics along the columns.

For every characteristic used to compare the symbols it is defined a weight  $w_j$  chosen in relation to the context where the symbol will be adopted.

Finally, the judgment  $S_i$ , for the choice of the “best in class” symbol, is obtained by the sum of the multiplications between the weight and the value of each selected characteristic, as reported in the following equation (Rovida & Viganò, 1994):

$$S_i = \sum_{j=1}^m v_{ij} w_j$$

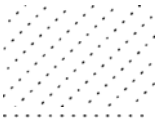
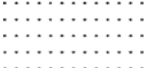

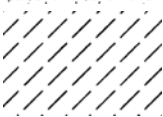


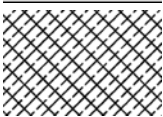
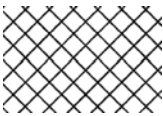
where,  $m$  is the number of the characteristics under evaluation.

To explain the proposed procedure for the selection of a symbol adapted to express a concept in a specific case, we report the operative sequence adopted in the case of the choice of the picture related to the concept of “fog.” Some different graphic symbols have been selected for the comparison, and their adequacy to transmit the content of the message was evaluated with regards to five characteristics. The characteristics used to the selection were simplicity of the symbol, completeness of the content, unambiguity, comprehensibility of the symbol in case of bad visibility, and readability of the symbol to distance. The considerations that lead to the choice of the characteristics are driven by the terminal behavior of the communication that you want to achieve.

Such terminal behavior requires the characterization of the content, object of the communication, and of the vehicle of the communication: the system of signs. The completeness is a property of the content, whereas the other characteristics are associated to the system of signs.

Each characteristic was defined a weight, which was chosen based on its importance for the message transmitted. The weight values are defined in relation to the specific requirement of the communication, and they could be different from signal to signal. In the proposed example, it has been assigned a greater value to the readability of the road sign rather than to its simplicity. This is due to the kind of signal and to its using conditions. To evaluate the behavior of the sign with respect to the specific characteristic, a judgment from poor to good, made by means of the values among 1 to 3, has been assigned to each symbol. Finally, for any symbol, the sum  $S_i$  of the multiplications, between each judgment  $v_{ij}$  and the weight  $w_j$  related to the characteristic considered, has been obtained. The comparison

**Table 6**  
Choice of the “fog” symbol through the application of the evaluation matrix method

“Fog” Symbols	Characteristics					S <sub>i</sub>
	Simplicity (w <sub>j</sub> = 1)	Completeness (w <sub>j</sub> = 1)	Unambiguity (w <sub>j</sub> = 2)	Comprehensibility with Bad Visibility (w <sub>j</sub> = 2)	Readability to Distance (w <sub>j</sub> = 2)	
	2 (2)	1 (1)	1 (2)	1 (2)	1 (2)	9
	2 (2)	1 (1)	1 (2)	1 (2)	1 (2)	9
	2 (2)	3 (3)	3 (6)	1 (2)	2 (4)	17
	2 (2)	2 (2)	2 (4)	1 (2)	2 (4)	14
	2 (2)	2 (2)	2 (4)	3 (6)	2 (4)	18
	3 (3)	3 (3)	2 (4)	3 (6)	3 (6)	22
	1 (1)	2 (2)	2 (4)	3 (6)	2 (4)	17
	1 (1)	2 (2)	2 (4)	3 (6)	2 (4)	17

among the sums obtained has permitted the choice of the most suitable symbol. The evaluation matrix relative to the proposed symbols, including the results obtained from the analysis, is shown in Table 6. In each cell of the table the judgment regarding the specific characteristic are reported and, in brackets, the result of its multiplication with the weight associated to the characteristic.

Following this approach, the proposed symbols have been chosen and adopted in the proposal of translation for road signs, as shown in Table 7.

Some considerations can be made about the results obtained by the application of the method and on the selected symbols. In particular, it is possible to observe that the application of the method proposed had led to the translation of the preposition *if* by means of the use of two black triangles (Table 7). Similarly, to the graphical translation of the concept *temporary kerbstone* has been added the indication of the opening and closure

**Table 7**

Some new symbols proposed for the translation of textual messages

Textual Message on the Traffic Sign			Proposal of Translation	
Italian	English	Concept	Before	After
<i>non illuminata</i>	not lighting	Tunnel without lighting		
<i>paracarro mobile</i>	temporary kerbstone	Temporary kerbstone		
<i>caduta castagne nel periodo autunnale</i>	falling chestnuts during autumn	Danger of falling of fruits		
<i>eccetto acquisto farmaci uno stallo</i>	except to buy pharmaceuticals one parking	No parking, except for customers (only one!) of the pharmacy		
<i>eccetto veicoli con contrassegno</i>	except vehicles with pass	Except authorized vehicles		

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**Table 7**

Some new symbols proposed for the translation of textual messages (*Continued*)



Textual Message on the Traffic Sign			Proposal of Translation	
Italian	English	Concept	Before	After
<i>in caso di nebbia</i>	in case of fog	Speed limit of the vehicles in fog case		
<i>a semaforo spento o lampeggiante</i>	when the traffic lights is flashing or off	Give way if the traffic light is out or service or active only with the yellow light		

time. This addition, that it was not included in the initial inscription, is an example of how it is possible expands the information content of the signal.

The research showed that special situations occur when the message includes information that assume different meaning for different countries or cultures. This is the case, for example, of the road sign in Figure 4, which is related to the prohibition of parking when the road has to be cleaned. The problem regards the indication of the day of the week, because not in all countries the week starts with the same day (Monday for the occidental culture). To overcome this problem, in the proposed road sign, the number indicating the Sunday has been colored in red.

Textual message on the traffic sign		Proposal of translation	
Italian	English	Before	After
<i>Venerdì dalle 0.00 alle 6.00</i>	<i>Friday From 12.00 p.m. to 6.00 a.m.</i>		

**Figure 4.** Indication of the days of the week in a road sign. The Sunday is colored in red as reference.

Textual Message on the Traffic Sign		Proposal of Translation	
Italian	English	Before	After
<p><i>AREA RISERVATA</i></p> <p><i>VEICOLI</i></p> <p><i>AUTORIZZATI E DI</i></p> <p><i>SERVIZIO UFFICI</i></p> <p><i>GIUDIZIARI</i></p>	<p>ONLY FOR</p> <p>AUTHORIZED</p> <p>VEHICLES AND</p> <p>JUDGES</p>		

**Figure 5.** Example of the concept “except authorized vehicles” applied in the specific case of law offices.



Another case is shown in Figure 5, where the use of a graphical sign for replacing the inscription related to the concept *except for authorized vehicles* allows inserting also the symbol of the particular organization that belongs the authorized vehicles, to better define the transmitted message.

## 2.5. Complex Road Signs

It is important to consider some general examples obtained from the study of the translation of complex road signs. A particular effort has been paid to the translation of road signs that include many textual inscriptions. In these cases, the number of the messages included in the road sign could bring to a reduction of the quality and of the comprehension of the transmitted information. This difficulty is more evident in the road signs that must be read in short time. We report the solution obtained in three explicative cases:

1. The road sign in Figure 6 is relative to the “prohibition of entrance except for bicycles or vehicles directed to the church or toward the private houses.” The graphical translation is made through the green traffic light, with the meaning of “allowed entry,” and the pictures related to the admitted categories of vehicles or users. The traffic light has precise meaning in relation to the road circulation. It admits the circulation when the light is green, whereas it is prohibited when the light is red. Therefore, it is logical to think that the symbol of the traffic light can be used to indicate when something is admitted (light green) or prohibited (light red). In this case the use of a single sign to explain the concept of “allowed entry,” also if it is applied to different categories of users, allows a good comprehension, in movement conditions for the vehicles, to the road sign proposed.
2. The road sign in Figure 7 means that the parking is free, for the authorized vehicles, only during the days of the fairs. This case is more difficult than the previous one, because the structure of the concepts of the road sign involves many messages and,





Textual Message on the Traffic Sign		Proposal of Translation	
Italian	English	Before	After
<i>eccetto veicoli alle funzioni religiose o diretti all'interno delle proprietà private o biciclette</i>	except bicycles or vehicles direct to the church or to the private properties		



**Figure 6.** General example with reference to the road sign with the meaning “circulation prohibited, with exception to the bicycles and the vehicles directed to the church and to private houses.”

therefore, the translation of the inscriptions is affected by this condition. The result could be considered as acceptable because that road sign may be mainly read at a lower speed.

- The road sign in Figure 8 invites the driver to pay attention to the road, because it has many dangerous curves, no guard rails, crumbling near the walls, and rough road surface. It is to observe that the abundance of the messages included in this road sign and the requirement that they must be read in very short time by the

Textual Message on the Traffic Sign		Proposal of Translation	
Italian	English	Before	After
<i>eccetto veicoli con contrassegno nei giorni di manifestazioni fieristiche</i>	except vehicles with pass in the days of fair events		

**Figure 7.** Example of indication of parking fee, except for authorized vehicles, during the fair days.

Textual Message on the Traffic Sign		Proposal of Translation	
Italian	English	Before	After
<i>SERIE DI CURVE</i>	SERIES OF CURVES		
<i>tratti senza parapetti</i>	verge without parapet		
<i>muri pericolanti</i>	unsafe walls		
<i>STRADA DISSESTATA</i>	ROUGH ROAD		

**Figure 8.** Road sign that invite to the attention, because the road has many dangerous curves, there are no guard rail, with crumbling walls and the surface of road is rough.

driver of a running vehicle make the information transmitted very complex. For this reason, it seems to be more useful to propose a modification of the road sign to make it easier. It should consist of a general warning sign and some symbols added to indicate the specific dangers.

### 3. Discussion and Conclusion

The major aim of the study is the proposal of a general method to the choice and the definition of a set of graphical signs able to transmit the message, which is included in road signal and is currently expressed in textual form. The new graphic signs, defined through the proposed method, may be added to the system of the road signage without changing the structure of that system, thus improving the comprehension of the information independently from the user's language. The signs proposed in this study are the result of the application of the evaluation matrix, as reported in Table 6. Of course, before applying the road signage in the field the symbol chosen by means of the application of the method proposed, a set of testing, supported by road users, on a samples of traffic signs should be performed.

The authors believe that the proposal of substitution of textual information with graphical signs could be a meaningful contribution to the safety of the road traffic. This consideration is based on the following reasons:

1. The graphical sign is independent from any language; therefore, it is comprehensible for people of all countries. This property is very important in the current

- period of time, characterized by a strong and increasing multiethnicity in every country.
2. The graphical information, in relation to the textual message corresponding, requires a more short time for reading them, with a significantly improvement of the safety.

The authors believe that the general principles stated in this article could be a useful basis to discuss and to propose new road signs, exclusively in graphical form, able to guarantee the transmission of the right information in a short time frame and independently by the countries of origin of the recipients of the message.

Also, the same criteria proposed could be applied to all those cases where the message must be immediately transposed, particularly in those places attended by a great number of people, such as train or coach stations, airports, supermarkets, offices, and so on. In these cases, also, this replacement can be a contribution for the general safety and the public order.

The quick understanding of the message, provided by the graphic symbol, permits in many case the reduction of the translation costs and the, always possible, mistakes. About this, particularly interesting could be the application of graphical signs, after specific critical elaboration, in the instructions for use and maintenance of industrial products.

The experiences developed by the authors in this field are available for all the people who could be interested in deepening the topic.

## References

- Arnell, A. (1963). *Standard graphical symbols. A comprehensive guide for use in industry, engineering, and science*. New York, USA: McGraw Hill.
- Auer, S., & Dick, E. (2007). When does a difference make a difference? A snapshot on global icon comprehensibility. *Human-Computer Interaction, Part II*, 4551, 3–12.
- Baines, P., & Dixon, C. (2003). *Signs: Lettering in the environment*. London, UK: Lawrence King Publishing.
- Ballardin, D., Bruno, D., & Rovida, E. (2005). Some observations about the semantics and syntax of road signs. *Traffic Engineering & Control*, 46(7), 267–269.
- Biggioggero, G., & Rovida, E. (1985). Proposal for methodic design in mechanical field. In H. Yoshikawa, *Design and Synthesis: Proceedings of the International Symposium on Design and Synthesis* (pp. 175–179). Amsterdam, The Netherlands: Elsevier Science Publishers B. V.
- Biggioggero, G. F., & Rovida, E. (1997). *Metodi di comunicazione tecnica*. Milan, Italy: Città Studi Edizioni.
- Bowman, W. (1968). *Graphic communication*. New York, USA: John Wiley & Sons Inc.
- Castro, C., & Horberry, T. (2004). *The human factors of transport signs*. Boca Raton, FL, USA: CRC Press.
- Chisesi, I. (2000). *Dizionario iconografico. Immaginario di simboli, icone, miti, eroi, araldica, segni, forme, allegorie, emblemi, colori* [Iconography dictionary. Imaginary symbols, icons, myths, heroes, heraldry, signs, forms, allegories, emblems, colors. In Italian]. Milan, Italy: BUR Biblioteca Univ. Rizzoli.
- Cole, B. L., & Hughes, P. K. (1984). A field trial of attention and search conspicuity. *Human Factors*, 26(3), 229–313.
- Crundall, D., & Underwood, G. (2001). The priming function of road signs. *Transportation Research Part F*, 4(3), 187–200.
- Cummins, G. (2003). *The history of road safety*. Retrieved from Drive And Stay Alive: <http://www.driveandstayalive.com/info section/history/history.htm>

- de la Escalera, A., Moreno, L., Salichs, M., & Armingol, J. (1997). Road traffic sign detection and classification. *Industrial Electronics, IEEE Transactions on*, 44(6), 848–859.
- Economic Commission for Europe: Inland Transport Committee. (1968). *Convention on road signs and signals* (E/CONF.56/17/Rev.1/Amend.1). Vienna: United Nations Economic and Social Council.
- Fisher, J. (1992). Testing the effect of road traffic signs' informational value on driver behavior. *Human Factors*, 34(2) 231–237.
- Fu, M.-Y., & Huang, Y.-S. (2010). A survey of traffic sign recognition. *Wavelet Analysis and Pattern Recognition (ICWAPR), 2010 International Conference on*, (pp.119–124). Qingdao, China: IEEE.
- Galli, P., & Rovida, E. (1993). Proposal of an approach to computer assisted methodic design. *International Conference On Engineering Design - ICED 93*. The Hague: Heurista.
- Gavini, G. (1965). *Manuel de formation aux techniques de l'enseignement programmé*. Paris: Hommes et Techniques.
- Harris, G. M., & Wakelam, H. T. (1909). *The first international Road Congress. Paris, 1908*. London, UK: Wyman & Sons, Limited.
- Hughes, P. K., & Cole, B. L. (1986). Can the conspicuity of objects be predicted from laboratory experiments? *Ergonomics*, 29(9), 1097–1111.
- Markle, S. M. (1969). *Good frames and bad: A grammar of frame writing*. New York, USA: John Wiley & Sons, Inc.
- McShane, C. (1999). The origins and the globalization of traffic control signals. *Journal of Urban History*, 25(3), 379–404.
- Modley, R., Myers, W. R., & Comer, D. G. (2011). *Handbook of pictorial symbols*. New York, USA: Dover Publications Inc.
- Moore, P., & Fitz, C. (1993). Gestalt theory and instructional design. *Journal of Technical Writing and Communication*, 23(2), 137–157.
- Mustienes, C., & Hilland, T. (2004). *1000 signs*. Köln, Germany: Taschen.
- Paniati, J. F., & Mace, D. J. (1993). *Minimum retroreflectivity requirements for traffic signs* (Report No. FHWA-RD-93-077). Washington, DC, USA: U.S. Department of Transportation.
- Rosa, F., Rovida, E., & Viganò, R. (2007). Product, service and communication: An integration as a contribution to the design methodology. *Proceedings of the Applied Engineering Design Science 2007 Workshop*, Pilsen, Czech Republic, (pp. 57–63). V. Vanek and S. Hosnedl, (Eds.). Castle Cary, UK: Design Society.
- Rovida, E., & Viganò, R. (1994). Scelta automatizzata della rappresentazione [Automated choice of the representation]. *Progettare*, 166, 88–91.
- Rovida, E., & Viganò, R. (2006). Communication for X (CfX): A contribution to the design for sustainability. *Proceedings of the 7<sup>o</sup> International Conference on Technology and Quality for Sustainable Development*, Bucarest, (pp. 615–618). Bucharest, Romania: Editura AGIR.
- Rovida, E., Viganò, R., De Crescenzo, A., & Raco, D. (2005). Development of innovative principles to perform given functions. *Proceedings of the Applied Engineering Design Science 2007 Workshop*, Pilsen, Czech Republic. S. Hosnedl, (Ed.) Castle Cary, UK: Design Society.
- Viganò, R., Rovida, E., Vincenti, R., & Ramondino, M. (2011). Road signs perception evaluation by means of a semi-immersive tool. *International Journal of Virtual Reality*, 10(2), 39–47.
- Zwahlen, H. T. (1994). Traffic sign reading distances and sign reading times when driving at night. *12th Biennial Symposium on Improving Visibility for the Night Traveller*, (pp. 140–146). Washington DC: National Academy of Sciences.
- Zwahlen, H. T., & Schnell, T. (1998). Driver eye scanning behaviour when reading symbolic warning signs. In A. G. Al., *Vision in vehicles VI*, (pp. 3–12) Amsterdam: Elsevier.