(FP-79)[3] or Class II (CIE 39-2, 1983)[4] sheetings will be required for U.S. lower beams, for yellow, orange, green and blue signs on the right shoulder and for all colors (including white) for signs in any other position, or for a higher percentage of performance, or for European type headlighting. Safety factors are not included in their table to offset decrements from nominally dirty signs or headlamps, the effects of weathering or for signs located in complex nighttime surroundings.

In a similar manner, Allen and O'Hanlon[5], and Serres[6] have quantified markings for pavements, as Figures 1, 2, 3 and Table 2 show.

A retroreflectometer for highway signs[7] can provide information that a device is below reflectivity requirements or specifications. In a similar manner, pavement markings may be evaluated with a marking retroreflectometer[8] so that objective, quantifiable information can be obtained in the field. Infrequent use is made of such instruments, and regular nighttime inspections using such instruments are frequently lower in priority than is appropriate, particularly considering that these inactions are hardly defensible in tort liability suits. A serious need has existed for more convenient instruments for both brightness assessment and record keeping. Today the means are nearly at hand. Portable microcomputers can be used by maintenance personnel in the field to record inspection results, location, and sign identification, much of the information required for a computer sign maintenance file. Programs[9] are available for such use. Bar coding is a technique which can simplify and speed the input of information in the field.

An intermediate step is the use of a sticker placed on the back of the sign to date the installation. The sign sticker should have three elements: a date code, a warning to vandals of unlawful defacement or theft, and a telephone number to call in the event of a knockdown. The date code is easily readable from a maintenance truck when the sticker is printed in color. A key element in a tort action remains regular day and night inspection which can be substantiated with record keeping, indicating that effective remedial action is taken in a timely manner.

Industrial research has made simultaneous progress in providing improved life expectancies for both marking and signing. Pavement markings are now available having an order of magnitude improvement in service life, reducing the need of continual restriping with seasonal periods of poor visibility. Signing materials are now in use with double the effective service life offering a greater degree of optimal nighttime performance.

We have an opportunity and an obligation to optimize the nighttime efficiency and permanence of signs, delineators and pavement markings. It is not enough to just conform to the provisions of the MUTCD[10]. These are minimum standards. It is the optimization of night vision aids which will produce a safety improvement, followed and augmented with a determined maintenance effort to avoid subsequent decay.

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TRENDS IN ROAD SIGNING IN EUROPE

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Introduction

Europe is a mixture of cultures, political and social societies with many linguistic barriers. Taken as a whole with both the Western and Eastern countries, Europe forms a very strong economic body which depends on its road infrastructure for its economic development. In other words, the road network of Europe must have the equipment in road signing and markings allowing drivers from any country to feel safe and comfortable when using the roads within and outside of their own country.

International and National Legislation

It is necessary that European roads show similar if not the same characteristics in their construction and equipment. To this effect several international and world Conventions and Agreements have been drawn up since the last world war by the United Nations' Economic Commission for Europe (UNECE) based in Geneva. They include the following:

- the (World) Conventions on Road Traffic and on Road Signs and Signals signed in Vienna on November 8, 1968 - known as the "Vienna Conventions";

- the European Agreements supplementing the two "Vienna Conventions" just mentioned, of May 1, 1971;

- the Protocol on Road Markings additional to the European Agreement supplementing the Convention on Road Signs and Signals.

Regarding the safety equipment and the construction of the European road network, the UNECE has also elaborated the European Agreement on Main International Traffic Arteries (AGR) on November 15, 1975.

National legislation in each European country is today adapted to the international documents just mentioned. In fact, the Vienna Conventions became effective in 1977 for the Convention on Road Traffic and in 1978 for the Convention on Road Signs and Signals. Each government had to modify its national legislation in order to ratify the Conventions and a certain number of governments had to do so for them to take effect.

During this period, as now, new traffic situations called for new measures in road signing and traffic rules. These are dealt with internationally by the UNECE, which has set up two Groups of Experts on Road Safety and on the Construction of Vehicles. The groups work out recommendations for governments to adopt similar measures to solve these questions on a national basis. In addition, the European Conference of Ministers of Transport, based in Paris, also develops recommendations which are transmitted to the UNECE for adoption.

Eventually, traffic authorities all over Europe have at their disposal all they need for legal implementation of traffic rules, signs and signals so that all drivers understand the messages they receive from road signing, wherever they drive in Europe.

Technical Requirements for Road Signs, Signals and Markings

Road signing in Europe today must be visible in the same way by day and at night. In other words, size, shape and colors must be seen in the same way at all hours and all year round. Sign symbols and texts must be understood by all as well.

Several international bodies have set out requirements for the technical execution of signs and markings. The shapes and sizes are similar today everywhere in Europe, and the photometric and colorimetric values are practically uniform as well.

ISO Standards and CIE recommendations and publications are the foundations of these technical requirements in most countries. These have integrated the technical values into their legislation.

Trends in Road Signing in Europe

Having explained the legal and technical organization in Europe, let us look now at the different types of signs one finds in Europe.

Signing

The different road networks in most countries are today practically completed. Each country has a network of motorways with limited access and particular rules, signs and markings. There are in addition road networks with mixed traffic and naturally urban roads with the different categories of road classes.

Danger signs, triangular with international symbols (black) in Europe, have normally a red border with a white background; two countries have adopted a yellow background for these signs, Sweden and the USSR.

Mandatory signing is in the form of a disc with a red border and a white background for "negative" instructions and white symbols on a blue background for "positive" instructions.

The symbols, as we said earlier, are similar in each country and in principle, all texts have been abolished to deal with the language barriers. The only symbols in text are the words STOP and BUS.

Priority signing is slightly more complex than in the U.S. Contrary to the fact that when there is no sign one has the right of way here in the States, in Europe one normally finds what is called the positive sign and the negative sign.

The positive signs on priority roads are in the form of a diamond-shaped sign with a yellow background and a black border and the yield signs can be either the octagonal STOP sign or the yield sign in the form of a triangle on its point. On other roads (non-priority), the signs for the positive information are triangular danger signs with a symbol.

Indication signs are of two sorts. The traffic indicators are square with normally a blue background and white symbols. The direction indicators, however, have many colors and are used differently in each country. There is still much to be done for uniformity. To make things simple, let me give you some examples.

In Germany, the signs indicating the access to and the directions on motorways are with a blue background and white letters and symbols. The ordinary road network is signed with yellow direction indicators with black texts.

In Switzerland, secondary roads have direction indicators with white backgrounds and black letters; main priority roads are equipped with signs with blue backgrounds and white letters and motorways have green signs with white letters.

The United Kingdom has blue direction signs on motorways and Italy has green ones.

In addition, Switzerland and France have recently set up touristic signs indicating places of interest to passing drivers with a brown background and off-white letters and symbols.

This is a sign of independence of each country and all endeavors to find a uniform solution have failed so far. It has its charm, though, and road safety is not affected. In fact, it is felt that drivers are thus constantly made aware of the fact that they are not at home and thereby are expected to be more prudent in their actions.

Most of the above-mentioned signs are now made of retroreflective materials. There are more and more high performance signs with brighter night performance and above all a longer life in the field.

In many cities and towns, signs are illuminated either internally or externally. The costs of such signs and their maintenance are high and there is a strong tendency to revert to retroreflective materials. Unfortunately, there are still many traffic authorities who believe that the use of retroreflective materials when street lighting exists is superfluous. This is of course totally wrong and it is a well known fact that the more ambient light there is, the brighter the signs must be. Studies are being undertaken in several university institutes to underline this fact and it is hoped that conditions will improve in the not-too-distant future. One easy and inexpensive way to solve the problem is to set up high performance retroreflective signs as a minimum requirement; these are sufficiently visible in built-up areas and should be used widely to ensure the required safety of road users in cities and towns.

Pavement Markings

Today in Europe, practically all road markings are similar and understood by all drivers. There are some differences in the colors used -- two tendencies are to use the U.S. color system of yellow and white lines depending on the type of lane separation or an all-white system for lane separation. However, most countries use only white lines for these purposes.

Yellow road markings are used either for parking regulation, as in the United Kingdom, or for pedestrian crossings as found in Switzerland, for example.

Other colors are used in some countries for parking regulation in relation to time restriction. For example, the most "colorful" system is found in the city of Lausanne, where parking spaces are marked in white for unrestricted time, blue for a one and a half hour space, or red for a fifteen hour system. Each zone is duly signed as well. Drivers use a disc to show the time of arrival.

As for the technical regulations for road marking products, Europe has a very strict type-approval system -- at least in some countries. France, for instance, has set up technical standards for the colors, the photometric characteristics and the life expectancy of its road markings which are difficult to comply with. Several other countries have used them as a reference. Currently, tests are being carried out for the different types of products in Germany by the CIE technical committee on road markings, and an attempt is being made to find a common measuring method between the test laboratories in Europe.

The situation today is such that road markings must be reflectorized in all countries. It is a well known fact that glass beads in paint, spray-plastics or double-component products applied hot or cold have secondary effects on their performance, durability and color. In addition, the climatic conditions in Europe and the time per year allowing road marking campaigns in the different countries or regions make it difficult to find the ideal product in each country. This makes it difficult for the road authorities to test and evaluate the numerous products offered to them in each country and it is essential to find a common or comparable solution for type-approval purposes.

It is safe to say that the European road marking system is more complex and detailed than in the U.S. Also, the authorities attach much more importance to the results of application and the finished aspect of the work.

Unfortunately, the more detailed the markings provided, the more they must be perfect and present at all times. The legal implications of not having a line because of abrasion can be drastic.

Regulatory Devices

In Europe, one finds three main categories of traffic regulatory devices.

Naturally, the first is the traffic light system one sees all over the world. The tendency in Europe is to use electronic command systems which are traffic activated for the isolated intersections. The fixed time systems are gradually being replaced for obvious traffic flow reasons.

In cities, on the other hand, there is much to be done to improve the traffic flow and energy conservation, and to reduce noise and air pollution. The control systems vary from place to place, and more often than not, the older fixed time systems are being replaced by computer-operated electronic regulation systems. There was a tendency to complicate the whole operation by trying to find the optimal solutions with highly sophisticated techniques, but one soon found out that once city traffic has reached saturation, the only thing a traffic regulatory system can do is organize the traffic flow and no more synchronize it. So, the tendency today in Europe is to revert to sound and proved techniques which are not seeking the optimal efficiency a traffic engineer could dream of.

Public opinion, ecology and the anti-automobile lobby are asking for simple but effective measures with more or less passion and the authorities are taking serious measures to ensure the best possible choice of equipment for traffic regulation in cities and towns.

The second category of traffic regulatory equipment is the variable message signing systems. These have become popular and are used in many countries, cities or towns. Variable message signing is used essentially to divert traffic when roads are congested. For example, near Zurich in Switzerland, the entrance to the city and the through flow of traffic going beyond Zurich is regulated by sending vehicles out of the motorway system up to three exits earlier. This avoids congestion in Zurich (which is not yet bypassed by a motorway because of political strife). The variable message diversion system is also used in many cities in Germany and the U.K., not to mention France and Italy as well as other states.

There are some limits to the efficiency of these systems in Europe. The first is that the signs must be respected by drivers. This is not obvious -- European drivers aren't as disciplined as those in the States -- and once a diversion "tells a lie" to an individual driver, it is very difficult to require that he or she follow the indications without police assistance. The second limit is that should traffic be diverted to a different routing on a non-motorway network, the direction indications on these roads must be accurate and consistent. This is more often than desired not the case, and communication with drivers becomes nonexistent. Thirdly, such systems are expensive to set up, operate and maintain. These arguments alone can dissuade an authority from investing in them, especially with the current economic situation.

Speaking of communication with drivers, the Commission of the European Communities has been working for many years on research for electronic traffic aids on major European roads. This is known as the COST 30 Project. Communication with drivers can be done in several ways, from using radio information systems, to in-board communication with external electronically given messages of the most complex type. During the past year, all the European countries involved have set up their systems on the motorway between the Hague and Rotterdam in the Netherlands and research is being carried out to find the most suitable mixture of solutions for uniform application in the Common Market countries. Once again, all these systems need serious direction indications that are accurate, consistent and always up to date. Otherwise, the most sophisticated hardware soon becomes inoperative.

Sign Maintenance and Public Funding

Lastly, a word on the situation in Europe regarding the maintenance and financing of all road signing.

Several instances, both international and national, have established that the quality of road signing in Europe -- and elsewhere in the world, too -- is far from satisfactory. According to the International Road Federation which published a brochure on the subject last October, road signing and safety equipment maintenance must be radically improved.

Many signs are set up and abandoned to the elements of time; they soon become ineffective and dangerous. It is urgent to set up well planned maintenance programs in all of Europe and for this the establishment of inventories is a must.

Several countries are beginning to set up systems using one of the three systems of data collection -- manual surveys, photo-logging, and video-logging systems. In the U.K., the research project for using a highly technical video-logging/computer system for the maintenance of all direction indication signing is well under way. It is expected to see the first application by the end of 1984.

The purpose is to save enormous amounts of fuel by eliminating the possibilities of drivers getting lost or choosing energy-wasting itineraries, by providing accurate and consistent road direction indications. It has been estimated that up to eighty percent of drivers conform to the indications they find on these signals and it is expected that once they become confident in the indication system, this will increase even more.

Funding can and must be found from existing sources of income. European tax systems ensure sufficient funds for road construction and maintenance; it is only necessary to reserve a small amount of these funds for the maintenance of all road signing and safety equipment along European roads, country by country. As said by the International Road Foundation:

> "In order to prevent the roads of Europe from becoming hopelessly inadequate, IRF strongly appeals to the responsible authorities that they should urgently establish definitive programs for road maintenance in general with sufficient funding, and in particular for the maintenance of road markings, signing and other safety equipment . . . and to recognize that highways generate far more income than the amount of money reinvested in the network."

In conclusion, the trend in Europe should be, in the coming years and generations, to improve the quality of road signing and to reduce the risks of finding a large number of signs and markings in poor state as is the case today in many places.

VISIBILITY REQUIREMENTS FOR OVERHEAD GUIDE SIGNS

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The work currently in progress is under contract to the Federal Highway Administration (Contract DTFH61-83-C-00141). Its purpose is to determine the driver's visibility requirements for overhead guide signs. To date we have determined the time interval requirements for the driver to detect, recognize, read, and act on an overhead guide sign. We have also identified the other driving behaviors to which the driver must attend, and the amount of time that these behaviors require. From these data we can predict the sight distances that the driver requires for using overhead guide signs.

We have developed a computer program for the IBM PC which uses the available data on headlighting patterns and sign photometrics to present a graphic representation of sign conspicuity and legibility. The overall structure of the program is illustrated in Figure 1. Ultimately the program will compute sign conspicuity and recognition distances. The basic geometrical variables have been implemented in the program thus far, including the graphical output shown in Figure 2 which shows sign location relative to the vehicle heading direction and the vehicle's headlight pattern.

In the future phases of the contract we expect: 1) to determine the luminance and array of various in-service sign materials; 2) to determine the photometric values of current signing materials; 3) to perform a laboratory study to determine the conspicuity requirements of drivers for a range of locations typical of overhead guide signs installed in accordance with MUTCD; 4) to identify situations where night illumination or reflectorization of signs may be needed; 5) using the FHWA HYSIM driving simulator, to determine the threshold values separating where either reflectorization or external illumination is needed; 6) to perform a field validation of the findings of the previous task; 7) to determine cost estimates for various overhead sign treatments; and finally 8) to summarize the findings of the project and provide recommendations for preferred treatments under specific highway situations.