



Maintenance of Road Signs,
Markings and Other Safety Assets:

**A COST EFFECTIVE
MEANS OF OPTIMISING
ROAD SAFETY**

Maintenance of Road Signs, Markings and Other Safety Assets:
A Cost Effective Means of Optimising Road Safety

A Publication by International Road Federation

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This publication has been elaborated by a broad range of road safety specialists from the IRF Permanent Technical Committee on Road Safety (PTCRS) under the chairmanship of Michael Bernhard, Traffic Safety Consultant and Honorary Life Member of the IRF, with the aim of increasing awareness among road authorities of the role of road infrastructure measures in reducing road accidents.

Providing an overview of road safety assets and their maintenance requirements, this brochure demonstrates how simple, often low-cost, measures can prove an efficient means of reducing the humanitarian and financial burden of road accidents and offers advice to authorities on maintenance planning and budgeting for road safety.

The brochure draws on the findings of recent publications and studies from all over the world which confirm the extreme urgency with which government authorities should establish modern and efficient road safety actions to enhance the condition of their roads and safety equipment with the close collaboration and expertise of the business sectors involved.

Through the distribution of this brochure, the IRF hopes to contribute to the improvement of road safety throughout the world.

INTRODUCTION

1.1. The Basic Facts Behind Road Safety

Roads and their condition have a major impact on both the road users' and general public's perceptions. These perceptions are associated with the requirements for comfort, safety and aesthetics of which the most important is unquestionably safety. As a result road safety is or must be the primary objective of any road administration, and this should be demonstrated by appropriate actions. Moreover it is felt that the way in which roads assets, such as pavements, bridges and tunnels, and their furniture - signs, markings and other safety equipment - are planned, designed, constructed and maintained reveals the attitudes of a country's administration and inhabitants to cater for the quantity and quality of human life. To this end, this paper summarises the IRF's views on how the road infrastructure should be managed to provide safe road transport.



The IRF wishes to draw to the attention of all readers that, according to its own findings and those of many fellow organisations and international bodies, such as the Global Road Safety Partnership, the World Health Organisation and other international competent bodies, the number of road crash victims is so high that it is of utmost urgency to take drastic measures to enhance the safety of all road users all around the world.

According to the PIARC Road Safety Manual (2005), the forecast of road deaths in the world by 2020 will be between 1.1 to 1.3 million people. In other words, every day, more than 3500 people die needlessly on the world roads. Translating this into Boeing 747 flights, it means that 5 or 6 planes crash fatally every day. This is clearly unacceptable and appropriate measures are needed to mitigate against it.



The IRF yearly road statistics confirm these figures, year after year. It is with extreme urgency that the IRF Permanent Technical Committee on Road Safety (PTCRS) implores all road authorities, engineers and political decision makers who assume the responsibility of maintaining their respective roads in shape to take the necessary action based on this awful fact.

In 2004, following a UN General Assembly Resolution, the World Health Organisation (WHO) was given the task of coordinating road safety activities among the UN Member States. Since 2003, a large number of experts, including IRF representatives, have participated in special meetings to discuss the question of road crash prevention and pre-hospital trauma care. Essentially, these experts discussed how to save lives by increased road safety once a crash has happened, and how to improve the victim's chances of survival.

A WHO publication on Prehospital Trauma Care Systems published in 2005 contains a table illustrating the leading causes of death among the population by age group. It shows that, from the age of 14 until 45 years, road crashes are the second cause of death; once one reaches 45, they are rated as the eighth cause. This shows that the world population suffers most from road traffic deaths of people in the strength of life when family members earn their wellbeing. Road crashes constitute a national health problem.

Change in rank order of DALYs for the 10 leading causes of the global burden of disease

Source: World report on road traffic injury prevention, World Health Organisation and World Bank, 2004

1990		2020	
Rank	Disease of Injury	Rank	Disease of Injury
1	Lower Respiratory Infections	1	Ischaemic Heart Disease
2	Diarrhoeal Diseases	2	Unipolar Major Depression
3	Perinatal Conditions	3	Road Traffic Injuries
4	Unipolar Major Depression	4	Cerebrovascular Disease
5	Ischaemic Heart Disease	5	Chronic Obstructive Pulmonary Disease
6	Cerebrovascular Disease	6	Lower Respiratory Infections
7	Tuberculosis	7	Tuberculosis
8	Measles	8	War
9	Road Traffic Injuries	9	Diarrhoeal Diseases
10	Congenital Abnormalities	10	HIV

DALY: Disability-Adjusted Life Year. A health-gap measure that combines information on number of years lost from premature death with the loss of health from disability.

In the United States of America, a report published in 2005 by the US Insurance Institute for Highway Safety states that on urban roads, motorists drive some 2 billion miles per year, accounting for about 8000 deaths per year. It also highlights that existing roads carry far more traffic than for what they were designed butow cost traffic management measures may drastically reduce the horrendous accident figures.

1.2. The Role of Road Safety Asset Management

A specialised Group of IRF Experts (PTCRS) was established in 2004 to set up dedicated collaboration between professional experts drawn from the European highway safety industry. Through this publication, the PTCRS seeks to answer the question:

"Is there a cost effective way of optimising road safety through the maintenance of signs, markings and other safety related assets?"



Evidence from all over the world shows that the answer is unequivocally and unquestionably in the affirmative.

As an example, a GRSP focus project campaign, in Hungary may be mentioned. The campaign was set up in 2004 to demonstrate the high efficiency of low cost and simple measures, such as road markings and signals, to eliminate three chosen black spots on the Hungarian road network with high fatal accident rates. Simple measures were implemented with a GRSP inspired partnership between local authorities, the police and the road signing business sector in Hungary. The before-after evaluation study undertaken by the national Road Research Laboratory (KTI) showed a spectacular effect. Indeed, at all of the three sites, accidents were practically eliminated and injuries and deaths were reduced to near zero.

At a more general level it is an established fact for all governmental authorities that the preservation of initial performance requirements for safety assets under their responsibility reduces the number of accidents and the gravity of casualties suffered by victims of road crashes and indeed saves lives. High performing road signs and markings, guard rails and crash barriers, public lighting installations, emergency telephone systems, traffic control equipment, and special types of safety road surfacing all contribute to safer roads.

An accident may be considered as a random multi-factor event involving the road user, the vehicle and the road environment. Educating road users to avoid the inevitable mistakes and errors they make is a costly and often frustrating business. With regard to the vehicle however, in most countries very stringent minimum safety levels are established for newly produced cars. In addition in many countries they ensure maintenance of these safety levels by a periodic inspection/certification system throughout the lifetime of the vehicle.

Even when driver error or impairment is primarily to blame, where the road environment is concerned, the IRF stresses that safety improvements to the road infrastructure are usually the most cost effective means of reducing accidents. In many cases however, no statutory responsibility exists with regard to the level of safety of the actual highway.

Since decades, the IRF has established that all too often these safety aids once installed are neglected, and that this neglect is a contributing factor to road users committing errors. Indeed, without these aids users feel unsafe and unsure of their required driving behaviour. This leads to a higher frequency of road crashes.

It is not by chance that the safest roads are motorways, generally equipped with advanced road safety devices. With the lowest death rate per 100 million vehicle kilometres driven, they provide strong evidence that the well-engineered highway offers the most forgiving road. In France for example, whereas the total highway network death rate is 4.6 deaths per 100 million vehicle kilometres, that for motorways is only 1.

In this publication the IRF will propose an analysis of the various road safety assets and their maintenance requirements. These proposals are directed at improving the current situation and at encouraging the appropriate authorities to accept their responsibilities and to ensure the implementation of systematic maintenance, replacement and further development programmes.

A publication by the United Kingdom Royal Society for the Prevention of Accidents (RoSPA) shows how simple, low cost measures can engender huge returns of the initial investment or expense for such things as improving road signing, markings, and installing efficient safety devices. Some examples taken from the analysis of a series of safety schemes throughout the UK are as follows:

Category of Measures	Number of Schemes	Average Cost in UK£	Reduction in Accidents %	First Year Rate of Return %
Anti-skid surface	34	8620	57	352
Markings	43	2020	34	957
Markings and signs	63	2537	41	820
Refuges	65	10387	37	259
Traffic calming vertical	58	23333	65	198
Warning signs	36	553	46	3491
New traffic signals	15	40717	67	153

Indeed, this extract of the RoSPA findings clearly demonstrates that a well maintained road, fully equipped with validly performing signs, markings and other safety installations is conducive to safe and comfortable driving. It is indicative of the fact that the authorities concerned are efficient and conscientious in performing their task that they are capable in their management of public funds and that they are conscious of their responsibility to road users. Above all it is also indicative that the authorities are capable of managing their assets and funds efficiently.



In order to highlight the problem areas, the group has addressed itself to the following headings:

- Vertical signs
- Road markings
- Lighting installations
- Traffic control devices
- Communication systems
- Safety equipment
- Safety road surfacing

1.3. Duties of Road Authorities - Maintenance Planning & Funding

The IRF believes that any road authority charged with the maintenance of the highway network is under the legal obligation to guarantee that the road will at all times satisfy minimum safety requirements. A systematic and regular maintenance programme is therefore essential in light of the economic, social, political and environmental consequences of road accidents. However, for optimum results, such maintenance programmes must be planned in detail.

The IRF encourages road authorities to take a positive attitude towards the implementation of maintenance programmes because, as this publication illustrates, they provide a low cost method for optimising road safety. A reasonable budget, within the means of a country, region or locality, should easily be allocated if it is planned on an annual basis over a chosen period of time. Although initially maintenance programmes may appear costly, in the long run they prove cost effective. Invariably, as shown by the RoSPA analysis, the return on investment far outweighs the cost and in almost every case even generated benefits, both financial and humanitarian. It is therefore a false economy not to commit oneself to this type of expenditure.

LEGAL CONFORMITY, TECHNICAL SPECIFICATIONS AND STANDARDS

At present, practically all over the world, signs, markings and other essential road safety devices should correspond to modern minimum performance requirements or standards.

For any road safety device described in national law, technical specifications should be linked or included into the law so as to ensure that the devices government authorities wish to use or install are not made of inferior quality materials. Any cheaply made device - an asset - turns out in the long term to be unreasonably expensive. Nor should road safety devices be designed or placed in such a way that they create a hazard to road users. National standards normally correspond to those elaborated by specialised experts collaborating within well recognised international bodies.



In addition, signs and markings, traffic lighting devices and traffic control installations should conform to existing legal rules and technical regulations officially recognised in any given country. These are usually elaborated in conformity with globally recognised and used United Nations Conventions and Agreements. Since 1949, IRF has been consistently represented at the UN competent bodies and has thus been able to contribute fully to the regular updating of all these documents.

What is known as "tort liability" cases have become increasingly frequent in many countries, such that the once traditionally recognised sovereign immunity of a government is rapidly disappearing. Everyone knows that a good lawyer can argue a case with ease when it comes to proving that an authority holds a considerable degree of responsibility in the cause of an accident.

The IRF recommends that all necessary measures are taken in each and every country to ensure that all road safety devices, signing and markings fully comply with national law based on international legal conventions and agreements. They must also perform according to the minimum requirements set out for them in globally recognised standards or norms.

2.1. Legal Documents

Worldwide legal documents in the field of road traffic and signing are based on the International Agreements and Conventions elaborated by the United Nations Economic Commission for Europe (UNECE) in Geneva, by which the IRF is officially recognized as a consultative body.

These documents in their latest form are:

- 1968** International Convention on Road Traffic (Vienna Convention); Amended in 1993 and subsequently in 2005
- 1968** International Convention on Roads Signs and Signals (Vienna Convention); Amended in 1993 and subsequently in 2005
- 1971** European Agreements supplementing the Conventions on Road Traffic and on Road Signs and Signals; amended versions of 1993 and subsequently in 2005.
- 1973** Protocol on Road Markings, additional to the European Agreement supplementing the 1968 Convention on Roads Signs and Signals, updated and integrated into the above documents in 2005.

The latest amended versions enter into force in April 2006. IRF calls upon all contracting parties to bring their respective legal requirements up to date.

2.2. International Recommendations for Harmonised Legal Rules and Regulations

Recommendations for harmonised application of rules that are not contained in or supplement the provisions of the above international legal documents can be found in the United Nations' "Consolidated Resolutions on Road Traffic and on Road Signs and Signals". These recommendations which can be imposed either worldwide or regionally - for instance in all EU Member States - are intended to encourage governments to adopt the identical harmonised measures, rules and regulations for traffic conditions which did not exist or have not been considered at the time of the drafting of the above mentioned international instruments. Many of these take into account research results from studies completed by the Organization for Economic Co-operation and Development (OECD), the World Health Organization (WHO), and non-governmental organizations such as the IRF.

The IRF recommends regular consultation of the above documents in order to adapt national legislation on a consistent basis. They are currently under revision at the UN ECE Group of Experts on Road Traffic Safety.

2.3. Technical Requirements

International specifications for road signs, markings and safety equipment have recently been the object of considerable work by the following international bodies, where groups of technical experts study in depth performance criteria, the design and the materials used in order to issue up to date technical specifications.

- ▶ **International Organization for Standardization (ISO)** based in Geneva, Switzerland, which regularly issues and updates technical Standards for implementation around the world;
- ▶ **Committee of European Standards (CEN)** based in Paris, which prepares European Norms that are integrated into the EU Member State legislation. These EN can of course also be referred to anywhere around the world.
- ▶ **The International Commission on Illumination (CIE)** based in Vienna, Austria, which issues technical publications, reports and recommendations involving the basic scientific requirements of lighting devices, including retro-reflective materials, road markings and active lighting devices (traffic control and street lighting). These CIE publications are elaborated and updated by special committees involving the participation of highly qualified international experts.

Finally, authorities and engineers are required to accomplish their tasks efficiently and effectively. To facilitate this, their own country's laws should adopt the above mentioned international documents and if necessary adapt them to local conditions.



The IRF recommends prioritising the use of the most recent CEN technical standards (EN Norms) anywhere around the world. Authorities must constantly adapt their legislation in order to benefit from the results coming out of this constantly changing and evolving international expertise. Thus they can ensure that all road safety assets correspond to the latest developments in the legal, and above all the technical field.

MODERNISATION OF SAFETY ASSETS

The modernisation and economical updating of all existing road safety equipment requires exclusive and recurrent maintenance programmes and the allocation of the necessary budgets, so that equipment may be maintained satisfactorily and serve the road user.

3.1. Vertical Road Signs

Basically, when driving at high speed, vehicle drivers/riders expect to be able to detect, identify and understand messages provided to them by vertical road signs easily and in sufficient time to react accordingly. Sign shapes, colours and specific symbols have been standardised world-wide in order that drivers using road vehicles anywhere can interpret their messages correctly and safely. The international documents mentioned in Chapter II also provide specific indications for their installation and design.





Moreover, international legislation stipulates that the road signs must be recognizable in shape, colour and size both by day and by night. This means that their aspect must be identical 24 hours a day, 365 days per year. This should result in very similar road signs in almost any country in the world.

Despite these requirements, scientific observations undertaken by several IRF members around the world, show that in reality these requirements are not always met. As a result it is possible to conclude that many road accidents are the direct or indirect result of poorly maintained and therefore inadequate traffic signs.

Several elements can be enumerated. For example, the original design of road signing can be poor from the outset and messages turn out to be incoherent. Some signs are difficult to read while others are not clearly visible. One sees either too many signs or too few of them.

For each of these cases however, a badly designed road sign certainly can neither fulfil its fundamental and/or initial role, nor conform to the regulations on quality or function. Regular checking and systematic maintenance are the only solutions to this lack of safety.

Time and again road signs are installed without any thought being given to their future. After several years, their colours fade, their night performance diminishes, and they may even have been stolen or damaged without any-one noticing. Signs can also be hidden by new constructions or growing vegetation. Eventually the authorities may find themselves at fault, and could be held responsible for any accident that may occur.

Periodic inspection is essential in order to provide a regular and systematic maintenance service. This service allows for improvement of the sign's quality, in particular regarding the changing needs demanded by new or changed traffic conditions, readability requirements and their adaptation to the latest developments of materials used to manufacture them.

From an economic perspective road signs have an important role to play. Their contribution to the safety of drivers and traffic in general cannot be stressed enough.

Their contribution in reducing national expenditure as a result of accidents largely compensates the relatively low investments for their installation and maintenance. Normally, about 10 percent of the normal road maintenance budget should be sufficient to ensure that signs perform effectively.

Maintenance and Budgeting

Sign inspections

It is most important to take into consideration the state of signs both by day and by night. Should a sign be perfectly readable in daylight, it is not at all certain that the same can be said for them in adverse visibility conditions and at night. Only extra hours of inspection show these defaults, mostly at unpopular times such as after work hours and in the worst possible weather!

Budgeting

To make road signing inspections possible, an annual budget is required. Moreover, the budget should be renewable year after year. Practice shows that these budgets need not be high, on condition that one sets up an operational planning system. It is even possible to employ redundant personnel to carry out such inspections.

In the case of newly constructed roads or road improvements, when establishing the cost estimate, it is also necessary to provide from the start reasonable funding for an inventory of all road signs (and other safety equipment) which will be installed. This expenditure represents a very insignificant amount when comparing it to the total cost of the road construction. Experience has proved many times that these funds are often equivalent to what is normally being accepted as overstepping the estimate.

Regarding roads that are already in service, new funds should be established for creating an inventory of all existing road signs, safety devices and signals in place. Although this can demand some months work, such an inventory is simple to set up using modern dedicated computer programmes, which exist almost everywhere today.

Inventories

Road sign inventories allow an authority to:

- have a precise picture of the condition of its assets,
- plan a dedicated updating and/or replacement programme
- elaborate a maintenance budget over several years.



Signing is in fact part of the investment on the road. Road owners have the obligation to know at all times the road safety assets that exist on their roads, where they are to be found, when they were installed and how long they can perform correctly before remedial intervention is needed to maintain the initial function of the assets. Expenditures dedicated to this purpose are all too often postponed if not totally ignored.

Modern technology ensures that once an inventory is established, further rapid "in-office" comparison of existing signs with what should in reality be installed is possible. Several IRF Members have elaborated or introduced such programmes which allow them to evaluate a cost estimate. A list of signs to be modified replaced or ordered may then be easily drawn up on the basis of the comparison of new and old, using the inventory.

Sign performance

Poor quality road signs are costly. Sign performance, except for new signs to be installed, must be assessed by local inspection both by day and just as importantly, at night. This of course is an integral part of an inventory.

In general a daytime inspection can provide significant information as to the condition of the road signs. However in extreme cases, signs that are effective in daylight can be of very poor quality at night. It is therefore essential to start off with both inspections. Once such an inventory is set up, because the information related to the performance requirements of each sign is established in it, further maintenance and replacement operations can be undertaken "in office".

The Benefits of Good Vertical Signs Performance

The IRF has chosen to illustrate the benefits of good vertical road sign performance with one example discussing directional signing. Indeed, the IRF has studied more than 8000 km of Motorways in Europe and their road signs within the scope of the "RightWay" programme, carried out in collaboration with the European Union by a group of IRF members.

In spite of modern GPS guidance, a large number of drivers rely totally on the route guidance provided by direction signs. Indeed, drivers will always use vertical signs to position their vehicle, since these are the only physical guidance devices. Electronic aids can assist a driver, but the real good old road sign gives the final message on how to drive or what to do.

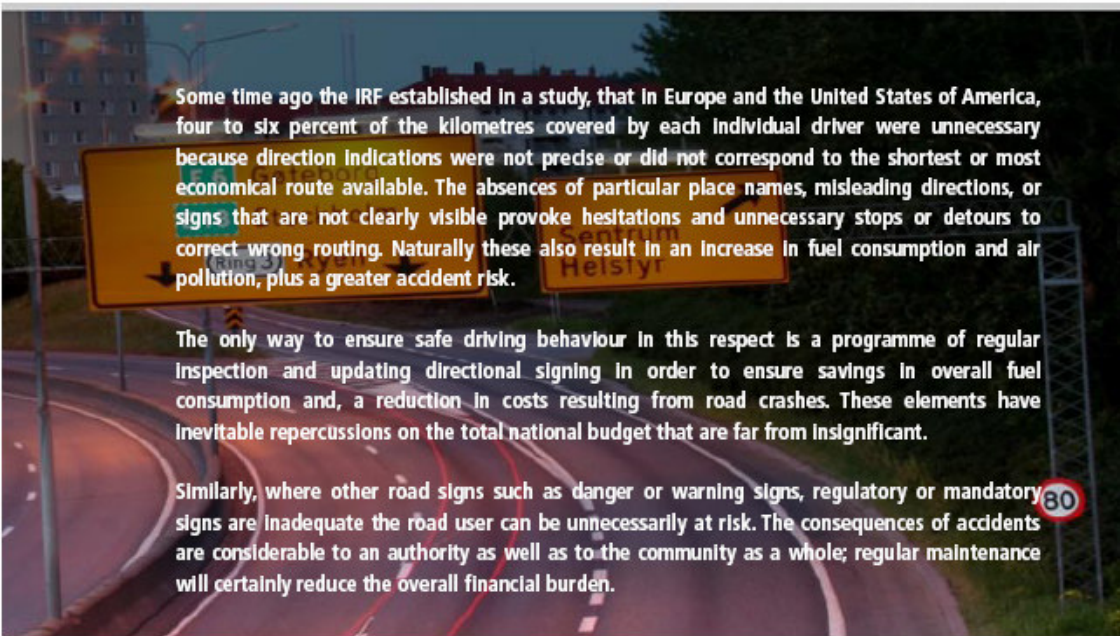
The IRF stresses the urgent need for a global improvement of the quality of vertical road signing. To achieve this goal, it is necessary to establish, on a local but coordinated level, a complete, usable and harmonised system for establishing inventories of vertical signs and to inevitably ensure adequate annual sign maintenance funding.

3.2. Horizontal Road Markings

According to the international legal practices, horizontal markings provide an invaluable tool both to the road user and to the highway engineer. Not only do road markings supplement vertical road signing, they also offer a vast range of possible applications and in so doing play a key role in reducing the accident toll and facilitating traffic flow. It is difficult to visualise a road without its markings.

Horizontal road markings have three main functions:

- To guide and channel the traffic
- To define the "territorial" limits of each road user
- To warn of approaching obstacles, hazards or road traffic measures, eg pedestrian crossings.



Some time ago the IRF established in a study, that in Europe and the United States of America, four to six percent of the kilometres covered by each individual driver were unnecessary because direction indications were not precise or did not correspond to the shortest or most economical route available. The absences of particular place names, misleading directions, or signs that are not clearly visible provoke hesitations and unnecessary stops or detours to correct wrong routing. Naturally these also result in an increase in fuel consumption and air pollution, plus a greater accident risk.

The only way to ensure safe driving behaviour in this respect is a programme of regular inspection and updating directional signing in order to ensure savings in overall fuel consumption and, a reduction in costs resulting from road crashes. These elements have inevitable repercussions on the total national budget that are far from insignificant.

Similarly, where other road signs such as danger or warning signs, regulatory or mandatory signs are inadequate the road user can be unnecessarily at risk. The consequences of accidents are considerable to an authority as well as to the community as a whole; regular maintenance will certainly reduce the overall financial burden.



These functions are fulfilled by the use of three main categories of markings:

- centre and lane lines (broken and continuous)
- edge lines
- special markings such as arrows, stop lines, symbols, etc.

Horizontal road markings also play a regulatory role as for example does a STOP bar or parking restriction marking. Changes in the pattern can be a means to convey authoritative messages to the driver. The double centre line system, for example, serves as a continuous self-contained message with regard to overtaking instructions.

Therefore road markings need to be made of the best quality materials, based on the role they have to play. Road markings must be reflective and be seen at night, and also provide high wet brightness to ensure both day and night contrast visibility with the road surface. In order to fulfil these various functions road markings need to fulfil the minimum requirements given in the internationally recognised standards.

Safety Role of Horizontal Road Markings

	Injury Cost Reduction	Benefit to Cost Ratios
Edgeline application Rural roads marked with a center line:		
Ohio (USA)	19%	NA
East Sussex (UK)	18%	12:1
Hessen (Germany)*	20%	NA
Lorraine (France)	27%	16:1
Improved junction marking & signing:		
TRRL (UK)	49%	10:1
Road Safety Directorate (Denmark)	57%	NA

In its first brochure on the subject, IRF published the following table showing the results of several studies undertaken until 1983. These results prevail still today and can be confirmed by further studies.

In February 2000 the COST Action 331 Final Report on the requirements for horizontal road markings following a five year research programme in 17 countries showed the efficiency of centre and edge lines. This research permitted the establishment of performance criteria, in particular of white and yellow longitudinal and edge lines on two directional carriageways. In addition the research developed a computer programme that establishes the minimal visual distance requirements needed by drivers to drive safely based on the width of the carriageway and the speed of a vehicle. It also provides the minimum requirements of edge lines to provide adequate optical guidance to drivers.

In fact, road markings play an important economic role. Their contribution in reducing national expenditure is twofold. Their cost both in application and renewal is low; normally only 2% of the average road maintenance budget in central or local government is spent on markings. Notwithstanding this insignificant percentage, their effect, as shown by numerous before and after accident studies, illustrates their major contribution to accident reduction. Roads are open to traffic throughout the year. They are used regardless of the climatic conditions: dry, rain, fog, snow, and by day and by night. There are five major criteria which must be met:

1. Wear rate

A sufficient quantity of the marking material must remain on the road at any one time to render the line visible at least for the time span between maintenance operations. Since markings play a vital role in regulating overtaking, lane use, indicating pedestrian crossings, bus stops, parking rules, etc. they must not only always be present on the road surface, but also retain their day and night visibility criteria, under all weather conditions.

2. Daytime conspicuity

The markings must contrast with the surrounding highway surface. Here the choice of colour can be important. Impairment by dirt must be avoided by appropriate cleaning operations.

3. Night-time retro-reflectivity

The line must be visible at night as best possible and also under rain conditions. Modern products provide all these properties today.

4. Skid resistance

Road markings should not present a skidding hazard. This is especially important for two-wheeled vehicle riders and pedestrians.

5. Rapid restoration of the newly marked roadway to traffic after application

Modern products using the latest technologies provide very short application times. The latest generations of road marking tapes do likewise.

The failure of a marking to meet the required standards for any one of the above-mentioned criteria should, in the interests of road safety, lead automatically to new marking operations.

Quality of road markings

In the opinion of the IRF, road markings must always be taken into consideration by road planners in any project, since a well equipped road should have all the possible safety features possible. The practice and principle regarding road markings in most countries only concur in part with the existing International 1973 Protocol on Road marking (Chapter II refers).



In spite of their existence, even within national boundaries local authorities do not always take into consideration new regulations regarding road markings. Indeed the IRF has noted a lack of uniformity and harmonised practices exists in most parts of the world.

The IRF supports the efforts made at ISO and CEN to establish international conformity with regard to colour, skid resistance, retro-reflectivity (or night visibility), wear, widths and patterns of road markings. A Council of Europe research, the COST Action 331, established in 2000 the absolute minimum visibility requirements for line markings needed by drivers to adopt safe driving behaviour and provides an easy electronic means to calculate them depending on the speed and visibility criteria. IRF strongly recommends considering the conclusions of this research study.

Products

Several types of products for the marking of roads exist. Basically, they fall into four categories:

- Paints
- Thermoplastics,
- Cold plastics
- Prefabricated tapes.



Application technologies differ according to the products. The first three require larger machines for their application, time for them to dry or harden, whereas prefabricated tapes and pre-cut symbols can be directly applied to a clean road surface. Another important criterion for choosing any one of the numerous products on the market is also the time needed before reopening the marked section of road to traffic.

Among these products some are highly durable, but others present less wear resistance over time. Each, however, has its use on roads, either as durable or as temporary markings.

Choice of a product

The choice of road marking products depends not only on the fact that these must perform all year round, but also that such items as pedestrian crossings, parking restrictions etc. ensure their role and the safety of all road users 365 days a year.

IRF recommends careful selection of materials according to the most appropriate local needs. These vary depending upon location, climate and traffic flow requirements on one hand and, on the other, the initial intention of a marking.





To allow a correct choice, the required financial resources must be made available as prices of products vary according to their types and use. The true expense of a square metre of marking can be estimated by dividing the total investment by the number of days of effective life required. This method of calculation shows that the lowest initial cost may not constitute necessarily the lowest annual cost. The technical attributes providing the daytime and night time conspicuity of a line differ considerably. Obviously the line must be visible by day with a high contrast against the road surface. However it is generally accepted that one of the more important functions of a marking is to guide the road user during hours of darkness, or under bad weather conditions.

Liquid based products

To provide a liquid-based road marking with a good night-time retro-reflectivity throughout its life, minute spherical glass beads are added. The correct grade of glass beads and methods of their application should be selected for each particular marking material. Care should be taken to ensure that the beads are well spread and applied in adequate quantities. Newer products offer raised surfaces on which different types of beads can be placed for improved wet retro-reflection.

New high performing products have been designed, in particular to ensure wet retro-reflection. Often drivers complain that road markings, when wet, are badly seen. Research has been going on for decades to solve this problem and today a few efficient products have been designed and can be found on the market.

Pre-formed road marking tapes

These tapes and pre-cut symbols also provide cost efficient solutions in spite of their higher initial prices, not only for permanent markings but also for temporary markings. These products can be more precisely designed and offer better distribution of skid resistance materials and more precisely designed retro-reflective properties (glass beads, micro-cube patterns, raised surfaces for wet visibility etc). Their application also demands less time for the closure of a section of road.

Notwithstanding the above comments, it is important that whichever product is chosen, it be of the best available quality in its range. The IRF has clearly established that in the long run, the additional initial expense for a better quality product repays itself through enhanced performance of the markings over time.

Maintenance and budgeting

On motorways and major roads, road markings are used extensively and are normally maintained to a reasonable standard. However, often this is not the case on local roads. Quite wide variations can be discerned both in the use and quality of the markings. The variation in quality is mirrored in the range of specifications, homologation systems and standards in general. Differences exist in the levels demanded of the four main criteria already listed and also in the methods of assessing them. A well-planned maintenance programme will ensure that the markings meet minimum technical and performance requirements.



It is therefore of paramount importance that the necessary funds be reserved for the renewal of road markings within the maintenance budget. The cost estimate for construction, road resurfacing or the introduction of road safety engineering improvements must include allowance for markings. Thereafter, a recurrent budget for regular remarking must also be provided.

An integral part of a road marking budget should be the cost of supplying the necessary safety arrangements for the operators and the road users. This must be fixed by the authorities in advance. A well-planned worksite will contribute to a reduction of fuel consumption.

In addition, the elimination of dangerous tasks such as pre-marking, necessitated by the fact that the original lines are no longer visible, will enhance the safety of those applying road markings as well as that of passing road users. The IRF cannot stress enough that the saving far outweighs the cost of providing the necessary precautions.

Markings provide a cost effective way of managing safety investments of the road network and the economic benefit, due to the reduction of accidents, may be considerable. These economic benefits will vary, depending on the site location, type of markings, the nature of the accidents occurring, and the traffic flow. The monetary saving will therefore tend to be quantified in terms of a range of values, although it should be noted that it is often understated.

The IRF stresses the necessity of considering the results of the COST Action 331 research mentioned above, bringing the quality of horizontal markings to the highest possible levels of performance, and extending their effective performance all year round through better inspection and maintenance programmes. The IRF also recommends that authorities ensure adequate annual funding under their recurrent budget to ensure continuous service to road users.

3.3. Lighting Installations

Road lighting installations as well as illuminated signs and signals are usually to be found in places where the normal vehicle lighting equipment is not felt to be adequate to ensure traffic safety.

Public Lighting

Public lighting provides excellent road safety and security of road users. It is found mainly on urban or sub-urban roads where traffic is mixed and conflicts between the different types of road users are most likely to occur. Also, several administrations have reverted to illuminating major junctions, crossroads or even motorways as a means of increasing night time safety on these roads.

Public lighting along roads requires however a permanent and sometimes necessarily costly budget. Not only must the regular provision of power supply and the necessary cabling along roads be considered, but also the maintenance of the devices, lamps and light sources must be taken into account when choosing whether to install lighting devices.

Road Sign and Safety Device Illumination

Regarding illumination of road signs and safety devices, because of the economic pressure of recent times, several authorities have begun to revert to high performing retro-reflective materials to replace the general use of illuminated traffic signs. Modern technology in the design of retro-reflective materials in recent years fully satisfies the initial requirements intended to through the use of illumination. For example, in Switzerland, a national decision was recently taken by the Federal Authorities to systematically replace illuminated direction and police signing on all its motorways, except for a number of selected signs or safety devices where no other solution could be envisaged for various safety reasons.

Despite the fact that all these installations have high initial costs, their resulting reduction to the night accident toll has been proved advantageous all over the world. However such installations do not function adequately without maintenance.



Maintenance and Budgeting

Maintenance requires careful planning, in order to ensure that all lighting devices are operating at all times. The following maintenance works should be considered:

Replacement of lamps and tubes

A systematic planned yearly lamp replacement programme avoids having to make several expeditions per year to replace individually blown light sources. Material must be chosen to last between these operations for them to be fully effective.

Cleaning and checking of electrical apparatus

This should also become a regular operation and if possible combined with the replacement of the light sources. Personnel should therefore be competent in both operations.

Cleaning and checking of underground cables and their connection points

Same comment as above applies to the maintenance of the electrical devices.

Replacement of ageing components

To avoid costly breakdowns, inspections of the quality and performance of devices should be carried out when executing other regular maintenance work.

Finally, it is easy to organise a permanent break down service to cater for emergencies on call 24 hours, especially in the case of external incidents.

Last but certainly not least, the electrical energy required should be taken into account under the heading "yearly maintenance" and not as a separate entity.

Thus, the recurrent maintenance budget for public lighting installations and for all illuminated signs must be well managed and the appropriate services should be operational twenty-four hours per day. More often than not, the specialized staff and their equipment, vehicles and reserve stock of parts are not included in the administration's budget or programme; in general, the installation and maintenance of lighting equipment on the roads is entrusted to private enterprises under contract and over which authorities have little control. The annual recurrent budget needs to take the many elements into consideration.

The IRF stresses the necessity of calculating the yearly maintenance budget at the same time as that of the design and installation of the lighting devices chosen. Maintenance planning to ensure that devices are operable at all times require adequate annual funding.

3.4. Traffic Control Devices

Traffic control devices, such as traffic lights, lane management signalling, variable message signing, toll road enforcement etc. play an increasingly large role in road traffic management, financing and safety. They are designed to ensure a safe and smooth traffic flow. From an economic perspective they also contribute to the maximisation of the network's use and to the reduction of fuel waste.

The equipment is scientifically sophisticated and complex. It is essential to keep it in a perfect and constant working order. Technology progresses rapidly, and traffic control devices need constant updating in order to guarantee that they fulfil the needs of local traffic conditions. Failures engender loss of road finance, traffic chaos and accidents.

Intelligent Traffic Control (ITS) has developed rapidly in the past decade. ITS is being introduced globally for many uses additional to the original functions of the well known traffic control systems such as traffic lights. Today, different traffic controlling devices and systems cover essentially:

- Traffic flow management
- Lane use and variable speed management,
- Automatic speed control,
- Parking management,
- Momentary event traffic,
- Tunnel safety,
- Toll collection,
- Variable message direction and police signing systems,
- Route planning for public and private transport,
- Road categories, use for selective or dedicated itineraries for different vehicle types
- Road work management and deviation
- Goods and public transport management
- Emergency, fire and police vehicle priority passage
- etc.

Modern and mostly very high-tech installations allow traffic monitoring and management in real time conditions to be carried out "in office" at a distance.





Specialised police authorities also revert to camera surveillance to ensure not only the safety, but also the security of road users, to reduce vehicle theft and for purposes of customs control. More recently, within the scope of a regional European breakdown service, such electronic installations can serve the national automobile club services.

The family of traffic control devices require specific and dedicated investment as well as maintenance budgets. They are electronic devices that are all subject to severe performance requirements, ageing, wear, vibrations and to the normal depreciation of lamps, cables and other material. Vandalism is not to be forgotten, especially in the case of police monitoring installations. A non-exhaustive list of traffic control devices includes the following elements:

- The control device itself, usually electronic or computerized with the required communication systems
- Traffic operated sensors in the ground and their amplifiers
- The traffic lights, automatic speed cameras, toll control devices and their suspension system
- The masts, gantries etc, supporting them
- The underground ducting with electrical and fibre-optic cables, connection boxes, etc,
- Aerial communication systems (antennas)

Maintenance and Budgeting

The IRF is conscious that the necessary budgets for such devices and installations are mostly separate entities to those regularly planned for road signing in general. Also, maintenance programmes for these devices and installations are costly and can be the object of political decisions independent to that of a given authority responsible for their management. However, once installed, their return on investment is effective and cannot be neglected.

Mostly permanent and efficient intervention services must be able to function on a continuous basis and thus must be assisted by highly trained and competent personnel to make sure that no given device breaks down creating a major potential source of danger to traffic or serious bottlenecks in the traffic flow.

Due to the extreme importance of maintaining traffic control devices and installations in perfect working order at all times, the IRF strongly recommends that the responsible administrations take the necessary steps to secure annual maintenance budgets, before deciding on their purchase and installation. This budget must take into account normal repair and maintenance costs, the electrical current and 24 hour emergency interventions for the length of the useful life of the installation. No economies are possible once the installation is completed and/or installed and working.

3.5. Other Safety Equipment

Any devices or safety equipment designed to protect the road user from possible risks of endangering people or vehicles using the road network shall be hereafter designated as "other safety equipment". This includes items like guard rails, safety barriers and bridge railings as well as any device used for visual guidance such as lateral delineators curve and bend indicator panels or bridge or tunnel outline markers.

It is obvious that, if any of these devices is missing or out of order, road users run the risk that these various pieces of equipment were intended to prevent in the first place. The IRF attaches great importance to this fact.

1. Guard Rails

Guard rails and crash barriers do not require yearly maintenance once they have been installed, apart from being prepared to replace those damaged after accidents. The main product "families" of guard rails are:

- Iron /metallic guard rails
- Cement guard rails
- Mobile guard rail systems permitting a change of the number of lanes in one direction on multi-lane roads during peak hour traffic.
- For temporary use, plastic guard rails used to separate traffic flows.
- Specially designed crash cushions to reduce the severity of eventual collisions with heads of guard railing.

Each of these are the object of strict technical performance standards - indeed a guard rail can be required to retain light passenger vehicles, heavy vehicles or both. Also their support systems can constitute dangers for users of more vulnerable vehicles such as



two wheelers. Their designs offer therefore several possibilities and one must make quite sure that no budgetary economies prevail in wrong choice of materials or products.

Also, from the point of view of motorcyclist safety, authorities should under all circumstances consider improving the safety of these vulnerable users when repairing or renewing existing installations. Metal barriers with their supports are an important hazard for riders in the case of an accident; these should be the object of additional protection especially to the exterior of curves. Also reinstalling such barriers further away from the edge of a carriageway should also be considered, thus avoiding seriously dangerous impacts of a fallen rider by offering a larger verge to slow their fallen speed.

All these types of guard railing require continuous maintenance management to keep up to their original performance requirements. Indeed, it is important to immediately repair or replace damaged sections of guard rails that present new hazards to passing traffic, such as twisted or bent metallic sections, broken cement elements, etc.

Guard rails are designed and calculated to retain traffic according to the type of vehicles using the road. In other words, when replacing an element, an identical one is to be used for obvious safety reasons.



Therefore the replacement of damaged sections requires the establishment of a permanent service. Regular periodical inspections are of course required to establish that no unannounced damage remains in place for long periods of time. This must be done by the authority using its regular staff. In order to refurbish damaged sections, it is recommended to have an appropriate stock of replacement elements always ready for use. If this is not possible, then the authority should establish a contract with a specialised firm to ensure this maintenance.



2. Moveable Barrier Technology

The need to have positive (crashworthy) barriers between motorists and highway workers is becoming a national and international objective. Many highway agencies are establishing warrants for conditions that justify the use of positive barriers based on the classification of the motorway, the level of daily traffic and the distance from the traveled way and the work area. These efforts are directed to reducing the large number of serious injuries and fatalities for both motorists and highway workers.

In congested metropolitan areas it is very difficult to construct or repair the motorways due to the need to maximize the lanes that are open to traffic during peak periods conflicting with the need to have positive barrier separation between the open lanes and the work areas. If typical Portable Concrete Barriers (PCBs) are placed to provide the required protection, they are difficult to move and thus minimize either the work space (restricted space results in higher construction costs and extended project times) or lanes available to traffic (increased traffic congestion with many related problems). This sometimes leads agencies to allow the use of channelizing and

delineation devices instead of positive barriers which then leads to unsafe conditions for both the motorists and the highway workers. Moveable concrete barriers provide the low deflection, positive barrier protection that is necessary while also providing the ability to reconfigure the motorway. This is not only true for work areas, but more so when managing pendular traffic flow to maximise the lanes available to traffic during peak hours. They also offer additional work space possibilities for small maintenance operations during the off-peak traffic periods.

3. Bridge Parapets, Railings

Bridge parapets can, in certain cases especially when pedestrians are at risk, replace guard rails or supplement them.

Railings and fences are used to separate certain road users from others for their protection, for instance in the case of pedestrian paths and cyclist routes. Their construction is not intended to retain motorised traffic as do guard rails.

These devices, just like guard railing, should be replaced immediately if damaged. In addition, they may require periodic maintenance and painting. Usually this work is assumed quite easily by the authority, or by specialist contracting firms. In any event, the necessary maintenance costs should be included in a maintenance programme when envisaging their installation.

4. Fencing

Fences are used to keep animals and in certain cases, pedestrians off the carriageway, especially along motorways and at urban crossings. They are often vandalised or damaged, and thus also require immediate replacement. Failure to keep fencing in order can lead to very severe accidents, often with severe consequences to victims. Recent cases of neglected fencing whereby larger animals found their way onto motorways have resulted in fatal consequences for both motorists and stray animals. This is to be undertaken by a central authority or to be entrusted to local or communal authorities.

5. Lateral Delineator Posts

Lateral delineator posts are usually made of plastic or painted wood equipped with plastic retro-reflectors so as to be highly visible both by day and by night. Placed next to the carriageway, they can often be knocked down and are prone to vandalism and damage. It is frequent that the retro-reflectors are removed for use on other vehicles such as on push carts, bicycles and even motor vehicles.

Maintenance of delineator posts requires regular inspections and frequent replacement. Very often "Saturday night vandalism" means weekly inspections are necessary. The cost of this operation varies with the number of delineators and time necessary for these operations. In addition, in certain locations with severe weather conditions and winter periods, regular cleaning of the posts may also be essential. Authorities have invented special washing devices for this purpose.

Maintenance budgets for these devices should therefore be mandatory, providing also for a reserve stock of delineators. In most cases, authorities purchase the required number of such devices on a yearly basis. Flexible delineator posts that will survive a number of vehicle impacts, and resist vandalism, can often be a good long term investment from the authority's point of view as long as they are kept in perfect working condition.

6. Road studs and raised pavement markings.

Another type of delineation is the retro-reflective road stud. These are used in addition to road markings where circumstances demand, both as a centre line and as edge delineation of carriageways and roads



Also, for instance, they are very useful for improving the wet performance of horizontal markings.

Studs or their retro-reflective elements can also be damaged or even removed by traffic, especially snow-ploughs, and regular replacement may be necessary from time to time. Maintenance of studs used in centre line marking is especially important.

As in the case of post delineators, road studs provide very high standards of night visibility especially on wet roads. They are therefore a major safety factor not to be neglected after installation

7. Curve indicator chevron panels

Chevron-type panels delineating curves and locations with other sharp deviations or dangerous obstacles are an important safety device. Properly placed, they ensure visual guidance to traffic. In addition the use of such delineators can substitute costly road works and realignment of bends, either permanently or temporarily. Indeed road work signing and delineation regularly use such safety devices.

Using high performance retro-reflective materials and even modern fluorescent colours no longer require frequent maintenance programmes. However, they are often placed in places where they are easily knocked down in the event of a vehicle leaving the curve. A reserve should always be available to ensure rapid replacement. They also need regular cleaning operations, since they are installed in places where road dirt gets sprayed onto them, especially in bad weather.

8. Bridge and tunnel delineators

The markings of the outline of obstacles next to or above the carriageway are mostly retro-reflective, like most road signs. Therefore they only need limited regular maintenance. However, they must be replaced when damaged and where necessary, cleaned periodically. This calls therefore for establishing a maintenance programme.

Road edge delineators placed in tunnels are particularly prone to become dirty especially when tunnels are short and not often washed down. Their role is very important if not vital, so authorities should not neglect their maintenance and check their condition frequently.

For all the above-mentioned safety equipment, the IRF stresses the necessity of establishing well planned and regular maintenance service. This also involves the provision of spare parts for easy replacement and servicing at short notice. The

IRF therefore recommends ensuring adequate annual funding for their maintenance and the establishment of an adequate inventory of all these assets.

3.6. Communication and Telephone Equipment

Under this heading the IRF considers all means of communication between vehicle users and the authorities along roads. This is most important in the case of break downs and above all accidents, where emergency intervention vehicles are required to reach the place of the call as soon as possible with all necessary intervention equipment.

In spite of the development of many GPS orientating devices and mobile telephones, as a rule a communication system using emergency telephone installations placed along a motorway network is still the best solution to know precisely where an emergency call is coming from. Some authorities have considered dismantling fixed emergency phones along their roads, stating that today almost everyone has a mobile phone.

The IRF and Red Cross evidence shows that in practice these fixed devices remain a real necessity. When callers use a mobile (cell) phone they are almost always unable to situate themselves precisely in relation to the road.

This is not the case when an emergency phone is picked up since it automatically indicates to the receiving end once activated, exactly where it is situated. Experience by police and emergency services confirms that precious time and even lives can be lost in the case of delays from wrong indications of the location of an accident requiring emergency interventions.

GPS location of vehicles is now possible, however until all vehicles are fitted with such devices, many emergency calls will continue to be requested using the traditional call post systems.

Therefore, the IRF strongly recommends for safety and even vital reasons to revert to fixed emergency phones.

Maintenance and Budgeting

Maintenance requirements are continuous since such a system has to serve road users twenty-four hours a day, all year round, it must function perfectly day and night.

Placed every two or three kilometres on each carriageway of a motorway, emergency telephones are connected to a central exchange that ensures permanent surveillance. The repair and maintenance service is automatically informed if any apparatus is out of order and a technician should be in a position to intervene at any time. Because of their technical specificities, the regular maintenance service must be composed of professional staff and have a supply of the necessary specialised material, which is not normally part of highway maintenance stocks. This should be taken into consideration when the installation of such equipment on motorways is being considered. Naturally, the costs are high and must be taken into account beforehand.

In tunnels, to ensure rapid and safe emergency interventions, high-tech communication systems are usually coupled to ITS safety devices. Fire extinguishers and emergency lighting are activated automatically when an alert is initiated in the tunnel. Regular and periodic testing ensures that

the whole system works and should be part of emergency drill exercises. This is a considerable additional cost factor that must not be neglected when planning tunnel safety installations.

The IRF stresses the necessity of ensuring that such safety installations, bearing in mind their benefits, not only to the users, but also to the national authorities and breakdown services, receive well planned maintenance funding at the time of the decision to install them.

3.7. Safety Anti-skid Road Surfacing

One of the more costly items in a maintenance budget can be the application of safety road surfacing. This involves special road works and traffic impairment during its application. However, the safety effects are considerable and in many cases replace renewal of road surfacing.

Particularly in cities the cause of many accidents is loss of vehicle control through skidding resulting in drivers not being able to stop quickly enough, especially in wet weather. This is due to the polishing of the natural road surface, which in return, leads to dangerously low skid-resistance levels. In particular in most countries, urban crossroads and junctions account for approximately 50 % of all accidents involving death or injury making them an especially appropriate site for this treatment. Treating priority areas with a special anti-skid surfacing will contribute significantly to improved road safety. Intersections, pedestrian crossing approaches, roundabouts, sharp curves, bridges, ramps, tunnels, roads junctions, are all skidding danger zones.

Application of the system does not involve a total resurfacing of the road. It is a formulation of polish-resistant aggregate, with a high coefficient of skid resistance, held in a tough, flexible bitumen extended epoxy compound. The end product is a deep-textured, tyre-gripping surface with enhanced skid resistance values which may be maintained for up to 10 years.

Economic considerations show that if a new treatment lasts two years and one accident per year can be prevented, the cost of installation is fully justified. In fact, there is evidence that many sites materially affect a reduction of accidents during at least 7 years, providing a 10:1 benefit to cost ratio.

A more expensive approach to reducing accidents due to poor skid resistance is that of an anti-skid overlay. Such a layer may also increase the strength of the entire pavement but its use should be justified at least in economic terms. Today appropriate models exist which facilitate the calculation of costs and benefits of alternative road safety measures such as those considered above.

The IRF stresses the necessity of recognising the possible advantages with regard to accident reductions offered by safety road surfacing. To enable the use of such road surfacing, authorities should ensure adequate annual funding for their maintenance and/or application.

REVENUES FOR THE MAINTENANCE OF TRAFFIC SIGNING AND SAFETY EQUIPMENT

4.1. National Budgets

State budget deficits in many countries, caused mainly by periodically recurrent economic crisis, have together with a change of priority in society itself, caused tremendous pressures on road budgets. Until just a few years ago traffic safety was not a priority in the minds of most authorities, including politicians. Only recently has road safety been assimilated as a growing national health concerns.

Generally funds reserved for road construction and maintenance derive from fuel taxes, customs duty on vehicles and their equipment and road taxes. The amounts available to the national authorities are in principle sufficient to ensure perfect road maintenance. These funds should allow them to provide sufficiently for the maintenance of the above road safety assets, namely signing, marking and safety equipment especially as the number of vehicles on the road is constantly increasing worldwide. Unfortunately increases in maintenance budgets are no longer evident.

Transport financing no longer carries the same commitment as in the past as far as dedicated road budgets are concerned. Taxing systems, including the allocation of revenues from road tolls, are increasingly used to cover overall national budgetary needs. More recently still, an increasing source of revenues from traffic offences is being dedicated arbitrarily to cover other national deficits than those used to improve road safety.

Road budgets being relatively large, the tendency to cut, reduce or defer maintenance and/or road works is strong. It is believed by many that the lack of proper information in the hands of the decision makers is a major factor in the reduction of road budgets such as those seen today.

4.2. Cost to Society

In the overall cost to society, motor vehicle crash fatalities and injuries are second only to cancer and AIDS. The IRF urges that the problem be addressed on a planned and continuous basis. WHO predicts that one of the two main causes of deaths in a country will soon be coming from the lack of safety on roads.

This is also becoming a very serious economic concern. Statistics in developing and emerging countries around the world show that the majority of all road crash victims are mainly the salary earning members of families, and in particular, the population of younger and active people.



As mentioned earlier, in April 2004, at the United Nations - where IRF is represented in the different Groups of Experts dealing with road safety matters on a global scale - the World Health Organisation was given the task of coordinating global road safety activities in the UN Regional Economic Commissions. WHO and the UN Economic Commission for Europe are both based in Geneva where the global office of IRF is also located. According to the WHO World Report on Road safety (2004), the trend of the number, severity and morbidity of road accidents around the world is still increasing.

The IRF joins the urgent appeal to authorities, by experts in global road safety matters, inviting them to dedicate funding to invert this trend. Among the items named in the report is road infrastructure. The need to improve their safety features is a high priority. Naturally dedicated budgets are to be reconsidered and adequately adjusted to the future requirements of modern traffic.

4.3. Adequate Road Safety Auditing and Budgeting

Efficient management and a solid information system are required to prepare well documented and cost beneficial programmes. The IRF regrets to say that road administrations no longer have another choice. To be faced with a road system that is in bad shape is incredibly expensive; many times more expensive than the total cost of regular maintenance. This is without taking account of the economic effect of an increase in wasted energy, if maintenance is not carried out.

The eradication of a hazard through low cost measures can avoid the certainty of seeing an accident happen at any given place identified as unsafe by a safety inspection or audit. In addition, it has recently been established that road safety audits allow authorities to substantially increase safety on their roads. Such audits tend towards improving road design, allowing for better road signing and enhancing vulnerable road user safety. Preventive treatment is essential to the reduction of the overall costs of unsafe roads. Prevention is better than cure!

The key to adequate road safety asset budgets is to establish programmes with a high return on investment, i.e. a high cost benefit ratio. This is feasible and easily possible, especially when the returns to society on capital invested in maintenance programmes are attractive. Well documented programmes which reduce accidents will always justify political decisions to grant the necessary funds.

Where countries benefit from outside financial assistance the amounts they plan to spend on the maintenance of roads and their installations should be included in their initial budget.

Already in December 1981, the World Bank issued a publication which mentions the road maintenance problem in connection with international aid. It pointed out that this aid encounters so many obstacles that any plan for road maintenance is either delayed or made impossible.

Since then the increasing experience of the World Bank showed that it is very difficult to co-ordinate all the elements concerned. Public opinion, problems of staff training and the techniques used for establishing a programme require detailed information for the policy-making individuals responsible for taking the initial decisions. The development of a project through the different administrative channels is often more difficult than building the road itself!

In 1999, the World Bank opened in one of its global programmes grounds for establishing a Global Road Safety Partnership (GRSP) with its headquarters also based in Geneva, Switzerland at the International Federation of Red Cross and Red Crescent Societies. This programme is innovative in the sense that the business sector is also invited to participate in national road safety activities in developing and emerging countries around the world. Thus a trilogy of administration, non-government organisations (NGOs) and the business sector has now become a fact in many instances.

From its early stages, the IRF has participated in the work of GRSP which has now been recognised as a reference in road safety expertise. Programmes have been carried out in many countries which illustrate the benefits of low cost measures to permanently reduce both the number and the severity of road accidents. Simple, low cost measures using or improving road traffic signing and safety equipment are recommended. IRF supports this and recommends similar practice.

Therefore, when establishing the financial programmes of the future, it is essential that the maintenance of road signs, markings and safety equipment be considered as low cost road safety measures.



Nevertheless, the IRF regrets to note that these items continue to remain the "poor relations" of any road maintenance operation.

It is time that all levels of decision making authorities be made aware of the fact that maintenance costs of these vital items require an annual budget renewable during the lifetime of the road.

4.4. Attitude of Government Authorities

Continuing efforts should be made at all levels of the government authorities to keep the outstanding communication system provided by the road network up to date, and in perfect operating order.

Already in 1982, the Road Information Programme (TRIP) (a non-profit organisation, sponsored by insurance companies, vehicle manufacturers, highway contractors and energy companies), in Washington DC, USA, published evidence that in the USA some 16.4 billion gallons (61.4 billion litres) of gasoline are wasted annually due to driving over substandard roads.

This situation prevails today in many countries and must be put right. Road maintenance involves several administrations and numerous authorities, in particular when road marking, signing and other safety installations are concerned. It is therefore, the responsibility of the head of the governmental road authorities, the state county and municipal administration to take the necessary political and financial decisions to correct the present situation. The continuity of all maintenance programmes on a nationwide scale should be automatic.

The management tools i.e., the inventory and the data needed for proper assessment of the maintenance needs must be kept in such a way that it is available to any administration. However, the IRF recommends that only one of them should assume the responsibility for its operation. There must be no conflict between ministries, departments or administrations, as competition of any such kind would result in confusion and duplication of effort. Existing signs, markings and other safety equipment would rapidly become inoperative due to a lack of systematic and regular maintenance. They would then no longer conform to the minimum criteria required for road safety and fuel economy, which would lead to the necessity of replacing them all at great cost.

The IRF stresses that all nations are obliged to take into consideration this concern. It is essential to avoid waste of fuel and money through a chronic lack of maintenance of road safety devices.

CONCLUSIONS AND RECOMMENDATIONS

In order to convince those responsible of the need to allocate the necessary funds for the maintenance of signs, markings and safety installations, the following considerations may be advanced.

5.1. Creation of Supplementary Local Revenues

Poorly maintained roads cost a great deal to the community. After a certain period during which roads gradually depreciate, complete reconstruction becomes the only solution to refurbish them. The cost of which will also have increased over the years. This also concerns road signs, markings, and other safety equipment, which depreciate over a period of time varying from ten to fifteen years.

The economies realised from their regular maintenance soon become evident. The sum thus saved could serve other purposes also of importance to the community.

5.2. Safety Audits

A reduction in the number of road accidents and less risk for the authorities of possible litigation is possible, in particular when reverting to safety audits.

As the absolute number of accidents increases due to gradual deterioration of road safety conditions, the overall cost to the community will do likewise. Moreover, requests for compensation sent to the responsible authorities increase in number, thus creating growing discontent which cannot be ignored. Authorities can be recognised as being partially or wholly responsible for negligence following a road accident. The risk of having to pay liabilities amounting to large sums rapidly becomes a burden that is too high for the local authorities to deal with. Only regular maintenance of safety installations which would allow timely replacement can save the authorities from such requests for compensation and the accompanying problems.

Safety audits are the best practice one can imagine reducing these risks.

5.3. Equipment and Staff

A carefully designed and well managed inventory provides the possibility to improve productivity in the domain of project planning and road maintenance in general. A good inventory provides an administration with full knowledge of the existence of all safety devices and signalling on the road. It reduces the need for expensive and time consuming independent interventions. An example of the additional benefits is that action can be taken for diversions of traffic without having to leave one's office to decide what signals to put up during the road works.

An inventory is also an aid to organise a service of maintenance vehicles, to make a better use of equipment available, and a more rational and efficient organisation of the staff by reducing unnecessary travel, wear on equipment, and energy consumption.

5.4. Development of Appropriate Management Systems

Good road management facilitates the reduction of costs and the increase of benefits accruing from the reduction of road accidents. It is necessary however that these costs and benefits may be accurately calculated and expressed both in monetary and non-monetary terms by means of appropriate management systems. The former can justify why the road sector needs investments on road assets that lead to the reduction of accidents. The latter can demonstrate how good management practices can provide roads that are friendly both to their users, the society as a whole and the environment.

A desperate and urgent need exists for leadership in the field of road management. The advancing age of a country's road network and shifts in the traditional methods of funding its upkeep, will combine to endanger what is generally a first class transport system, essential to a country's economy.



IRF Recommendations

In order to prevent the world's roads from becoming hopelessly inadequate, the IRF strongly appeals to the responsible authorities all over the world that by establishing definitive programmes for road maintenance in general, they should urgently

- 01 Recognise that highways generate income far in excess of the amount of maintenance money reinvested in the network.
- 02 Set up procedures within the road administrations to ensure that safety is understood as one of the most important aspects of road transport and consequently that the road administrations can responsively meet the needs of the society for safer roads.
- 03 Provide the funds for road safety audits and/or detailed before and after accident studies to assist in the establishment of the definitive programmes referred to.
- 04 Ensure sufficient funding and management of road marking, signing and other safety equipment and encourage expenditure in this field. The expenditure will be repaid through the reduction in the number and gravity of accidents as well as through better traffic flow.
- 05 Set up an efficient highway safety related road asset inventory system using modern techniques of data and other information collection, storage, retrieval and analysis.
- 06 Ensure that traffic engineers and local authorities have access to these facilities in order to improve, complete and replace sub-standard installations.
- 07 Encourage local authorities to develop, upgrade and improve all road marking, signs and safety equipment on a regular basis, and to elevate these to a consistent standard throughout the international network.
- 08 Communicate with politicians, road users and the entire society to establish the base to answer efficiently the need for safer roads



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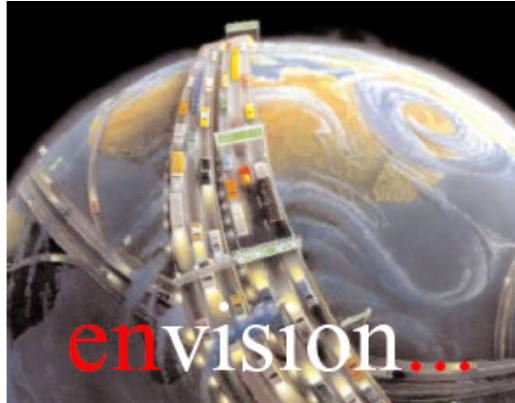
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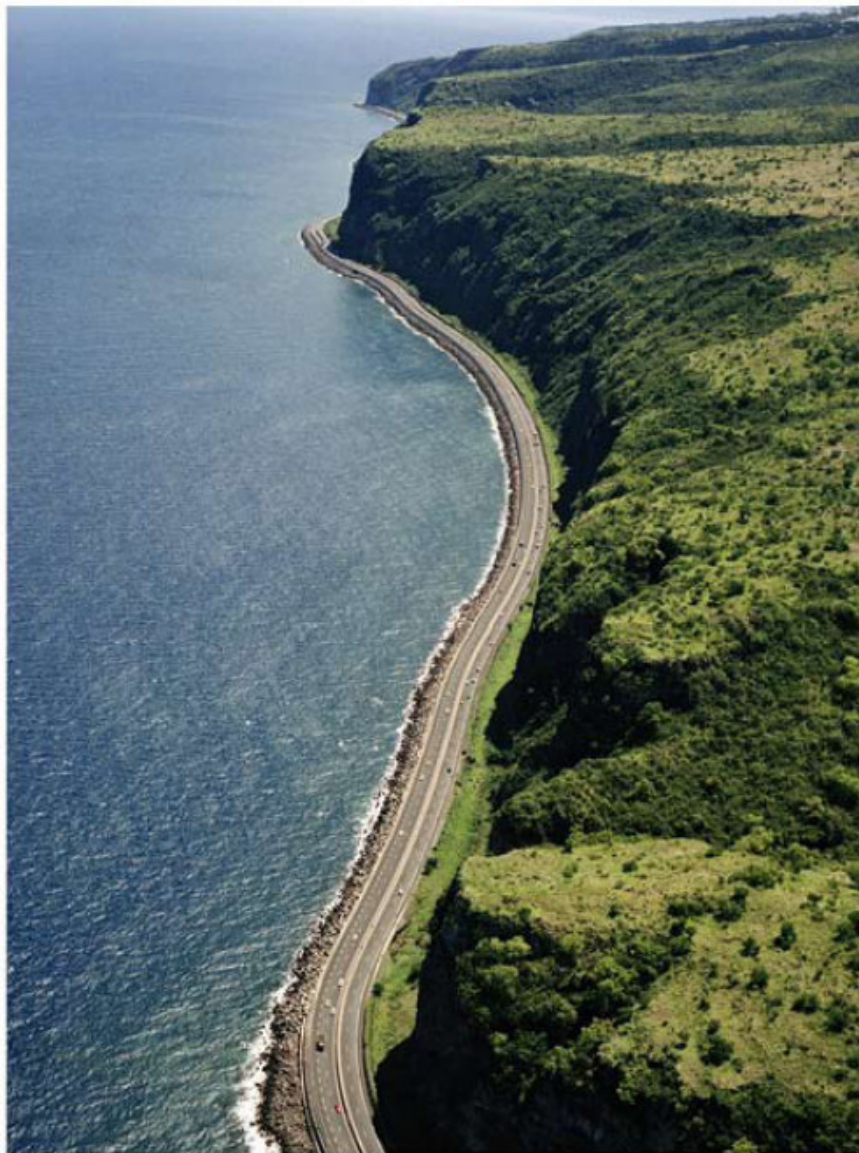
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