

Road Network Management

Roads - A new Approach for Road Network Management and Conservation

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GERMAN TECHNICAL COOPERATION
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It contains minor changes and some amendments, especially in section 7, where proposed alternatives for solutions are presented. Although the book was originally written within the context of prevailing conditions in Latin America and the Caribbean, the authors believe that both the analysis of the present situation and the alternatives proposed for solving road sector problems are equally valid for many other countries around the world.

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Introduction

The extensive road networks of Latin America and the Caribbean show alarming signs of neglect and abuse. Gigantic investments, meant to be long term, are being destroyed after relatively few years of use, due to the absence of adequate conservation.

It is estimated that poor road network management in Latin American and Caribbean countries results in an unnecessary increase in vehicle operating costs equivalent to between 0.5 and 1.5% of the gross national product of each country. Moreover, the resulting annual loss in road asset value in the region is estimated at some US\$ 3.000 million.

There is abundant evidence documenting that the prevailing system of organizing and financing road conservation is inadequate. Moreover, under the present system, it is unlikely that improvements can be made which will be both substantial and sustainable over the long term. For these reasons, the time has arrived to introduce profound changes in the management of existing road networks.

This book provides a guideline for reform and is designed for those who will be responsible for introducing the necessary changes. It also indicates the basic components required for these changes to be successful. Some of these key components are the transfer of road management from a "government ministry environment" to a "company environment", the self financing of road conservation, its separation from short term policies, and the increased participation of road users. The book also introduces the new and revolutionary concept of negotiable road management contracts, opening up the huge area of existing road infrastructure to institutional investors.

PREFACE

The extensive road networks built in Latin America and the Caribbean over the past decades were supposed to provide a solid basis for the economic and social development of the region. Today, at the beginning of the 1990s, these networks show alarming signs of neglect and abuse, and in a few more years they will most likely be in such a deplorable state as to have serious repercussions on the economies of the region. Gigantic investments, meant to be long-term, will have reached the end of their useful lives after relatively few years of use, due to the absence of adequate conservation.

It is estimated that poor road network management in Latin American and Caribbean countries results in an unnecessary increase in average vehicle operation costs equivalent to US\$ 300 per year and vehicle. The sum of avoidable vehicle operation costs reaches a value which varies between 0.5 and 1.5% of the gross national product of each country. Moreover, the resulting annual loss in road asset value in the region is estimated at some US\$ 3.000 million. The economic sacrifice made by previous generations is wasting away. Even worse, since parts of the road networks were financed by long-term foreign loans, the economic sacrifice of future generations is also being lost. They will not have the opportunity to enjoy the benefits of past loan commitments, but will, nevertheless, be responsible for paying them back.

In Latin America and the Caribbean, there is abundant evidence documenting that the prevailing system of organizing and financing road conservation is inadequate. Moreover, under the present system, it is unlikely that improvements can be made which will be both substantial and sustainable over the long term.

For these reasons, the time has arrived to change the approach to the management of existing road networks, more especially to the organization and financing of their conservation. This book provides a guideline for future reform and is designed for those who will be responsible for introducing the necessary changes. It also indicates the basic components required for the changes to be successful. Some of these key components are the transfer of road management from a "government ministry environment" to a "company environment", the self-financing of road conservation, its separation from short-term policies, and the increased participation of road users.

WHY ROAD CONSERVATION AND NOT MAINTENANCE?

con_ser_va_tion \ n [ME, fr. MF, fr. L conservation-, conservatio, fr. conservatus, pp. of conservare]: a careful preservation and protection of something; esp : planned management of a natural resource to prevent exploitation, destruction, or neglect.

Webster's Seventh New Collegiate Dictionary

Note to the Reader:

During the authors' extensive travel while preparing this book, it became clear that there is considerable confusion about the meaning of the term road *maintenance*. Even when asking several road experts gathered around a table, endless arguing is inevitable. In order to avoid any misinterpretation in the context of this book, it was decided to use the term *conservation*, because its official definition comes very close to what this book wants to promote. Although the word *conservation* is frequently used in relation to natural resources (see the extract from Webster's Dictionary above), the authors believe that it is perfectly applicable to roads as well.

Note:

In this book, the term "billion" is used to represent the amount 1.000 million.

SUMMARY

It is widely recognized that, due to the lack of timely conservation measures, the condition of an extensive part of the road network in Latin America and the Caribbean leaves a great deal to be desired. The state of most roads is regular to bad, with a tendency toward accelerating deterioration. Only a small proportion of the network is in good condition, but it is by no means certain that it will remain good. A number of countries are making efforts to overcome this unfavorable situation. Some of these efforts have been partially successful, although there is room for doubt that these are definitive achievements which can survive for long.

The life of roads seems to be subject to an inexorable cycle of construction, inadequate or nonexistent conservation, deterioration, collapse and reconstruction. The basic cause of this pernicious and extremely expensive cycle is the lack of road conservation. The difficult lessons learned from the collapse of road networks, which were thought to be an integral element of daily life in each country, seems to have led to reflection and the determination to look for improvements.

Preserving the legacy left by previous generations, or even the product of our own efforts, is an attitude appearing timidly in the region, although it is not yet firmly established. The tendency to automatically replace the old with something new still seems to prevail. The consequence of this attitude has been great enthusiasm for building new roads and little interest in conserving ones that already exist.

The present situation has two main causes:

- The absence of a system ensuring adequate financing for road conservation, and
- The ineffectiveness and inefficiency of the agencies responsible for roads.

Today the situation has reached crisis levels. The loss in road asset value resulting from the deterioration of existing road networks is far greater than the amount spent on building new roads or improving existing ones. It is absolutely essential to react quickly to reverse this alarming situation, by simultaneously attacking the two basic causes mentioned.

To do this, it is necessary to seriously question two firmly rooted convictions which are implicit in the traditional methods of managing roads. These convictions are:

- Roads are public goods which must necessarily be provided free of charge by the State, because the mobility they provide is deemed a right of all citizens.
- The best way to provide roads is through the public administration.

Traditionally, the State has been the great provider of roads, constructing the road network and putting it at the disposition of all citizens. The use of roads has been largely free of charge. Here roads differ from the other components of the transport infrastructure, such as ports and railways, where it has always been necessary to pay explicitly every time they are used. An exception is found in countries which introduced a "road fund", made up of earmarked taxes collected specifically for financing roads. Toll roads are the second exception to the rule.

The special treatment given to roads, as compared with other transport infrastructure, could have been the result of an inability to develop a fair and efficient charging mechanism for this service. The proposals put forward in this book are meant to provide food for thought about this aspect and a concrete solution to put an end to today's unsustainable situation. In fact, financing road conservation out of general taxes, as is now done, is tantamount to considering roads to be an area which needs to be subsidized by the State. History shows categorically that the governments of Latin America and the Caribbean will never allocate sufficient funds for road conservation, because other needs will always seem more urgent. Although it may be the State's responsibility to provide access to the entire national territory for reasons of sovereignty, there is no need at all for these access roads to be paved and of a high geometrical standards. It is the road users who should pay for the enjoyment of better roads, although, where necessary, some poorer groups in society may be subsidized directly.

Charging user rates for road infrastructure is convenient, because it makes road user costs explicit for vehicle operators. It will also put the road transport system on an equal footing with other modes of transport. Road user rates will bring transparency to the transport sector, and transparency is a necessary condition for an optimal allocation of funds in any economy.

The method of payment proposed here is including user rates in the price of fuel. The amount of fuel consumed by a vehicle is an acceptable measure of the amount of “road service” it uses. This method of charging is inexpensive (costs are less than one percent of the amount collected) and ensures a satisfactory relationship to the use made of roads. The road user rate must not be confused with a tax; it should be independent of any taxes on fuels which may exist and be used for purposes not related to roads. The road user rates collected could make up a Road Conservation Fund whose purpose would be to finance road conservation. Thus, guaranteed and stable financing would be assured for this purpose, independent of short-term political interests.

The question whether the public administration environment is adequate for the effective and efficient production of goods and services has been debated for some time. Once again, experience indicates the contrary. Aspects such as low salaries, the lack of incentives for good performance, the virtual absence of sanctions for errors and bad performance, and the predominance of interminable and exhausting bureaucratic procedures usually inhibits the public administration from being agile and effective in tasks involving management and production. The pillar of public-servant behavior is personal and professional ethics. This virtue can be useful for establishing norms, supervising their observance and defending the public interest, but it is not sufficient in a production environment.

A large part of the activities of a road agency are productive by nature. Physical construction and conservation must be carried out and projects and studies developed, either internally or by third parties. There is no difference between these activities and those of an industry producing goods and services, be it public or private.

The second basic proposal of this book is thus to relocate road management and the related production tasks in an environment where they can be effectively and efficiently carried out. In other words, all management and physical administration of the road network should be carried out by Road Network Management Companies. Only these can combine the autonomy and flexibility required for road management with agility in decision-making, contracting, rewarding and sanctioning, etc. However, the responsibility for safeguarding the public interest in roads would remain in the environment where it belongs: in a relatively small specialized agency within the public administration, acting in representation of the State, and staffed with well-paid professionals. The resulting overall system would be a public-private partnership, and should not be confused with outright privatization.

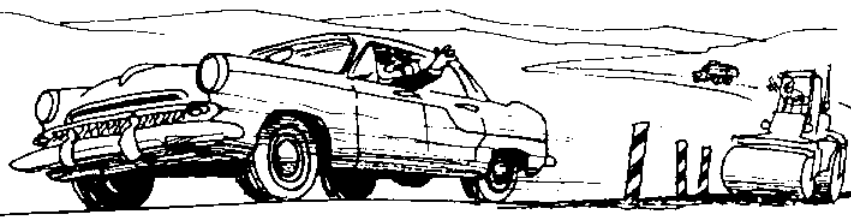
The reorganization of the road sector is, at the same time, a great opportunity for institutional investors such as pension funds and life insurance funds. Through public tender, they will be able to buy into the negotiable road management contracts proposed in this book, thus investing in a safe, long-term business.

Finally, today’s bad road management has a very negative effect on the environment. Although it is true that the various types of environmental damage caused by the original construction of a road cannot be avoided, it is possible to avoid the additional damage caused by the reconstruction and rehabilitation of the same road, made necessary as the consequence of today’s management and maintenance deficiencies.

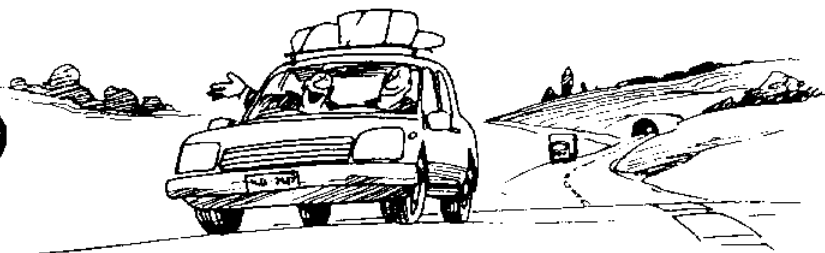
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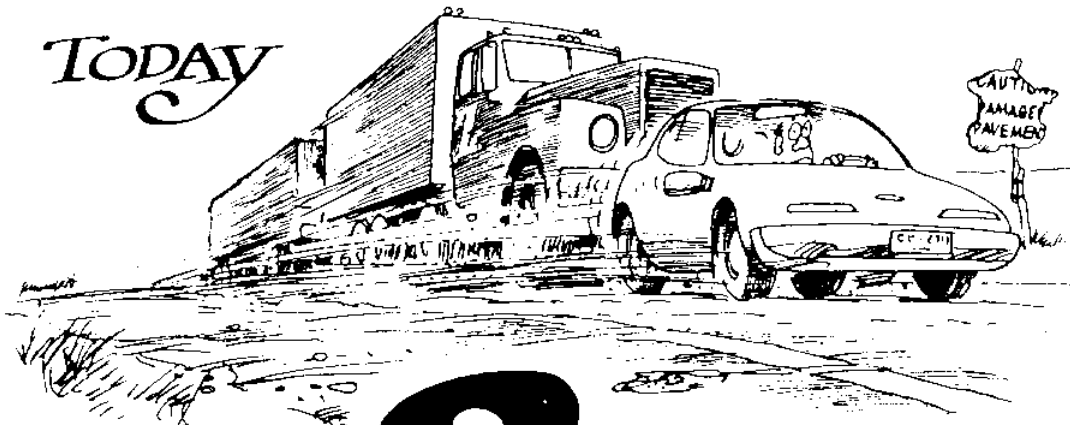
1960



1980



TODAY



2000

?

WHAT IS HAPPENING TO OUR ROAD NETWORK?



THE PAST

From the 1950s, and steadily more rapidly until the 1970s, the governments of the countries of Latin America and the Caribbean invested a significant portion of public funds in the construction of extensive road networks and other transport infrastructure. The funds came largely from tax revenues, but also from domestic and foreign loans. The purpose of this gigantic effort was to lay a solid base for economic and social development. At that time, no one was greatly concerned about the resources that would later be required for the conservation of the new infrastructure.

As a result of this investment, the Latin American and Caribbean road network is today approximately 2.2 million kilometers long, not counting urban roads. The total replacement value is estimated to be about US\$ 200 billion, based on an average cost of US\$ 90,000 per kilometer. Investment in urban roads and streets has been of an equally enormous magnitude.

Inter-city and rural road infrastructure is the biggest single investment existing in each country, controlled by a single unit, in this case by the State. This is true of almost every country in the world, not only in Latin America and the Caribbean. The investment made in roads surpasses the value of the entire infrastructure in the area of electricity, which includes dams, generating plants and distribution networks. More than 80% of passenger transport and more than 60% of freight movement in the region is by road.

The great expansion of the inter-city road network started slowing down considerably in the 1980s, after several decades of intense investment and construction. In many countries, the general extent of the road system is considered to be sufficient for today's needs and, in some countries, even more than adequate. At present, road construction is mostly limited to improving the quality or adding capacity to existing roads. Only in few cases is the physical coverage of the network being expanded, opening roads where there were none before.

Now that big inter-city road networks and other transport infrastructure seem almost complete, the thrust of public fund allocation has turned in another direction. The governments of the region are confronting a series of urgent problems which are affecting all countries to some degree. The allocation of public funds is largely directed to solve problems related to the disproportionate population growth. Countries are forced to make urgent decisions about the quality and quantity of public services such as health, education, justice, the battle against extreme poverty and delinquency, environmental protection, the creation of employment opportunities, sanitation in the big cities, etc. The construction of new roads on a grand scale is not considered one of the great and urgent priorities for public spending today.

The task in the past was to build a network of highways and roads; today's challenge is to preserve this network and to adapt it to the users' needs. This may go against human nature since people often find it easier to build something new than to keep what they have in good operating condition.

The demands placed on the road agencies have also changed. Public Works Ministries, through their specialized departments (frequently called Road Department) have been and continue to be responsible for the network of inter-city and rural roads. For several decades their activity and main responsibility has been to "produce" roads using funds allocated by the national budget. Their success was measured in engineering terms, that is, the most important criteria was to establish how many kilometers of road had been built and to what design standard. On the other hand, the task of maintaining the roads already built has been given a secondary role and little prestige.

What has been successfully achieved in the electric energy sector of many countries but has failed in roads, is the optimization of the use of past investment. Roads and electricity have a similar history in many countries: at some point over the last sixty years, they have both been directly managed by the State, either by a Ministry of Energy or by a Ministry of Public Works. Because of the inability of the private sector, or for other reasons, the government had assumed direct responsibility and made the necessary investments.

Over time, the form of organization in the electricity sector has been adapted to meet the need for reliable, stable, cost-effective and economical energy service. In many countries today, the utility companies providing electricity services are reasonably well managed and the service to the consumer has gradually improved, especially if they are owned by the private sector.

In contrast, an important part of the road infrastructure has begun to show obvious signs of deterioration, often premature and accelerated. After few years of use, roads are often in such bad condition that they cannot be maintained, but must be completely rebuilt at a high cost. Ministries of Public Works have vast experience in the design and execution of new road construction, but are not prepared for the task of adequately maintaining the existing road infrastructure in order to meet the needs of users and the economy in general. Nevertheless, it would be a mistake to blame this failure on the professionals or workers employed in this area.

In Latin American and Caribbean countries the serious deficiencies in inter-city and rural road conservation is causing a reduction in the net value of the road system of between US\$ 2 billion and US\$ 3 billion per year. This estimate is the result of a study carried out by the World Bank, also revealing that net annual losses in road asset value show a clear tendency to increase. Today it is already evident that deteriorated roads are a serious impediment for economic and social development and that soon it will be necessary to replace this infrastructure, lost through neglect. The question remains, who is going to pay?

The loss of infrastructure is only one part of the problem. Road users spend a similar amount (US\$ 2 to 3 billion) every year unnecessarily in increased vehicle operation costs resulting from bad road conditions.

Apart from very few notable exceptions, there is no adequate, planned and optimized road conservation system in the region. Most often, superficial or technically inadequate repairs are made after damage has already occurred or, in the worst cases, roads are not maintained at all. "Optimization" today usually means trying to stretch the insufficient funds allocated to road conservation as far as possible, attempting to slow down the general deterioration of the road network. There is clear evidence that the present system is not capable of reversing the present catastrophic trend.

Recognizing their deficiencies in the area of road maintenance, a number of Ministries of Public Works have begun to look for answers to the multiple problems in that area. Some countries have improved their knowledge of engineering or of maintenance planning; others have developed projects for reorganization, decentralization and even recentralization, and a few countries even allocated more funds. These technical and organizational improvements may have contributed to increase the quality and quantity of maintenance carried out, in spite of the limited funds allocated. Although it is possible that some governments will continue attempts to strengthen road maintenance, the overall results will remain far from satisfactory.

In fact, the advances made have not produced a general improvement in the condition of the road networks in Latin America and the Caribbean. With a few exceptions, such as Chile and some States in Brazil, road networks are in worse condition today than they were five years ago. The large majority of road agencies continue to work inefficiently and bureaucratically and the funds allocated for road maintenance continue to be inadequate. Under present circumstances the road networks do not provide a solid base for social and economic development in the region.

What is the cause for the relatively good performance and development of the electricity sector and what, in contrast, are the reasons for the poor outlook of the road sector? This book attempts to explain the reasons for this discrepancy. At the same time, it puts forward a new concept for approaching the road management problem more effectively than in the past.



THE CATASTROPHE AHEAD

The predominant trend in 1993 is clearly towards a progressive deterioration of the road networks. The state of paved roads can be used to illustrate this problem. They can be divided into four groups:

GROUP 1: “COLLAPSED” ROADS

Over time, there has been an accumulation of a great many paved roads which have not been adequately conserved and, as a result, their structure is now seriously damaged. Many of these roads have at some point been superficially repaired to correct their most obvious faults and to make them temporarily easier to use; however, these measures did not correct their basic structural faults. The basic structure of these roads is destroyed and they are difficult, expensive and dangerous to use. They can only be recovered by a partial or complete reconstruction at a cost which exceeds 50% of the cost of building a completely new road.

GROUP 2: ROADS AT THE “CRITICAL POINT”

There is a much larger number of roads which are coming to a critical point in their lives and need surface strengthening immediately to keep their basic structure intact for several more years. Such reinforcement costs between 5% and 20% of the cost of a new road. In Latin America and the Caribbean only a small part of necessary surface strengthening works can be carried out with present road sector budgets, which means that most of the roads in this group will deteriorate with no real possibility of stopping the process. They will gradually become part of the first group of “collapsed” roads, if the necessary surface strengthening is not done to prevent the destruction of their basic structure. In spite of surface wear, many of the roads in this group still have an acceptable appearance and, therefore, the majority of their users do not perceive how critical their state is.

GROUP 3: ROADS in “accelerated wearing process”

There is another large group of roads which, assuming adequate routine maintenance, will have to be strengthened in a few more years, to compensate for their normal surface wear. Nevertheless, either as a result of insufficient routine maintenance or because of technical deficiencies in their original construction, or a combination of both causes, these roads are rapidly wearing out and will need to have their surface strengthened much sooner than anticipated. Even more than in the previous group, roads in this group still look rather good and only specialists and road engineers can detect the symptoms of an accelerated wearing process.

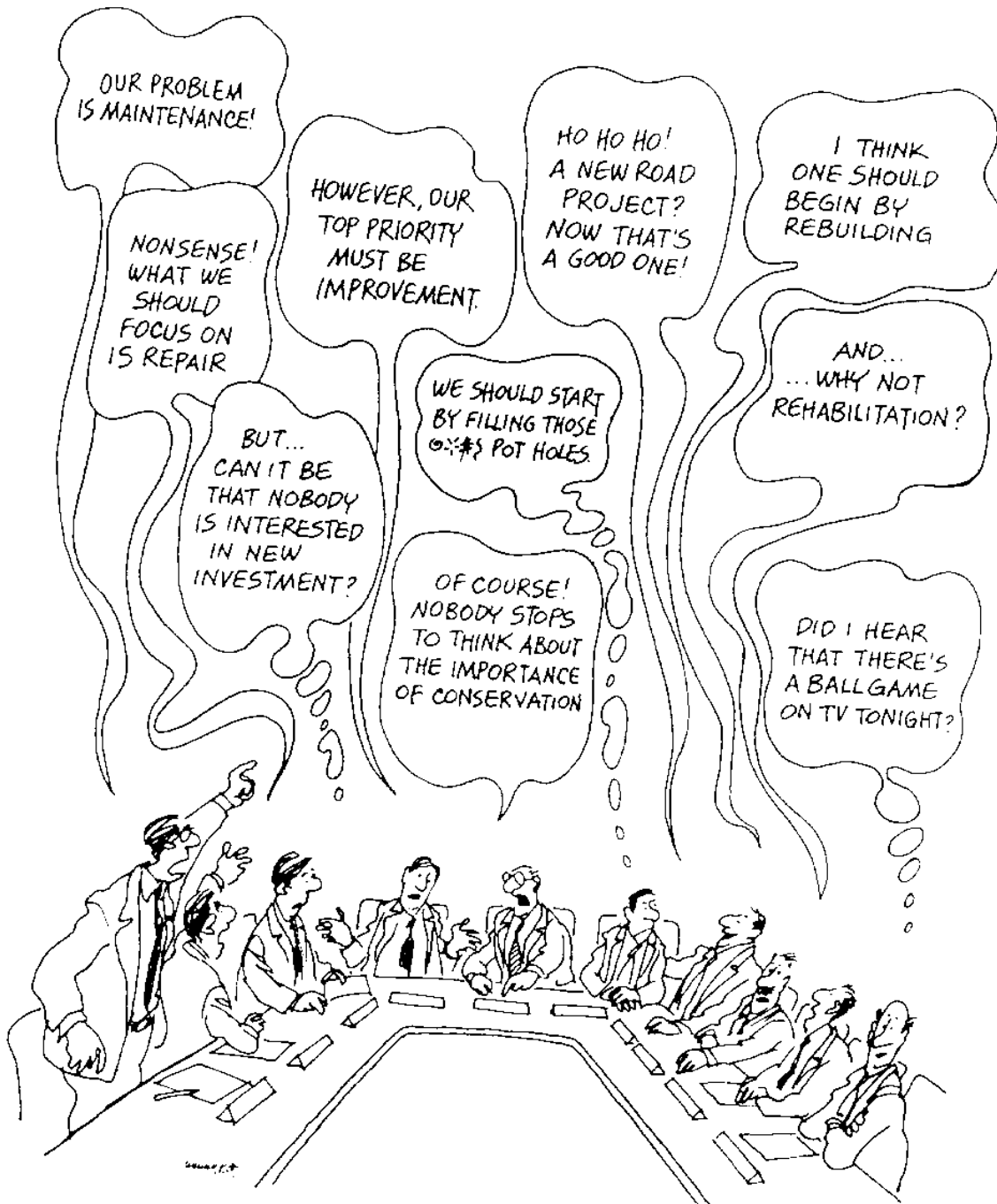
These are roads which are included in an adequate conservation program adapted to traffic volume and type, climate, road type and other variables. There is guaranteed long-term financing for the conservation of these roads and all conservation measures are carried out professionally and to high technical standards. In Latin America and the Caribbean, the number of roads which could be included in this category is incredibly small.



The World Bank has estimated that, in Latin America and the Caribbean, the accumulated overdue needs for surface strengthening, rehabilitation and reconstruction of roads would cost at least US\$ 25 billion, or US\$ 2.5 billion every year over the next ten years. In each of the countries of the region, this corresponds to an annual expenditure of between 1% and 3% of the Gross National Product. If the countries had carried out adequate road maintenance at the right time, they would have spent only one third of this amount and would not have to worry about the nightmare they are now facing.

In summary, the volume of overdue surface strengthening, rehabilitation and reconstruction works will soon become unmanageable. At the same time, there are no efficient and flexible organizations which can carry out this gigantic job, and there is no proper mechanism which could ensure adequate financing to pay for it. Roads which are being reconstructed now are likely to soon fall victim to the same deficiencies existing today. And, as if that were not enough, the cost of the overdue and urgently necessary works is only half of the problem. For each dollar that countries should have spent on road maintenance, road users are obliged to spend about US\$ 3 in additional unnecessary vehicle operation costs. These costs represent a great burden on the economies in the region, especially on the compe-

titive advantage of their exports on international markets, which is the basis of their hope for future well-being. Moreover, they represent a considerable loss of "hard currency", since a significant part of vehicle operation costs must be paid in foreign currency.





WHAT DOES ROAD CONSERVATION REALLY MEAN?

This section seeks to explain the true meaning of road network conservation, which goes beyond simple road maintenance.

In the many countries of the world there are different ways of defining works which are carried out on roads after their initial construction. At international meetings of road experts a considerable degree of semantic confusion is always evident. Many words are commonly used, like “maintenance” (routine and periodic), “rehabilitation”, “reconstruction”, “renewal”, “reinforcement”, “strengthening”, “recycling”, and many others. However, the content of these words varies from one country to another and even between experts of the same nationality.

OPTIONS WITHIN A HEALTHY SYSTEM

In every road agency there are a number of persons responsible for making decisions about how the road network is to be conserved. Today, the decisions being made in Latin America and the Caribbean resemble the decisions made by a very big man with a very small blanket who has to spend a cold night out in the open: which part of his body should he let freeze? None of the available alternatives is healthy; the “patient” can only get worse. One may ask then, what are the characteristics of a healthy road conservation system? The reply to this question is not so complicated as it appears. The following pages are an attempt to answer it.

COMPONENTS OF THE ROAD TRANSPORT SYSTEM

To better understand the issue of road conservation, the role of road infrastructure within the overall system of road transport should be examined.

The decision to build a road is a response to the need of people to move themselves, passengers or freight from one place to another by motor vehicle. The resulting road transport system is made up of two components or sub-systems: the VEHICLE and the ROAD. They are interdependent as neither is functional without the other.

The type of road built depends largely on the volume of traffic anticipated. If the expected traffic is only a few vehicles per day, a simple track is adequate. If the demand is in the order of one hundred vehicles to use it daily, a better designed road

should be built with a dirt or gravel surface. If traffic is expected to be more than a hundred vehicles per day, some type of pavement should be considered in the road design. The higher the traffic volume expected, the higher is the design standard required, until reaching the level of multiple-lane superhighways for several thousand vehicles per day.

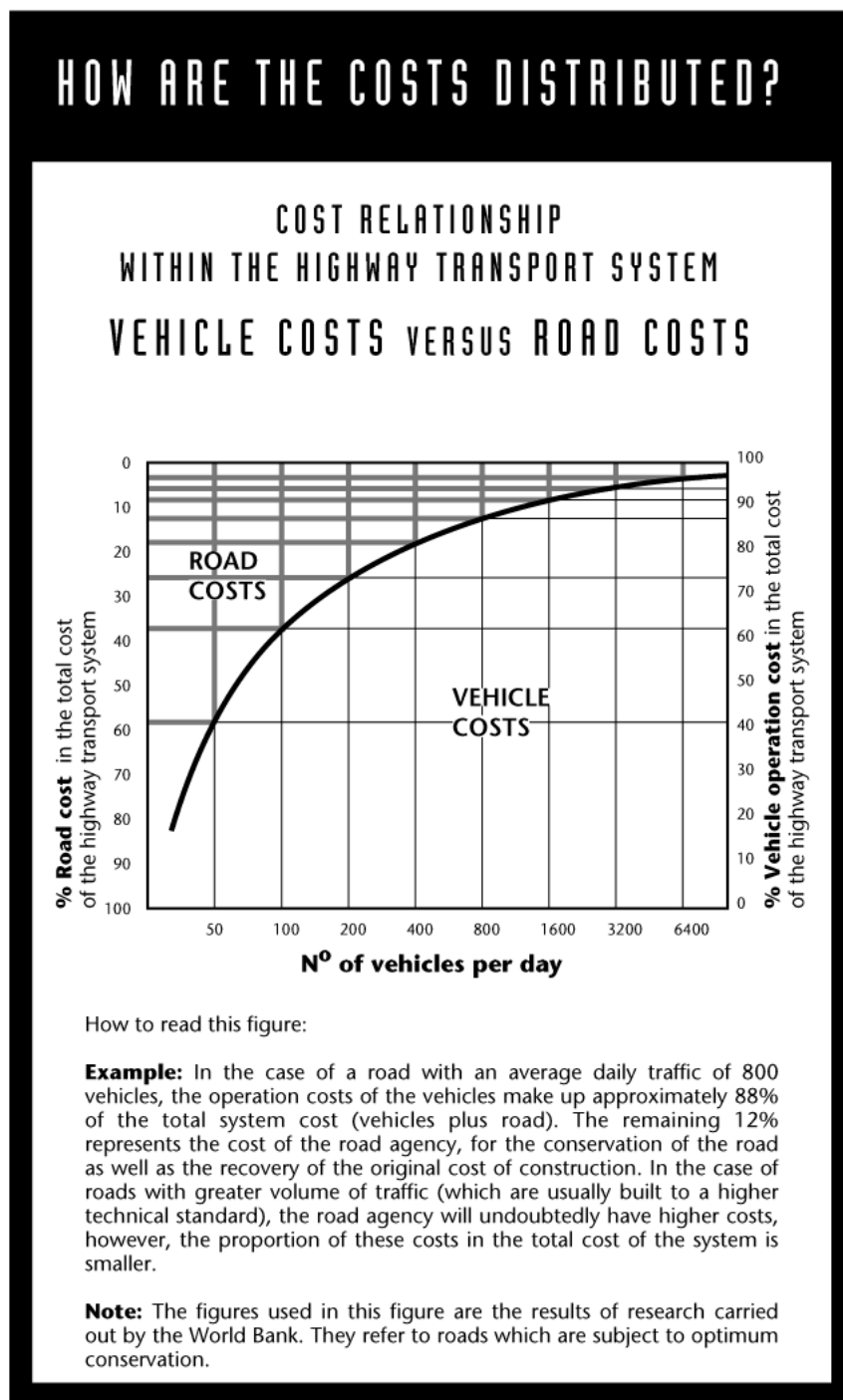
The cost of the road transport system can be divided between the cost related to the vehicles and the cost associated with the roads. Examples of vehicle-related costs are those for fuel, tires, spare parts, repairs, the amortization of the original purchase cost and, for commercial vehicles, the driver's salary. Costs related to the road are the original cost of road construction, plus the cost of all later interventions needed to keep the road functioning, which are mainly conservation activities.

What is the relationship between road costs and vehicle costs? Within the total cost of the road transport system, the share of road costs becomes steadily less important as traffic volume increases and the technical standard of the road itself is higher (See figure on next page). As traffic increases, the road-related costs are distributed over the greater number of vehicles using the road. The percentage-range varies between two extremes. If the road has a very low volume of traffic, say 10 vehicles a day, the road-related costs (construction and conservation) could equal 90% or more of the total system cost. The other extreme is a multi-lane superhighway, with more than 10,000 vehicles using it every day. On that type of road, the road-related cost is approximately 5 to 8 % of the total system cost.

For the system to function optimally, each of the two sub-systems should tend to reduce its cost as much as possible. In fact, there has been much progress in the reduction of vehicle operation costs. Vehicle manufacturers compete on the market with better, lighter and more economical models which consume less fuel and are more durable. Also, most car owners are concerned to purchase economical vehicles, to keep the engines well-tuned and to drive at sensible speeds in order to avoid unnecessary fuel consumption or losses resulting from accidents. Generally, the vehicle sub-system shows a clear trend and determination towards optimization. This determination is based mainly on the economic interest of the large number of individuals owning vehicles.

THE TWOFOLD ECONOMY OF SCALE

There is a twofold economy of scale in road transport which can be illustrated using typical data for Latin America.



Let's imagine the following situation: We are in a room with four windows, one in each wall. From each of these windows we can observe a different road, travelled by vehicles, and of each road we can see a stretch exactly one kilometer long. Each of the four road sections is part of a different newly constructed road and each road has a different type and density of traffic.

Road 1 is a rural gravel road over which 30 vehicles travel per day. Building this road cost US\$ 60,000 per kilometer and its conservation costs US\$ 600 per kilometer per year. Because it is an unpaved road, the cost of vehicle operation is rather high, to the order of US\$ 0.28 per kilometer.

Road 2 is a local road with asphalt pavement over which 250 vehicles pass per day. Building the road cost US\$ 150,000 per kilometer and US\$ 600 is spent per year for its conservation, the same as on the gravel road. Due to the smoother surface of the road, vehicle operation cost is only US\$ 0.20 per kilometer.

Road 3 is technically the same as road 2, but it has twice as much traffic (500 vehicles per day). This makes a greater degree of conservation necessary, costing about US\$ 1,200 per year for each kilometer. The operation cost of the vehicles is US\$ 0.22 per kilometer, slightly higher than on road 2, because of the high traffic density at some times of the day.

Road 4 is a paved highway built to advanced technical standards, much wider than roads 2 and 3. This highway has fewer curves and more gradual slopes; and 1,500 vehicles use it every day. Because of the good characteristics of the road, vehicle operation cost is only US\$0.18 per kilometer. This road was built at a cost of US\$ 280,000 per kilometer and US\$ 2,000 per kilometer are spent annually on its conservation.

If we watch these four road stretches over a period of twenty years and record, for that period, the total cost of vehicle operation and the total amount spent on the roads, we arrive at the following results:

Costs	Road 1	Road 2	Road 3	Road 4
Total cost (US\$)	133.320	527.000	977.000	2.291.000
Road cost within total cost	54%	31%	18%	14%
Vehicles cost within total cost	46%	69%	82%	86%
Road cost divided by number of vehicles using it (US\$)	0.33	0.09	0.05	0.03
Total system cost per vehicles/km or unit cost (US\$)	0.61	0.29	0.27	0.21

To understand the twofold economy of scale, one needs to analyze the results of this example:

First, let us compare roads 2 and 3, which are technically the same. Because of the simple fact that road 3 it is more travelled, its system unit cost is reduced from US\$ 0.29 to US\$ 0.27. Even more impressive is the reduction in road cost per vehicle/km, from US\$ 0.09 for road 2 to a little more than half (US\$ 0.05) for road 3, in spite of having spent twice as much on its conservation.

Obviously, there is a limit to how much the volume of traffic on a given road can be increased without upgrading the road design standard. The second economy of scale results from such changes in road design standards. This effect is very noticeable in the case when an unpaved road is paved, as can be seen from comparing road 1 with road 2 in our example. There, the significant reduction in the total system cost per vehicle/km stems not only from the distribution of the road costs over more vehicles using the road, but mainly to the more rational use made of the vehicle on a better road.

Optimization should also be a concern on the part of the suppliers and administrators of roads. To start with, they should guarantee that road construction is of good quality. They should also make sure that the necessary conservation measures are carried out to keep the roads in good condition as long as there is a demand for them. The suppliers of roads should aim to minimize costs employing a long-term view. The State, which today is the supplier of roads and also usually their administrator, should ensure that the demand for roads is satisfied at the least possible cost. However, observing the actual situation in many countries of the region provides grounds for serious doubt about whether the present system of organizing “road service” is capable of fulfilling this condition.

TOWARDS A HEALTHY CONSERVATION SYSTEM

The existing road network in most Latin American countries is relatively complete. Only few countries need to add new road infrastructure on a larger scale. In all countries, however, there is an urgent need to implement a healthy system for preserving the already existing road network.

First, it must be clarified what characteristics should dominate in a healthy system for road conservation. We consider the basic conditions for a healthy system to be the following:

- It should guarantee an adequate conservation of the road network at a reasonable cost.
- It should ensure adequate road network conservation not only today and tomorrow, but in the long term.
- It should tend to optimize the cost-benefit relationship of the road transport system, which not the same as trying to spend as little as possible on roads.
- It should rationalize the use of funds.
- It should minimize damage to the environment.

At this time, there is no country in Latin America and the Caribbean with a healthy system for preserving the road network. Available information shows that the prevailing system is not healthy, because it does not meet the above conditions.

- It is evident that the predominating system in the region is not capable of conserving road networks in acceptable condition at a reasonable cost. Today a very dramatic example is the collapse of a large part of the federal highway network in Brazil. Many of these roads are densely traveled, which not only makes them profitable, but also means that they are of great importance to the economy of the country. Nevertheless, the present conditions under which their conservation is organized makes it impossible for this work to be adequately done. It appears that the collapse of part of that network is inevitable and in the future a large programme to rebuild the federal highways in Brazil will have to be carried out at a cost many times higher than the cost of adequate and opportune conservation would have been. This collapse results in a significant increase in the operation costs of the millions of vehicles using these roads daily, not to mention the number of serious accidents and loss of life caused by the bad state of the pavement.
- The policy of constantly allocating insufficient funds for road conservation is not sustainable in the long term and certainly does not permit an optimization of the cost-benefit relationship. Many countries try to “save” funds by not spending on road conservation, without realizing that this “saving” means much higher future costs. The system is incapable of reducing long-term costs, because the allocation of funds is conceived with a short-term perspective. Today, it is close to impossible to allocate budget funds to pay, for example, for the strengthening of a road which at first sight still looks reasonably good, but which engineers think will collapse in one or two years more. However, once the road has collapsed, and this collapse is obvious, it is relatively easy to allocate funds for its reconstruction, even though the amount necessary is four or six times more than the amount previously “saved”.
- Without an adequate road conservation system, significant natural resources are wasted and the environment is damaged. The construction of a new road requires large quantities of raw materials and labor, at a very high cost. Also, the extraction, preparation and laying of the material results in various types of environmental damage. For example, the large quantities of fuel burned by heavy construction machinery cause air pollution. Fuel, in turn, is a non-renewable energy resource which will be scarce in the future. Local population and animals are exposed to the noise and hazards of construction equipment. It is true that the original construction of a road cannot be done without these resources and the various negative effects on the environment. What can be avoided, however, is environmental damage caused by road reconstruction and rehabilitation, through an adequate and opportune conservation of existing roads. Reconstruction requires demolition of significant parts of the road and transport of the resulting debris. Both of these activities use much non-renewable energy and damage the environment. The debris, much of which is non-biodegradable and definitely ugly, has to be deposited somewhere in the landscape. Lastly, the reconstruction of a road involves expenditures on new raw materials, similar to those used in the original construction.

In summary, analysis of the present situation makes it very clear that the countries of the region do not employ a healthy system for the conservation of their road networks.

THE “MIRACLE” OF INDESTRUCTIBLE ROADS

Many villages and small towns in Europe, particularly in Belgium and France, are served by roads which were paved in the 1930s or 1940s. These roads have been serving for fifty years or more and have never been reconstructed or rehabilitated. In rural areas, where there has been only a moderate increase in traffic, these roads are still adequate for present needs, and according to road engineers, they will not need any type of reconstruction or rehabilitation in the foreseeable future.

How can a paved road can be fifty or sixty years old and still be suitable for many more years? Isn't it general knowledge that after 10, 15 or 20 years roads have to be reconstructed, which includes the demolition of the destroyed parts of the pavement and basic structure, and their replacement? Does pavement not disintegrate after a certain period of time? Have we come across a miracle?

The basic answer to this question is that these roads have been conserved in the true sense. Before the first thin layer of pavement was applied, fifty or sixty years ago, care was taken to see that the road had proper drainage. Then, engineers did not wait until the original pavement disintegrated. After some years, at a relatively low cost, they applied a second thin layer of pavement over the first which, although somewhat worn, still had no major faults. Some years later, a third thin layer of pavement was applied over the two already existing, which showed symptoms of “fatigue” but still had no structural faults. This surface strengthening programme has continued to the present day, combined with other routine and preventive maintenance measures. According to engineers, these roads which now have as many as fifteen or more layers of asphalt and whose pavement is as much as 40 centimeters thick, are practically indestructible. No expensive demolition works or removal of collapsed sections have ever been done. The existing road has always been conserved and used as a base for reinforcing the surface at low cost.

Naturally, this way of making roads “indestructible” has not always and everywhere been possible; often the increase in traffic has made it necessary to build a road with greater capacity and a different design. However, the point to be demonstrated here is the contrast between the results of a serious conservation system, such as in this European example, and what most people in our countries have come to accept as the “normal” cycle for roads.

THE “COPPER HIGHWAY”

A SUCCESSFUL EXAMPLE OF ROAD CONSERVATION

The “Copper Highway”, located in Chile, is an exceptional case among Latin American and Caribbean roads. After 22 years of existence, which is longer than the period for which its pavement was designed, it is still in good condition. The traffic volume is considerable and the climatic and topographical conditions are severe. In spite of all this the highway has never needed rehabilitation and certainly no reconstruction took place. What is the secret behind this seeming “miracle”?

Neither secret, nor miracle. It is simply a case of good road management and conservation, carried out by the mining company (CODELCO) responsible for the road.

The road is located some 90 kilometers south of Santiago and connects the city of Rancagua with the largest underground copper mine of the world. Every day some 11,000 workers, more than 1,000 tons of copper plus hundreds of tons of other materials are transported over it. Since it is the only access to the mine, this road must be serviceable every day of the year without any interruption.

The highway is fifty kilometers long; the pavement is mostly asphalt concrete, 10 meters wide and 12 centimeters thick. From a valley 500 meters above sea level it stretches into the Andes mountain range to an altitude of 2,400 meters. The winter is crude, with heavy precipitations of rain and snow and frequent below-zero temperatures; in contrast, the summer is very hot. Daily traffic is approximately 1,400 vehicles, 30% percent of which are heavy trucks and 32% large buses.

Difficult climate and traffic conditions have not been obstacles to keeping the road open and in good condition at all times. The conservation program in place has included all necessary tasks. Routine maintenance, which is carried out continuously, consists mainly in keeping the drainage system and traffic signs in perfect condition. Periodic maintenance, which for asphalt pavement consists mainly in surface seals, is carried out in intervals of several years. Moreover, some 70% of the pavement has been strengthened to compensate for wear and to keep up with increasing traffic. Attention has also been given to the correction of inevitable errors and omissions in the original construction, but always before those defects led to the collapse of a road section.

The cost of the conservation has been quite moderate. The average annual expenditure has been 5% of the cost of the pavement, or 1% of the replacement cost of the entire road. These figures are lower than the usual estimates for annual road conservation costs, of 2.5% to 3.5% of the original construction cost (or replacement cost) of the road.

The result is a reliable road in good condition which will continue to provide service for many years to come. If the Copper Highway had been treated like most other roads in the region, it would long have collapsed and would have required complete reconstruction years ago. Truly this highway is a source of pride for the mine workers and provides the mining company CODELCO with an excellent visiting card.

DEFINING ROAD CONDITIONS

Very good. New roads, or roads which in their physical condition are equivalent to new roads.

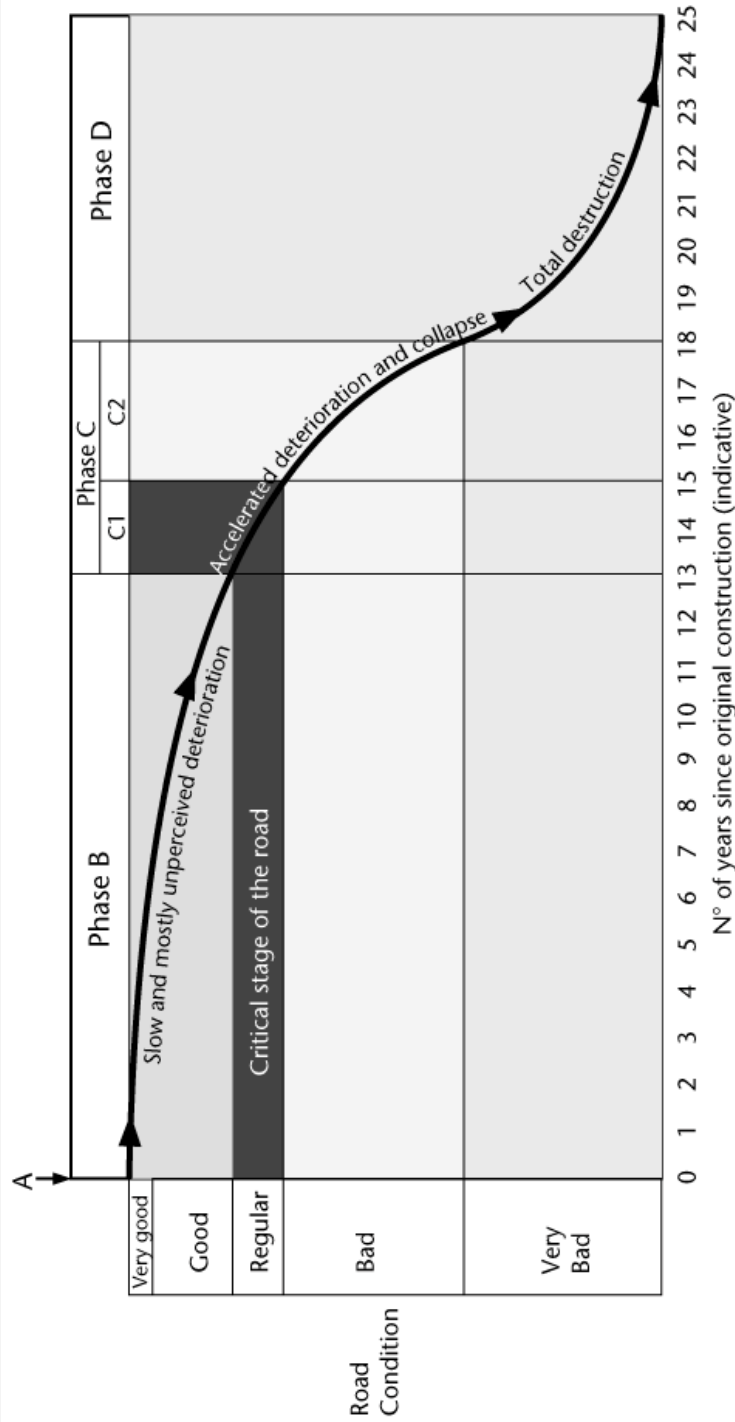
Good. Paved roads, largely free of defects, requiring only routine maintenance and perhaps surface treatment. Unpaved roads which need only routine grading and localized repairs.

Regular. Paved roads with defects and weakened structural resistance. They require strengthening of the pavement, but without the need to demolish the existing base structure. Unpaved roads which require grading and additional new gravel, plus drainage repair in some places.

Bad. Paved roads with structural defects needing immediate rehabilitation; this includes the previous demolition and removal of deficient sections. Unpaved roads which require rehabilitation and repair of drainage.

Very bad. Paved roads with serious structural defects needing reconstruction, with previous demolition and removal of most of the existing structure. Unpaved roads which need reconstruction and significant drainage works.

THE DETERIORATION OF ROADS OVER TIME



Note: The shape of the curve shown here is based on asphalt concrete pavement. The deterioration curve for other types of roads is different from the curve shown. However, the "general message" of the figure is equally valid for any type of road.

THE “NORMAL” ROAD CYCLE

In the countries of Latin America and the Caribbean, as in many others, the “normal” cycle of roads consists of four stages, which are described below (See also “The deterioration of roads over time”).

For the description of these stages we shall use the example of roads paved with asphalt concrete, since they are very common throughout the region. Although there are certain differences between asphalt-based pavements and roads paved with concrete, or roads without pavement, the basic message valid for all roads is that their excessive deterioration or the collapse of their basic structure should never be permitted.

The four phases of the “normal” road cycle are the following:

Phase A: Construction. Results of initial construction may be varied, ranging from extremely solid with little or no faults, to an entire construction based on inadequate design or sloppy execution. In any case, roads are put into service as soon as completed. On the day of the ribbon-cutting ceremony they are usually in excellent condition and fully satisfy the demand and expectation of the users. This moment corresponds to point A in the deterioration curve.

Phase B: Slow and mostly unperceived deterioration. Over a number of years, the road is subject to a rather slow deterioration and weakening process, mainly in its pavement, but also, to a lesser degree, in the basic structure below the pavement. This deterioration is caused by the large number of heavy and light vehicles using the road, but also by factors such climate, rain or surface water, solar radiation, oxidation, temperature changes, and other factors. The speed of deterioration also depends on the quality of the original construction. In order to slow down as much as possible the process of deterioration and weakening, various types of conservation measures must be carried out regularly, mainly on the pavement and the drainage works. Moreover, routine maintenance must continuously be carried out.

In many countries, conservation during this period is practically nil, for the simple reason that insufficient funds are allocated for roads, or because the limited existing funds are used for rehabilitating those roads which are already in very bad condition. Consequently, the period of slow deterioration turns out to be not so slow; instead of covering a period of ten or fifteen years, it may last only six or eight years.

Another factor contributing to the neglect of the roads during phase B is a complete misunderstanding of the concept “road design for x years”. Engineers often say that a pavement is designed for five, ten, or even twenty years. This misleads many people to think that conservation is not necessary during this period, because at the end of that period the road will have to be reconstructed anyway. There are even some road engineers who consider it inevitable that after the design period of the pavement any road ends up being destroyed and will need reconstruction.

Throughout phase B, the road remains apparently in good condition and most users do not perceive the weakening process of the pavement. In spite of the gradual increase of minor faults, the road continues to offer good service quality (See phase B of the figure).

Phase C. Critical stage of the road. After several years of use, the pavement and other components of the road become increasingly “tired” and the road deterioration process accelerates rapidly. The road structure gradually loses its ability to withstand traffic (See phase C of the figure). At the beginning of this phase, the road’s basic structure is still intact, surface faults are relatively minor, and the ordinary user may get the impression that the road is still quite firm. However, this is not the case (See section C1 of the figure). A little further into phase C visible damage to the surface becomes much more obvious and the basic structure below the road surface starts to become damaged. In other words, when a road starts to have major potholes and deformations on its surface, it is certain that its basic structure is also damaged.

Damage begins at isolated points and soon spreads until large portions of the road are affected (see section C2 of the figure). Phase C is relatively short, usually only three to five years. Once superficial damage becomes obvious, it is a fast lane for destruction.

In a healthy conservation system the surface of the road must be strengthened at the beginning of phase C (section C1 of the figure), when the road condition becomes critical. Surface strengthening is meant

- to stop the rapid deterioration and weakening process
- to totally preserve the existing basic structure, which is still intact
- to guarantee the serviceability of the road for another prolonged period.

At the beginning of phase C (see section C1 of the figure) it is sufficient to reinforce the road surface at a relatively low cost. Paved roads are usually strengthened applying a layer of new asphalt concrete four to eight centimeters thick (“an overcoat”) at approximately 5% of the original construction cost. Once the surface is adequately strengthened, the road is once again suitable for its purpose and can withstand traffic for many more years. However, since at the beginning of phase C road faults are not very obvious and the vehicle ride not that uncomfortable yet, necessary surface strengthening is usually not carried out and faults become severe.

Further into phase C (section C2 of the figure) simple surface strengthening will no longer be sufficient. Damage to the basic road structure will have to be eliminated first. This means demolition and removal of the damaged sections of the road, reposition of the road base in those sections, and then repaving the entire road.

The longer these works are delayed, the more severe the damage and greater the extent of demolition necessary to the basic road structure. The term “rehabilitation” is normally used to refer to the combination of partial replacement to the basic structure plus surface strengthening.

If no works at all are carried out in phase C, the road begins to collapse, that is to say, the defects in pavement and basic structure become very severe and gradually extend over the entire road. Throughout phase C, traffic continues to circulate on the road. Although initially the use of the road is not difficult yet, the inconveniences of surface irregularities gradually increase: large holes, wide cracks, depressions and deformations.

At the end of phase C and during the final phase (D), the only solution is a complete reconstruction of the road, at a cost which can be as high as between 50% and 80% of the cost of a completely new road.



Phase D: Total destruction. The total destruction of the road is the final stage of its existence and can take several more years. At this stage, the first sign is the disappearance of the pavement. Each time a heavy vehicle passes chunks of asphalt break off until the pavement is gone. The highway ends up being a gravel road and, in the long run, a dirt road (see phase D in the figure). Using the road becomes more and more difficult; the average vehicle speed drops abruptly and the traffic capacity of the road decreases to only a small portion of what it originally was. The vehicles begin to suffer damage to their tires, axles, springs and chassis. In general, vehicle operation costs and the number of serious accidents rise considerably. At the end of the deterioration curve ordinary cars can no longer circulate on the road and it is used only by some trucks and four-wheel-drive vehicles.

In Latin America there is a “perfect” example of a road which collapsed. The longitudinal highway in Chile, which forms part of the Pan-American Highway, is the main highway in the country and virtually the only route for long distance travel from North to South or vice versa. More than three thousand kilometers long and of vital significance to the economic and social life of Chile, this road was paved in the early 1960s at great national sacrifice. The design of the pavement (mainly concrete pavement) had some defects which made surface strengthening necessary as early as 1970. At that time, the Government of Chile was building the underground railway (METRO) in Santiago and a considerable part of the national budget was diverted to this great piece of infrastructure. As a result, “there were no funds” for road maintenance in general, and even less for strengthening the longitudinal highway. Between 1974 and 1977, a traumatic event occurred in Chile: the general collapse and decomposition of the longitudinal highway over a section approximately 1500 kilometers long, in the very part where it was most travelled. Chileans had to accept that their principal highway turned from a national pride into a nightmare. Some sections even turned into simple gravel roads with long lines of vehicles moving at a speed of thirty kilometers an hour, raising great clouds of dust and soil.

The highway was rebuilt between 1977 and 1983 at an enormous cost, and the country had to contract foreign loans at a much higher degree than was desirable. Chile learned a hard lesson at a high cost. Unfortunately, with the passing of time, lessons tend to be forgotten. (Note: A new METRO line will soon be constructed in Santiago...)

THE NARROW MARGIN FOR SOUND ALTERNATIVES

As has been explained on the previous pages, there are rather precise moments for carrying out certain conservation works on roads. For example, the surface of a road with asphalt pavement should be strengthened at the beginning of phase C. It may be done sooner than necessary, however, during the “anticipation period”, the opportunity is lost of using the capital required on something more necessary and more profitable. Another example is the clearing of the road drainage system, a typical routine maintenance job which should be carried out with some frequency, especially before and during the rainy season. Increasing

the frequency of that task has a cost, but it reduces the risk of accumulated water attacking and destroying parts of the road. In essence, there is a cost of advancing road conservation tasks to a point in time earlier than the optimum time. Economists call that the “opportunity cost of capital”, and it is equivalent to the interest lost by having used the capital earlier than necessary. However, more serious damage occurs when the correct moment is missed and necessary conservation tasks are delayed. The delay, in the examples of pavement strengthening and drainage clearance, causes damage to the entire road structure. The loss caused by delay is much greater than the opportunity cost of anticipating conservation works. Therefore, the precise moment must be identified for each conservation task, especially on paved roads. Dirt or gravel roads, because of their technical characteristics, have a more flexible margin of time for carrying out maintenance activities.

The figure “Optimum and non-optimum road policies” shows that the additional cost which results from strengthening the pavement earlier than necessary is much less than the enormous cost of delaying it. In the example of reinforcement, the very high cost of delaying results from the gradual destruction of the entire road structure, once the critical phase is past.

What is the main task in preparing an overall conservation programme for a road network? To identify specifically for each road or road section:

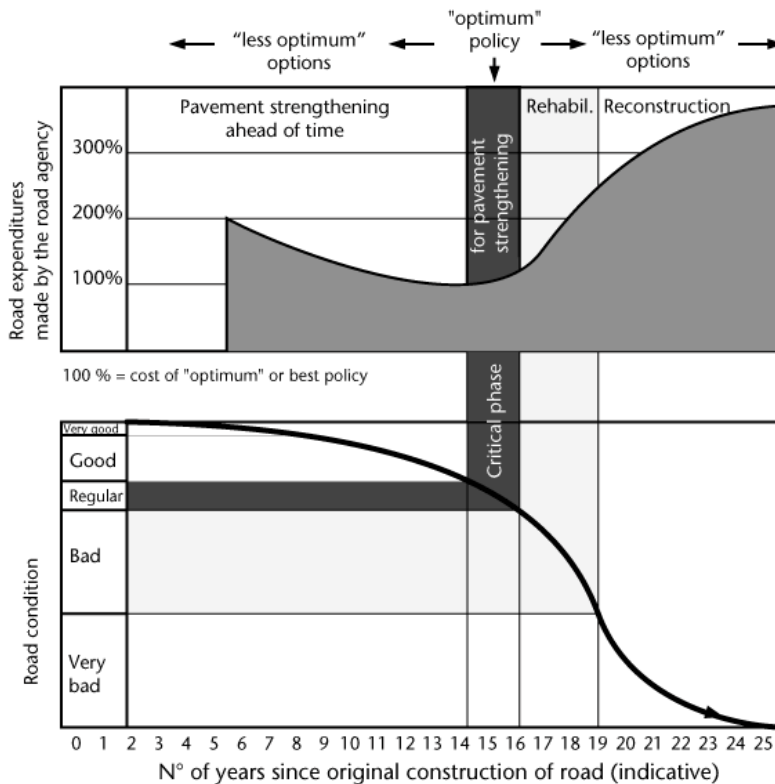
- the optimum type of conservation measures to be carried out
- the precise time frame for the measures to be carried out; with special care to avoid any delay causing damage to the road structure.

Which alternatives are available, then, in a healthy road conservation system? There are two: the timing option and the dimensioning option.

OPTIMUM AND NON-OPTIMUM ROAD POLICIES

AND THEIR EFFECTS ON THE ROAD AGENCY AND ROAD USERS
(using the example of pavement strengthening vs. rehabilitation/reconstruction)

A: EFFECTS ON THE ROAD AGENCY (expenditures on roads)



How to read this figure:

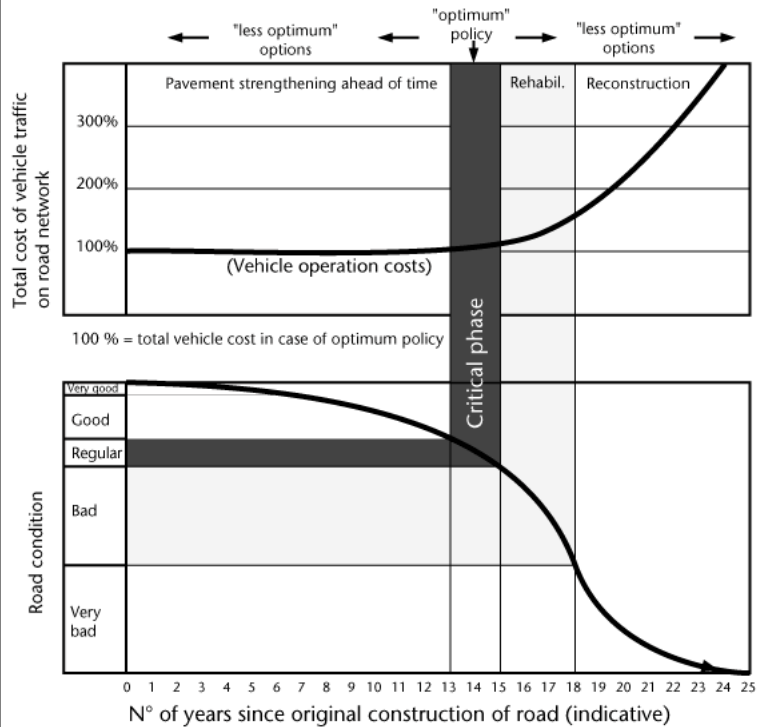
Example: The best policy is to strengthen the pavement when the road is in *regular* condition (lower figure), because in the long term the costs for the road are lowest (upper figure). On the other hand, if the policy of the road agency was to rehabilitate the road when it goes from *bad* to *very bad*, the long-term costs would be about 2.5 times higher than with the optimum policy. It also shows clearly that it is preferable to move conservation measures forward rather than to postpone them.

Note: The figure is qualitative and means to explain the long-term increase in cost for the road (or the road agency) when the policy moves away from the optimum policy, because of timing or dimensioning options (see text). The form of the two curves can vary for different types of roads and different levels of traffic.

OPTIMUM AND NON-OPTIMUM ROAD POLICIES

AND THEIR EFFECTS ON THE ROAD AGENCY AND THE ROAD USERS
(using the example of pavement strengthening vs. rehabilitation/reconstruction)

B: EFFECT ON THE ROAD USERS



How to read this figure:

Example: When the road agency applies an optimum road conservation policy, the users always find the road in *very good* to *regular* condition (lower figure). In this range of road conditions, there is almost no variation in vehicle operation costs. As a result, the total cost of traffic on the road is not affected by moving forward the maintenance measures (horizontal line in the upper figure). However, if conservation measures are postponed and the road reaches the *bad* or *very bad* state, the users face increased operation costs which make the total cost of vehicle traffic grow rapidly with the degree to which conservation is delayed.

Note: The figure is qualitative and means to explain the increase in total vehicle traffic cost which the road users face as a group, when the road agency postpones conservation.

THE TIMING OPTION

In a healthy system, each conservation measure necessary should normally be carried out within a specific time frame. In order to determine the correct time for each measure, a thorough technical knowledge of roads is necessary, as well as the effects of traffic on them. Such knowledge makes it possible to estimate in advance the appropriate moment for the different types of conservation measures. Advance estimates may be made months or even years before a specific task must be carried out, especially if major works such as surface strengthening is involved.

The timing option means that conservation measures may be carried out earlier than required. Once the optimum moment for each intervention is established, engineers can decide whether it is convenient to anticipate some measures. Postponing measures beyond the optimum moment is seldom a viable alternative in a sound conservation system. It has been shown above that when measures are delayed, physical damage to the road appears rapidly and increases disproportionately with time.

But why do conservation measures earlier than needed? The reasons for moving forward (or delaying) conservation measures can be operational or financial. The most frequent operational reason is to avoid sudden ups and downs in the work volume offered to the market, given that there is a certain limited physical capacity offered by contractors. For example, if a large volume of works is scheduled for a certain period of time, which would exceed the existing capacity of the contractors in the market, experience shows that contractors will ask for higher prices. In addition, quality of workmanship may decrease. On the other hand, if for some time period there is little work offered in the market, contractors will not invest in equipment and technology and may reduce their capacity, which in turn makes production difficult once the volume of works starts to pick up again. From an operational point of view, the ideal situation is a rather steady flow of works offered on the market, resulting in stable prices and promoting real competition among contractors. Another operational reason for a change in timing could be to avoid the execution of works during seasonal bad weather periods.

Among the financial reasons for advancing or delaying conservation tasks is to make expenditure flows compatible with income flows. In this context one should also mention the level of short-term capital market interest rates.

Another reason, based on operational and financial factors, is to avoid disturbances during those periods when the traffic is heaviest, for example the holiday season.

THE DIMENSIONING OPTION

The second type of options available to the road agency consists in defining technical dimensions of conservation measures. For example, strengthening an existing asphalt pavement can be done with an additional layer of asphalt which may be four, six or eight centimeters thick, or even by applying a different technology such as recycling of existing pavement. Each alternative satisfies the immediate need: to strengthen the surface and thus to avoid the collapse of the basic structure of the road; and to guarantee that it will last for some more years. The differences between the various options lie in the cost of each measure, the time necessary to carry it out, and its durability.

Similar options exist for surface treatments; different techniques such as fog seal, slurry seal and others can be used. For sealing pavement cracks, there is a variety of products available which vary in price, durability and application technique.

Healthy conservation policies are usually those directed to the medium or long term. Short-term solutions are ultimately not suitable although they can be applied in some special circumstances.

Similar to timing options, arguments for one or another dimensioning option can be operational or financial. For example, aside from strictly technical considerations of each option, contractors in a country may not have the necessary knowledge or experience for certain techniques and may want to use other methods. Financial capacity for initially more expensive long-term solutions may not exist and medium-term solutions may therefore be applied. And the dimensioning of solutions to be applied may also depend on the current rate of interest in the capital market.

THE CONTRAST WITH THE REAL WORLD TODAY

The above pages illustrate that the management of a road network consists largely in determining the optimum moments for taking adequate conservation measures. But how do government ministries or other agencies in charge of roads usually proceed?

Many countries of the region do not have a road network conservation program. The personnel in charge tries very hard to fix the most serious and obvious faults in the road network, always restricted by an insufficient budget. This system is far from optimum and leads to a gradual deterioration of the road network and to an accumulation of overdue or postponed road rehabilitation and reconstruction. This generates a great dependency on foreign loans needed to finance required reconstruction. In

the long term, this contributes to a country's under-development and inability to compete with other countries or regions where the road infrastructure is better managed.

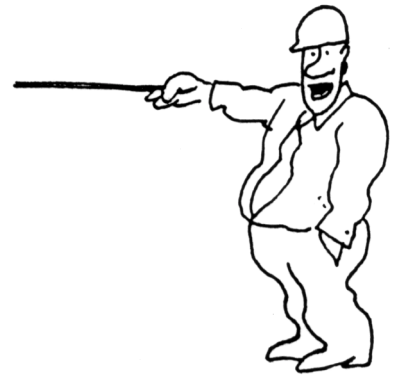
In a number of countries, the development of conservation programs is becoming increasingly generalized. In some cases, they are prepared as part of a general road sector program; in others they are isolated efforts. Development banks, especially the World Bank, have given road sector programs emphasis by requiring their existence to qualify for new road sector loans. In the development of road sector programs the focus is usually placed on the optimization of the use of a specific amount of allocated or borrowed funds. Generally, this amount is insufficient. The problem of inadequate funds is so serious and widespread that the World Bank has developed a computer model (called EBM - Expenditure Budgeting Model) to be used for scaling down optimum conservation programs so they can be financed with insufficient funds available. This fact shows the degree to which it is recognized that funds allocated are consistently insufficient for an optimum conservation policy.

The procedure being followed is similar to that used by an electricity company who discovers it has insufficient funds for maintaining its generating plants. The task is to decide which plants will not be adequately maintained, knowing that these plants will suffer destruction some time later. Obviously, the least damaging option is sought.

THE FORBIDDEN OPTION AND ITS CONSEQUENCES

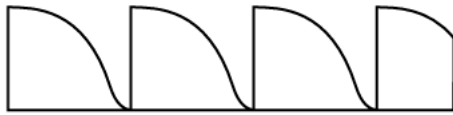
Another alternative frequently applied today is the "forbidden option". That option is usually initiated by not carrying out necessary road conservation measures at the correct time, while the road structure is still intact ("Why should we do anything, the road still looks good enough!"). Soon the critical point is passed and the road starts to fall apart. Once the road is in terrible condition and public opinion is outraged, the search starts of what can be done ("We have to fix that road, or the mayor will lose the election!"). As the reconstruction of the road was not foreseen, there are no resources budgeted for that purpose. Out of desperation and under heavy pressure from the public, an emergency repair contract is given to a contractor ("...I will make the road look fine before the election."). Needless to say, the price charged is high, as things have to work out fast. The repairs carried out are mainly of a superficial and cosmetic nature, leaving the basic structural damage unchanged. The contract is paid for by diverting funds from the regular maintenance budget, with the result that necessary maintenance work on other roads which are still in reasonable condition can not be carried out. This causes, with absolute certainty, that the critical phase is passed on those roads and that a little later they start falling apart, too. ("We will solve that problem next year, after elections.")

The "forbidden option" has no return and the inevitable result is growing accumulation of semi-collapsed roads. Since the funds originally budgeted for conservation are used for emergency repairs on collapsed roads, the roads which are still reasonable today will collapse totally in the near future. They will then need emergency repairs, and so on successively, in a vicious circle which is difficult to break. In reality, this process is worse than a vicious circle, it is a descending spiral which, as a whirlpool in the sea, carries its victim down. Emergency repairs become the standard solution. The overall ride quality and public opinion grow worse, until a foreign loan is taken for the reconstruction of the road network. That loan will have to be paid back by the next generation ("Imagine, we get a 8-year grace period and then have 20 years to pay back!").



"CURVOLOGY" FOR ROADS: A COLLECTION OF SAWS

In the previous pages it was shown that the deterioration of a road can be shown graphically. The road deterioration curve begins at a high point, expressing the very good condition of a new road after its original construction. Then the curve drops, slowly at first and then gaining speed until it reaches a bottom point, representing the extremely bad state of a destroyed road. The road agency normally intervenes before the road collapses completely, either by renewing its surface or, if it is too late for that, by rehabilitation or reconstruction. After the intervention the road is again very good. This is shown in the figure by an abrupt rise of the curve to the initial, high level. Over time the entire process is repeated and the curve takes the form of an inverted saw in which the teeth represent the interventions improving road conditions.



General form of the road cycle

The exact form of the saw can vary considerably according to the various factors affecting the road:

- The teeth can be more or less distant from each other, showing the speed of deterioration, and depending on the volume of traffic, climate, quality of original construction and of the routine maintenance carried out.



Rapid deterioration cycle

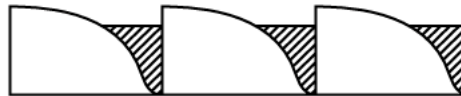


Slow deterioration cycle

- Spaces between the teeth can be more or less deep, showing the maintenance policy followed; this can be proper conservation (taking measures while the road is still adequate) or rehabilitation/reconstruction (taking measures when the road is in bad or very bad condition).



Conservation type cycle



Reconstruction type cycle

In the reconstruction type cycle there are periods when road users have to bear high costs of vehicle operation, because of the bad or very bad state of the road (shaded areas of the curve).

- To illustrate what should not be done, the curve is shown here of the “forbidden option” described in the text,



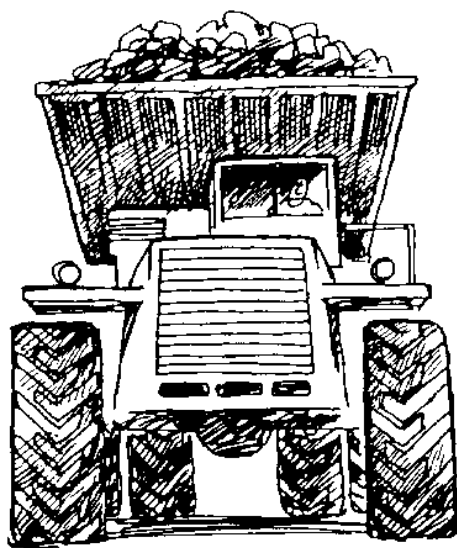
Cycle for “forbidden option”

where the measures taken are results of emergencies, and are usually of poor quality and short-lived.

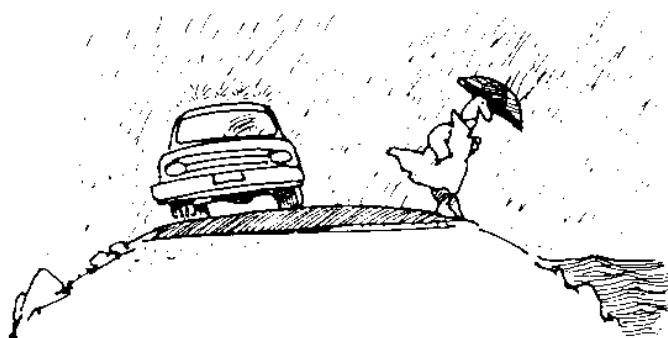
- Apart from the curves shown and described, there are an infinite number of other curves and cycles showing various decisions made in practice. Real life is “a collection of saws”.

TEAMS AND CONCEPTS USED IN ROAD CONSERVATION

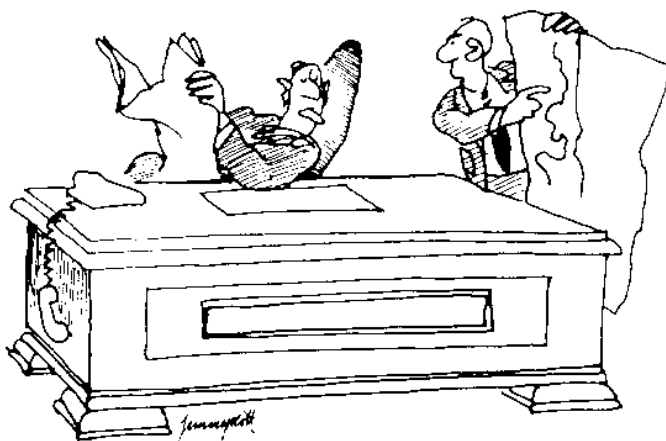
The following pages are intended to avoid different interpretations of the terms used in this book and in the general discussion about management and conservation of roads. The interpretation of terms was made by the authors. However, some definitions were taken from previous publications on the road maintenance issue, among others, from World Bank publications.



HEAVY VEHICLES



WATER



(.....)

THE ENEMIES OF THE ROADS

Road conservation. A broad set of measures for guaranteeing the adequate long-term functioning of a road or a road network at the lowest cost possible. One of the basic purposes of conservation is to prevent, as much as possible, unnecessary loss of capital previously invested, through the physical protection of the basic structure and surface of the road. Conservation is intended specifically to prevent the collapse of road structures and the need for rehabilitation or reconstruction. The term conservation includes maintenance (routine and periodic) and surface strengthening, including the application of additional layers to the road, without altering its existing structure.

Routine maintenance. Localized repair of small defects in the roadway and pavement: leveling unpaved surfaces and shoulders; regular maintenance of drainage, lateral slopes, edges, traffic control devices and other accessories; clearing right-of-way, dust and vegetation control, snow or sand clearing and the maintenance of rest areas and safety devices. The cost of one routine maintenance application may fluctuate between less than US\$ 300 and more than US\$ 5,000 per kilometer. Depending on the specific conditions of each road it should be carried out at least once a year.

Surface treatment. Conservation measure applied on paved roads, where the purpose is to ensure the continued presence of certain pavement characteristics, without actually strengthening the pavement. One of the characteristics to be maintained is surface texture, as to ensure adequate friction between road and vehicle tires. On asphalt roads, surface treatment maintains the durability of asphalt and prevents premature development of superficial fissures and cracks often caused by oxidation and solar radiation. Surface treatment should normally be applied every four to seven years, while pavement is still in good condition and before it has deteriorated to regular condition. Some techniques applied are: grooving, fog seal, slurry seal, sealing and surface treatment.

Surface renewal. On unpaved roads, this means applying a new layer of gravel. On paved roads, it means adding one or more layers on top of the pavement, without altering its supporting structure. It also includes pavement recycling. The purpose of surface renewal is to preserve ride quality for road users, to guarantee structural soundness of the road for a prolonged period and to prevent its collapse. Paved roads normally need surface renewal when they have reached regular condition and the process should definitely be carried out before they reach bad condition. This is also true for unpaved roads, except in cases where traffic volumes are very low. Surface renewal is sometimes called “periodic maintenance”. The cost of surface renewal can vary between less than US\$ 8,000 and more than US\$ 40,000 per kilometer.

Surface strengthening. This measure is similar to surface renewal, but with the specific purpose of increasing the structural resistance of the pavement.

Periodic Maintenance. This expression can lead to errors, because all conservation measures are periodic, that is to say, they should be carried out at certain intervals. Surface treatment and renewal, however, are often called “periodic” maintenance measures.

Rehabilitation. Selective repair and strengthening of the pavement or shoulder after partial demolition of the existing structure. Rehabilitation is carried out when the road is too deteriorated to support future traffic and may also include some drainage improvements. The purpose of rehabilitation is to reestablish a solid road structure and good ride quality. The cost of rehabilitation can vary between less than US\$ 30,000 per kilometer for unpaved roads and more than US\$ 200,000 per kilometer for paved roads. For paved roads, rehabilitation is significantly more expensive than surface renewal, because of the high cost of demolition and replacement of damaged parts. In most cases, rehabilitation is a result of insufficient or inadequate conservation. If a healthy conservation system is applied to a road network, little rehabilitation should be necessary, such as eliminating defective fractions of new roads.

Defective fraction. A small proportion of new construction which does not meet the general quality required. Defects may result from a lack of homogeneity in the construction process. The defective fraction is considered normal and can make a small amount of rehabilitation works necessary, even in a healthy conservation system.

Reconstruction. Complete renewal of the road structure, after partial or complete demolition of the existing structure. Reconstruction is usually carried out over the existing alignment of the roadbed. The typical purpose of this measure is to correct consequences of prolonged neglect. It is carried out when rehabilitation is no longer possible. The need for reconstruction may have two causes: deficient original construction or the absence of a healthy conservation system (or both). The cost of reconstructing a road varies considerably, between around US\$ 45,000 and more than US\$ 300,000 per kilometer.

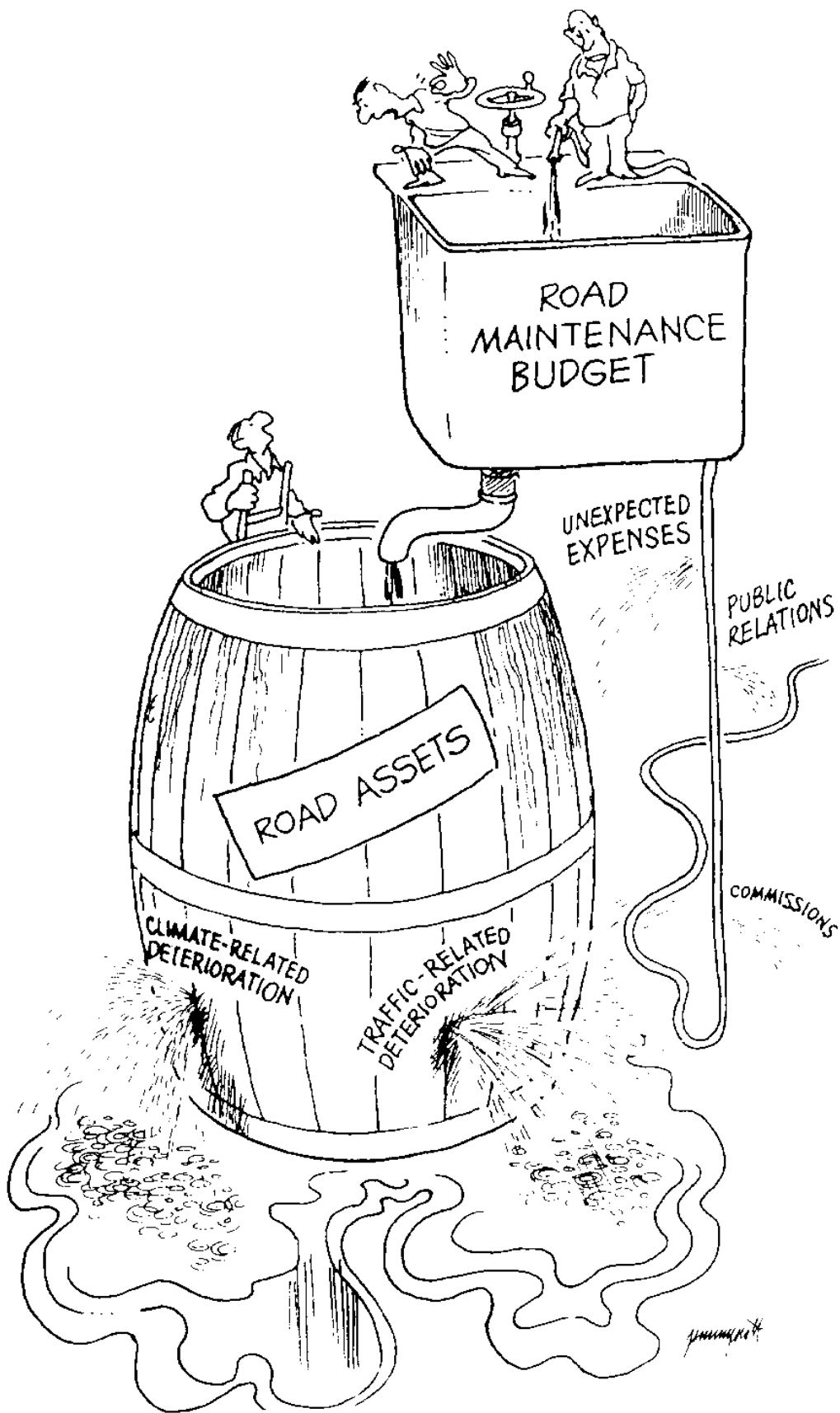
Restoration. A combination of major rehabilitation and reconstruction works on a road.

Improvement. Works carried out with the intention to upgrade the design characteristics of a road, usually related to width, alignment, curves, or longitudinal slope, including the works related to surface renewal and rehabilitation. The purpose of road improvement is to increase the capacity of the road and the speed and safety of the vehicles using it. Improvement works are not considered conservation measures, except for the incidental surface renewal. The cost of these measures can vary considerably, according to the complexity of the geometric improvements made.

New construction. The construction of a new road (paved, gravel or dirt surface), with new alignment; the paving of a gravel or dirt road; an increase in the number of lanes or the construction of additional roadways, service roads, split-level intersections or divided highways with various lanes. The cost of a new construction can vary between less than US\$ 50,000 per kilometer for a gravel road to more than US\$ 1 million per kilometer for a four-lane road with limited access.

Deferred maintenance/conservation. Maintenance and conservation measures which should have been done in the past but for some reason were not executed.

Emergency repair. Superficial repairs carried out when the road is impassable or in extremely bad condition as a result of prolonged neglect or natural disaster. Emergency repairs are often done because necessary funds and/or time is not available for reconstruction which would normally be required. Existing structural faults are usually not corrected, but regular traffic flow is made possible for a limited period. In the best cases, emergency repairs bring the road into regular condition.





THE HIDDEN LOSS OF THE NATIONS' ROAD ASSETS

This section introduces the concept of the “national road asset”. As a point of departure, let us recognize that a country’s road network represents a gigantic investment whose value can only be preserved by means of an intelligent conservation policy. In order to ensure the preservation of the road asset, it is recommended in this section that management methods and tools should be adopted which have long been obligatory in business. One of these tools is to periodically evaluate a company’s assets or, in our case, a country’s national road asset. (A practical method for estimating and updating the value of the national road asset is presented as an annex in this book.)

The assets (or patrimony) of a nation are the sum of all resources and elements which can be used, directly or indirectly, to satisfy the needs of its population. The national patrimony has two basic components: natural resources and elements resulting from human effort. Natural resources are those which are found in nature and were created without the intervention of man, such as water, the landscape, minerals and the native forest. The infinity of man-made elements and resources are the fruit of efforts and sacrifices made by the present and earlier generations. At some moment in history, these elements became part of the national patrimony or asset. If they have survived, they can still be useful today and may continue to be useful in the future.

The large number of roads in Latin American and Caribbean countries make up a very important component of the national asset of each of these countries.

Built to meet the need for economic and social development in each country, road networks have been financed largely with taxes paid by generations of citizens. Governments have collected various types of taxes and spent a significant share of them on building roads, thus creating and extending the country’s national road asset.

The taxes collected have often not been sufficient to finance the large number of roads needed. In this event, the successive governments have contracted loans, inside and outside the country, to raise the necessary funds. These loans are later paid back from new taxes. Thus, the companies and individuals who pay taxes today, are in fact paying for financing of many already existing roads.

Over time, several generations have created and extended the national road asset which, in almost all countries, is the biggest single investment in existence, with a monetary value much greater than the value of the electricity or communications systems or of port infrastructure. A country’s road asset is one of the foundations of its social and economic development and, moreover, is constantly providing the whole society with valuable services. Given that roads can and should last for many years, the tax-payer trusts implicitly that today’s sacrifices (taxes) will offer future benefits for a long period.

This confidence, however, appears increasingly less justified. In most countries of the region, roads are deteriorating at an accelerated pace, mostly because of serious deficiencies in their conservation. In a few years more, large parts of the road networks will be in such a bad condition that they will have to be reconstructed. This catastrophe is already evident to road

users in many countries. Gradually, and almost unnoticed, we are losing our national road asset. What is the cause of this loss? Or, for that matter, how can a component of a country's national asset be lost?

There is, broadly speaking, only one cause: the community neglects or abuses the component in question and in the end it is lost. This neglect can be the result of one of the following causes:

- Through conscious and rational decision. This means that society has become aware that the component in question is not particularly useful. In such circumstances, the public is not willing to provide new funds for its conservation. In essence, this is a deliberate decision which is not prejudicial to society. This situation can occur in the case of roads, but is rather uncommon.
- Through economic or technological incapacity. This means that society no longer has the necessary funds or technology available for conserving the asset in question. Thus, in spite of the fact that it is still useful, the asset deteriorates, at a loss to society. In the majority of Latin America and the Caribbean this situation is rare as there is no problem accessing conservation technology, and, in addition, the financial resources (taxes) collected from road users are usually greater than the cost of conserving existing road networks.
- Through institutional incapacity. This means that the institutional arrangements and mechanisms created by society to manage and conserve the national assets are not capable to rationally raise and allocate funds and other resources necessary for the task. This situation may arise in spite of the fact that the assets are still needed by society and that adequate funds and technology for conservation also exist or could be raised. The ensuing loss to society is serious. In the case of roads, it is evident that their gradual deterioration is due to the deficiencies in the institutional setup and mechanisms created for their management.

Current estimates show that in Latin America and the Caribbean the annual loss of road infrastructure fluctuates between US\$2 and US\$3 billion¹. Nevertheless, very few people seem to take any notice. How is it possible for this gigantic loss to happen almost unnoticed? The press, always eager to make sensational revelations and turn them into scandals, usually goes no further than complaining about the bad state of specific roads, without perceiving the regular pattern of huge losses in the road network value. The answer is that there is a general lack of information which would allow for detecting and quantifying these losses.

Concerning information on assets, there is an important difference in the attitudes shown by the public administration and companies. To illustrate how asset accounting is done in companies, we use the example of a transport company owning only one truck. When the truck is new it appears in the annual balance sheet as an asset, with its original value. With time and use, the truck gradually loses its value. In the company's annual balance sheet this loss of value is expressed as depreciation, that is, as a cost or a loss. Depreciation is a constant process and ends only when the value of the asset reaches zero.

If the truck, the company's main asset, suffers a serious accident and is reduced to scrap metal, it is depreciated completely at once. This loss could mean bankruptcy for the company. On the other hand, if the truck receives regular maintenance, annual loss of value is small and the company will probably make a profit. In other words, good asset management produces profits and bad asset management produces losses. When losses occur companies usually pinpoint the problem and find ways to improve management in general, including asset management. To do this, the first task is to generate and collect the necessary information.

In contrast to the business world, the enormous losses resulting from the bad administration of road networks go almost unnoticed. Road networks are managed in a different spirit than found in business undertakings. The traditional road agency is part of the public administration and does not usually

consider using the management tools and methods normal and obligatory in the business world. Today's road agencies do not view roads as an asset and do not generate the information necessary to evaluate the development of the road asset value. There is no interest in adopting the road asset concept, perhaps because it could lead to uncovering some very uncomfortable truths.

Conceiving roads as a gigantic asset may be a useful weapon in the fight to introduce a healthy road network conservation policy. This in turn will be indispensable for preserving road networks and ensuring the value of today's achievements and sacrifices for future generations.



THE NATIONAL ROAD ASSET

DEFINITION

The national road asset is all road infrastructure expected to generate benefits to present and future generations. The value of the road asset can be calculated in monetary terms.

APPLICATION OF THE CONCEPT

The concept of the road asset is a tool which makes it possible to evaluate the results of a road conservation policy applied in the past (ex post evaluation). If evaluation results are negative, adjustments can be made in order to get better results in the future.

Road asset value can increase either by building new roads or by improving existing roads to higher design standards. Road asset value decreases as a result of road deterioration, which is strongly related to the intensity of use. The essential purpose of road conservation is to reduce normal deterioration as much as possible and restore them to their original condition once they have reached regular condition. Conservation should also guarantee that roads retain their value and usefulness. The purpose of road rehabilitation and reconstruction is to recover those elements of the road network which, for some reason or another, have been lost.

The basic task of road agencies should be to supply and conserve a road network which in size and quality satisfies the needs of road users, and which can support and sustain the social and economic development of the country in general. At the present time, with generalized growth of population and trade, this task implies a gradual increase in the value of the road asset mainly by improving the existing road network. However, an excessive increase in the road asset can also be an inappropriate use of funds, especially if the network is being extended at the expense of maintaining existing roads.

As a general rule, loss of road asset value means that the conservation policy applied by the road agency or the government has been deficient and should be changed. Only very rarely may occur a situation where partial or total loss of some asset components is the result of deliberate and rational decision, for example when a road becomes obsolete because no one uses it.

The concept of the national road asset is neither a planning nor an optimization tool, but rather a means of assessing the degree of success or failure of the conservation policy applied in the past. It is based exclusively on real observed data and can only analyze changes which have occurred in the past. Policy planning and optimization employ other tools, such as the Highways Design and Maintenance Model (HDM III), developed by the World Bank. It is possible, however, to combine these tools. In fact, success or failure of the policies developed and optimized with the HDM III or other similar tools can be later evaluated analyzing fluctuations in the national road asset value.

CALCULATION OF THE NATIONAL ROAD ASSET VALUE

The calculation is generally carried out with the help of a personal computer and a spreadsheet programme and needs three types of data:

- Information usually available from each country's road inventory, such as a list of all existing roads and their various sections, section lengths, design characteristics and the approximate volume of daily traffic.
- Information about the cost for construction of new roads, and the cost of routine maintenance jobs, surface renewal, rehabilitation and reconstruction of the different types of roads existing in the country.
- Information which enables classification of the actual condition of each road section, preferably defined in five categories: very good, good, regular, bad and very bad.

Four values are calculated with this information:

- The present monetary value of a country's road asset, as the sum of the values of all individual road sections in their present condition.
- The maximum value of a country's road asset; that is, the value which the road network would have if all its sections were brand new and in very good condition.
- The lowest permissible value of a country's road asset, which is the value the road network would have if each section were in the worst permissible condition from a technical criteria. This usually corresponds to regular road condition.

- The percentage of the network in worse condition than the minimum permissible state. This percentage includes roads which have deteriorated to the extent that normal conservation activities (routine maintenance and surface renewal) are not sufficient for recuperation and they must be rehabilitated or reconstructed. For this calculation, all individual sections in this condition are identified.

These calculations make it possible to pinpoint the present value of the national road asset on a scale spanning the following range:



In a well-maintained road network, the total road network asset value should be close to the middle between the maximum possible value and the minimum permissible value.

With these calculations it is easy to identify the individual road sections where the “sin” has been committed of allowing the deterioration to go beyond the permissible point. Another result is the quantification of the approximate investment required for recuperating the road network.

PRACTICAL USES OF THE CONCEPT

What is the purpose of knowing the value of a country's road asset?

- The general public will be able to assess the degree of success of the road agency and of road management companies.
- Road users can judge whether their user rates have been well or badly spent.
- A road agency can prove the quality of its management and, if necessary, defend itself against possible attack.
- Road users may try to encourage the road agency to improve its performance.
- Society may develop a clear awareness of the gigantic value of the road network and of the enormous losses resulting from the lack of an adequate conservation policy.

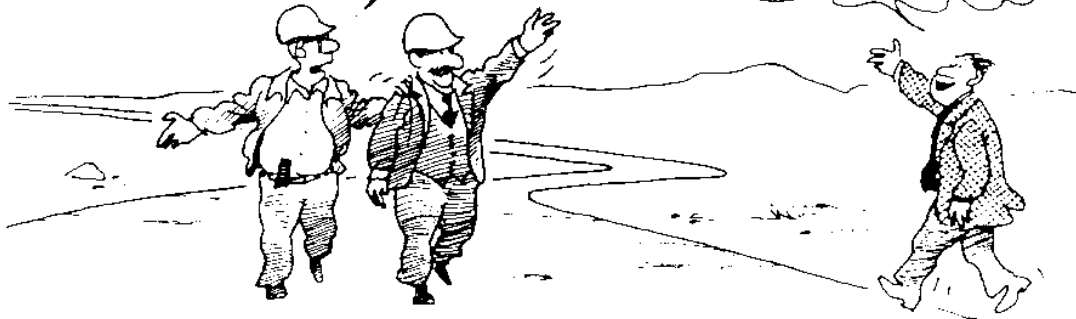


WE NEED FUNDS TO STRENGTHEN
THIS ROAD, IMMEDIATELY..



... OTHERWISE, NEXT YEAR IT
WILL BE A DISASTER!

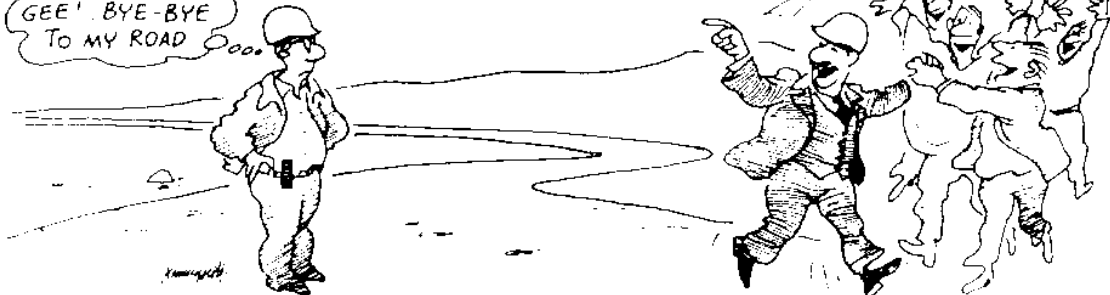
YOU'VE GOT
MY VOTE,
MR. SENATOR SCOTT!



CALL ME
NEXT YEAR!

SCOTT FOR SENATOR!
SCOTT FOR SENATOR!

(GEE! BYE-BYE
TO MY ROAD



THE REASONS WHY ROADS ARE NOT PRESERVED



This section looks at the attitudes of various groups in society toward roads in general and how these different positions eventually turn into decisions about road conservation.

Some groups of the population are in favor of good road conservation and others act as if they were against, but the majority reacts indifferent. Although the need to adopt a healthy road conservation policy cannot be doubted from a technical or economic point of view, in the minds of many, interests and perceptions seem to predominate that prevent an adequate road conservation policy from being put into practice.

The question of why roads should be conserved is answered here from two different perspectives. First, typical perceptions and aspirations of society about roads are looked at. Second, we examine the different interests of road users and other specific groups in the road network, including those groups with the decision making power. These interests help to explain the attitude of each group toward road conservation (in favor, against or indifferent). The type of road conservation policy finally applied is the result of the predominance of one or various of these groups.

ROADS AND THE ASPIRATIONS OF SOCIETY

A house which is not regularly maintained is subject to deterioration. This is plain to see even without expert knowledge in construction because it is clearly visible as time passes. Good working condition of machinery depends even more on maintenance, as can easily be seen in motor vehicles or elevators. Neglect soon leads to defective operation, complete breakdown or even greater dangers. Some people neglect maintenance while the deterioration is only of aesthetic nature, but in the case of technical equipment this neglect always has the risk of malfunction or even self-destruction, as happens to a vehicle engine which never has its oil changed. Things look different then. Most people probably see maintenance as tedious and uninteresting, but accept it as an unavoidable obligation.

Road conservation, however, does not seem to be very pressing at first sight. This is not only the general opinion of the public, but even of some road engineers. What causes this view? Roads, especially paved roads, have an air of "nobility". During the first years after construction, their deterioration is almost imperceptible by the average person. For this reason the idea exists that a road is something permanent and will last forever.

To better understand the typical attitudes towards road conservation, the general aspirations of society with respect to roads must be looked at.

Roads have existed from immemorial times. They are a basic means of connecting one place to another and their importance does not need to be discussed. Everyone, without exception, benefits from their existence in one way or another, and many people use them daily. Even those who do not use roads very often perceive their importance for moving people and goods and for providing access all parts of national territory. Roads are of interest to all groups of society although not everyone sees them in the same way.

Most people associate the idea of progress with construction, reconstruction or improvement. For roads, progress is mostly associated with paving. If someone were asked what he would like to see in roads, most probably he would mention improvements. If a road engineer were given the opportunity to realize his "golden dream", he would undoubtedly carry out a grandiose or spectacular new construction, thus contributing to his country's progress and at the same time satisfying personal ambition. No one should be surprised by the existence of these desires since they are present in all areas of human activity.

New construction, reconstructions and improvements bring prestige and public recognition to their promoters. The inauguration of a new piece of infrastructure is an especially gratifying moment for its instigators and for those who directly benefit. Therefore, petitions and pressure from the various interest groups are usually directed towards road improvements.

In contrast, conservation of existing roads has no popular appeal. The scarce attractiveness of conservation lies in the fact that it has no other purpose than to maintain something which already exists, and it does not satisfy the desire for progress. But mere preservation of what has already existed leaves a sense of stagnation. In a world where everything evolves so rapidly, things that do not go forward seem to retreat. However, lack of proper road conservation is a concealed form of retrogression. In fact, what has been achieved is gradually consumed and wasted, even though the manifestation of this waste is not at first apparent. Paradoxically, general interest in road conservation appears only when roads have deteriorated to such a degree that serious traffic problems arise.

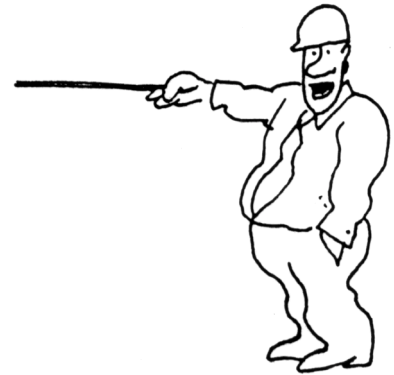
DEMOTED TO MAINTENANCE



Not all road experts are in agreement about the fundamental role of conservation. Many think that road conservation is simple and not very important and tend to think of it as something to be done by those who are not capable of doing anything more important. Often it is a real punishment for a road engineer to be relegated to the maintenance department. This attitude originates in a complete misunderstanding of what road conservation really means. It reaches the point that many roads agencies in Latin America and the Caribbean do not even understand the concept of conservation itself. Many maintenance departments believe that their task is to do nothing more than fill in potholes or fix obvious flaws in roads which have already collapsed from a lack of conservation.

The truth, however, is quite different. The truly complex activity related to roads it is precisely conservation, specifically in its planning aspect. Not all road engineers are capable to identify required conservation activities sufficiently ahead of time in order to avoid road collapse. It is a difficult task to decide what conservation measures should be carried out and how to allocate scarce funds in such a way as to get the best possible results. Therefore, conservation requires the most qualified experts, the best trained and most enterprising road engineers.

In annual government budget debates it is not easy to plead for road conservation because there are other sectors which are perceived to have greater priority (for example health, education or social security) competing for the same funds. Unfortunately, experience in several countries seems to indicate that it is difficult to convince people that road conservation is indispensable, until serious deterioration of the road network makes this obvious. Even if the general public were convinced of the need for road conservation at a particular moment in time, no one could guarantee how long this conviction would last. Once the emergency is overcome and roads are reconstructed and again in acceptable condition How long would it take for that experience to be forgotten and how long before funds are again redirected to other areas?



INTERESTS OF ROAD USERS AND OTHER GROUPS

Who benefits from roads? Which social groups most interested in their existence and why? Obviously, the answer to the first question is very simple, in general terms: all of us benefit from roads. However, to thoroughly understand the problem of road conservation this answer is not quite sufficient. Specific groups benefit in a particular way from the existence of roads. On the following pages, we identify these groups and their motivating interests along with the attitudes they adopt toward road conservation.

Roads serve the direct users who drive on them and move people or goods from one place to another. Important groups of direct users are commercial transport companies, owners and drivers of trucks, buses and utility vehicles. They are among the main beneficiaries of roads since their business or work takes place on them. Other direct users are drivers of individually owned cars who use roads to get to work or business, or simply for the pleasure of driving.

The main interest of direct users is that enough roads exist for them to go everywhere they want. As for quality, they would like all roads to be paved and in good condition, to minimize vehicle operation costs and make travelling comfortable.

Motivated by these legitimate interests, direct users are usually in favour of a constant increase in public spending on roads. They assume that increased spending on roads is equivalent to increasing the number and quality of roads and reducing vehicle operation costs and the discomforts of travelling. They also perceive that a reduction in road spending leads to contrary effects.

Users are not generally aware or convinced that they should pay for the service they get from roads. Nor are they aware that there is a relationship between their demand for more and better roads and the amount they should pay for the use of those roads. For example if a truck owner association demands better roads, it is not clear to most of their members that this may result in additional cost for them. This perception has its origin in the fact that there are few roads where tolls are charged and, except in these few cases, the user does not pay directly for the use of the road; in most countries he is required to pay general taxes which have no perceptible relationship to roads and whose amount bears no specific relationship to road spending. Incidentally, users usually do not specify what the greater funds they demand should be spent on and do not differentiate between funds for new construction and funds for conservation of existing roads.

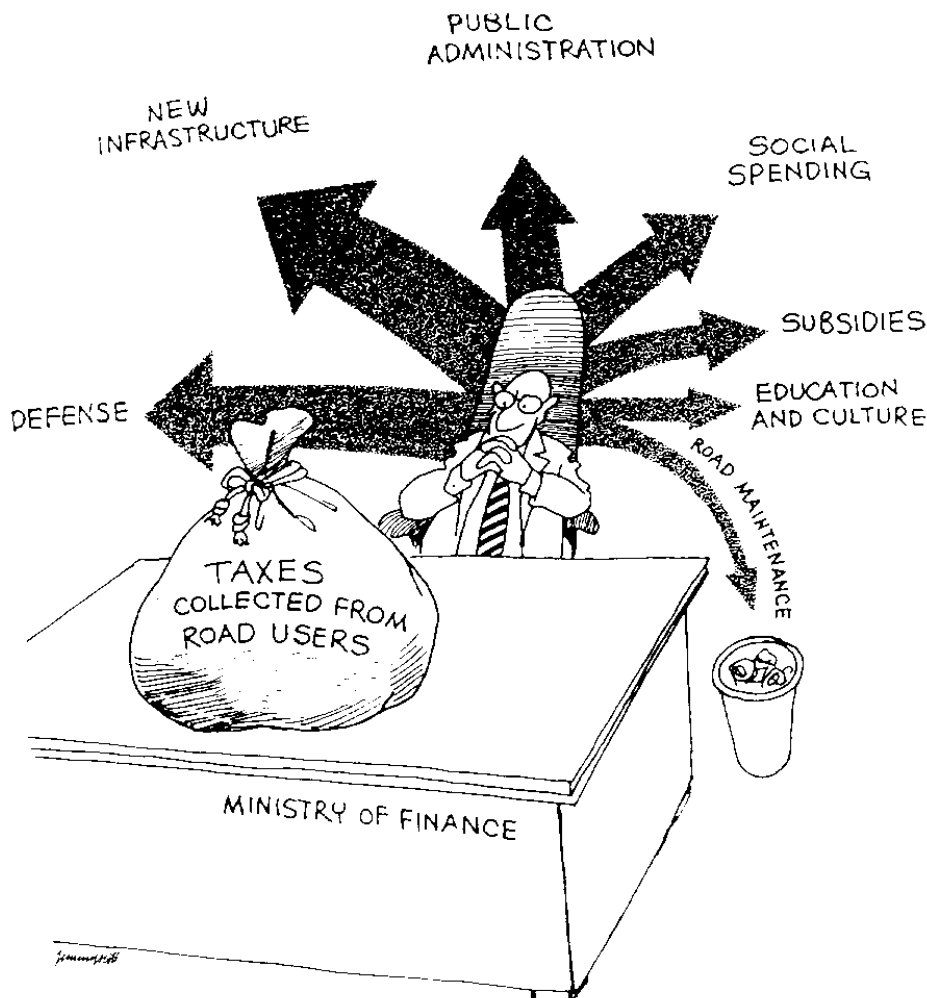
Another main beneficiary from the road network is the group of manufacturers of goods or services and agricultural products. These groups sometimes have their own vehicles but usually contract transport services from third parties, either for the trans-

port of inputs they need, or for sending their products to markets. Their main interest is fast and secure transport at the lowest possible cost. Consequently, their wishes and their attitude towards the road network are very similar to those of the direct users, that is, they are in favor of increased public spending on roads.

Passengers of transport companies are in a similar situation but add the special interest of personal safety. Here roads conditions plays an important role. Consumers should also be interested in the state of the roads because it has an influence in the price of transport and, therefore, in the final price of goods.

There are other groups whose interests are somewhat different, such as legislators, government authorities and leaders of opposition parties. These politicians want to be elected and reelected to govern and impose their particular conceptions of how to reach the common good. Politicians like to be considered promoters of economic and social development. In relation to roads, the attitude of local politicians is different from politicians active on the national stage.

Many local and regional politicians show a clear preference for public works as signs of progress and personal commitment to the local population. Specifically, they like to promote construction and paving of roads, because of the great visibility and geographical coverage, both important factors to gain votes. By promoting local road infrastructure measures, the local politician hopes that the public he or she represents will reward him or her with votes. He tries to create the image of being an ally in the "fight" for funds with the central government, often presented as the "common enemy" of both. The legitimate interest of local politicians results in asking for more public funds for the roads in his or her jurisdiction. This request is usually for the construction of new roads or the reconstruction of badly deteriorated roads, but very rarely for the conservation of existing roads which still may look presentable.



National politicians, for their part, are usually busy dealing with more general subjects of interest to the entire nation. They participate in the decisions on distribution of public funds and normally adhere to agreements reached by their political parties. Areas of national interest are usually such as basic health care, subsidies to the poor, education, public service salaries, military spending and new public works. It would be extremely unusual for a national politician to get deeply involved in road conservation since it is not very attractive and visible and not something which would generate much support or popularity. A good politician is one who "feels the pulse" of national events, senses the current interests of the mass of society, takes up those interests and lances them into the public debate, taking the stand which reflects his clientele, the voters. It would be against the legitimate interest of a politician to waste efforts or to "get worn out" on a matter like road conservation if it is not attracting much interest in the national environment.

Senior public servants of the Ministry of Finance are responsible for drafting the national budget, which should balance government income and expenditure. They are subject to strong pressure from various social and political sectors. Generally speaking, their behavior is governed largely by political agreements, the program of the governing political party and by measures taken to win electoral support for the government. It is not likely that their interests will include road conservation, except when the road network is in an advanced state of deterioration and causes great inconvenience to the economy and the public. In this case, however, funds have to be directed to the rehabilitation or reconstruction of roads because it is already too late for conservation. In very few countries of Latin America and the Caribbean there is an awareness that road conservation spending should not be simply the result of political negotiations over a budget package, but should stem from a long-term optimization policy resulting from a professional road network management.

Other groups owe their main activity to the road infrastructure. Among these are the employees of road agencies. These agencies are part of some government ministry and are responsible for the good functioning of the road network. Although many road agency employees are aware of the importance of road conservation, their performance is restricted by the lack of funds allocated by the government and by the desire of many of their colleagues to build new roads instead of conserving existing ones. Among the legitimate interests of senior road agency employees are: obtaining funds for expanding the network by building new roads, reconstructing or rehabilitating deteriorated roads, carrying out road maintenance and developing and strengthening the agency in general. In the pursuit of their interests they frequently come into conflict with the ministry of finance and other government ministers, because of the competition for limited public funds. Sometimes conflicts also occur because of criticisms toward the road agency for its supposed inefficiency.

The main business of road contractors is the construction of new roads. Although they should be equally interested in all types of jobs, their traditional work has been new construction, and they usually feel uncomfortable with road conservation. Their interest is that the amount of public funds allocated to the road system is as high as possible to guarantee permanent employment of their capacities and to maximize profits.

In several countries there are road associations which are non-government organizations bringing together professionals working in different areas connected with roads. Members come mainly from the private sector, but the road associations also include public road agency employees. Given the diversity of interests represented, road associations promote the development of roads in general, studying a whole range of related subjects and usually arriving at a rather balanced position between new construction and conservation. However, their influence on public opinion varies considerably from one country to another.

Another sector of society whose interest relate to proper road conservation are ecological groups. Roads are an alteration to the natural environment. Construction of the existing road network has already caused an environmental impact whose consequences are still felt. Defective conservation causes roads to deteriorate and requires subsequent reconstruction, which has a very negative effect on the environment. In fact, when a road has to be reconstructed, it must first be partially demolished. This produces large volumes of rubble and debris which have to be deposited somewhere in the landscape. Large quantities of newly extracted materials are necessary for reconstruction, and those excavations also alter the landscape. Adequate and timely road conservation requires a much smaller amount of resources. This is also true of resources used by vehicles, such as fuel, oil, tires, spare parts, etc. Consequently, conserving roads is consistent with defending the environment and ecological groups should support conservation of road networks. Unfortunately, the relationship between road conservation and protection of the environment is not sufficiently known at present and ecological groups have not yet discovered the issue.

Finally, the general public should be included on the list of potential road conservation interest groups, since they also support the general progress of the country. However, when asked about roads, most people prefer improvements and paving over all other measures. Road conservation only becomes a public issue once the network is in very bad shape, in other words, when it is too late.

The media, that is, the press, television and radio can collaborate in forming public opinion and are sensitive to public interests. They highlight what impacts the public and they usually cover inaugurations of new roads or planning and execution of improvements. However, usually they do not bring up road conservation until the state of the roads has become noticeably very deteriorated.

This exploration of attitudes by various groups in society shows that many individuals and groups have an interest in roads. However, the degree of interest and the specific perceptions of various groups make that road conservation is relegated to second or third place.



THE DECISION-MAKING PROCESS

Deficient or absent road conservation is the direct result of a series of decisions. However, those who make these decisions do not specifically ask themselves whether they should maintain roads and then decide against it; things do not happen that way. How are decisions about roads made, especially concerning conservation? The previous pages contain the beginning of the answer to this question. We have examined various groups interested in one way or another in roads, their relationship with roads and the legitimate interests behind their behavior. It can be assumed that the final decisions are result of interaction or even conflict of these interests.

Who finally dominates in decision-making are those groups controlling the financial resources. Today, in almost all countries funds for roads and their conservation come from general tax revenue. Although control and distribution of tax money is in the hands of the legislative power, the executive power has a decisive influence on their distribution. Thus, the distribution of budget funds depends on political negotiation, where technical and economic arguments carry only a limited weight.

There is no fundamental objection to this way of proceeding. The overall decision on national priorities is undoubtedly a political matter. In the end, the use of the limited funds in the public treasury is a political decision.

It should not be forgotten, however, that decisions have consequences. If it is decided to build a new road this is because that road is expected to give a service to the community over a very long period. It is hoped that the road network will continue to improve and what has been achieved will not be lost. The logical consequence is that the decision to construct (clearly a political decision) implicitly contains the decision to later carry out necessary road conservation. It would be unreasonable to decide on road construction worth hundreds of millions of dollars without being sure that it is worth maintaining those roads afterwards. Once a road is built, management and conservation issues move from the political to the technical level and should not be subject to annual political decisions whether conservation should be carried out or not.

In practical terms, if a government decides on the construction of a road worth 100 million dollars, it is not only committing itself to those 100 million dollars to be spent during construction. It is also committing itself, implicitly, to spending thereafter annually some 3 million dollars for conservation, making sure that the road will provide continued service as long as there is a need for it.

In most European countries this fact is totally clear to ministries of finance. The allocation of funds for construction of any type infrastructure has consequences on the budget for as long as that infrastructure may last (usually longer than any long-term budget planning period).

In Latin America and the Caribbean the approach to financing road network conservation is quite different. How are negotiations for road conservation funds carried out in practice? We have already explained that road conservation it is not a subject of high interest to politicians, and therefore it is unlikely that a political or parliamentary debate will ever take place on that issue. Thus, most decisions about road conservation are merely incidental sub-products of other decisions related to matters which are considered of high importance and current interest.

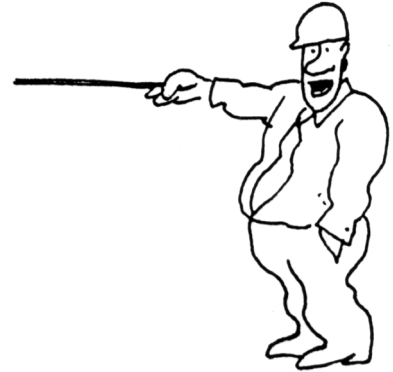
For instance, a factor which usually carries decisive weight in the allocation of funds to a specific activity is how much has traditionally been allocated to it. The basis of a new budget is almost always the previous year's budget with only minor modifications. This is one more reason why in the present system it is very difficult to rescue road conservation from its crisis. Unless there is strong political demand and as long as the distribution of funds continues to be based on the amount which has been allocated in the past, there is no way we will ever get better roads.

It happens at times that strong political currents in favour of allocating more funds for specific sectors or purposes arise. When an issue captures the interest of a wide sector of the public, typically money is diverted to support that cause. If the global revenue remains constant, an increase in spending in some areas will necessarily have to be accompanied by cut-backs

in others, usually in those where the budget decrease meets least resistance. Road conservation is one of the favorite areas for such cut-backs because it can be years before the disastrous effects become apparent.

Demand for the allocation of more funds for road conservation, either from road users or from the ministry responsible for roads, is unlikely to be successful unless it is echoed by important sectors of society. As we know, conservation measures must be carried out while the infrastructure is still intact and while roads still look reasonable. But this very appearance is counter-productive: while roads look presentable, no large sector of society will be compelled to raise its voice to demand more spending on conservation. Only when roads have collapsed for lack of conservation will the need for reconstruction be obvious. At that time it will be relatively easy to raise the necessary funds, even if these funds are three or four times more than the amount which timely conservation would have required.

Consequently, while decisions about the financing of road management and conservation continue to be made with a clear predominance of political interests, it is very unlikely that the deterioration of roads can be halted.





5. PROBLEMS AND THEIR BASIC CAUSES

The purpose of this chapter is to identify the basic causes of the erroneous or unsatisfactory decisions which are repeatedly made in relation to road conservation. Starting from familiar problems we can conclude that these problems are mainly the result of two basic causes. These causes are the present system for financing road conservation in general and the way road network management is presently organized.

The condition of large parts of the road networks in Latin America and the Caribbean leaves much to be desired. Most of the roads are in regular or bad condition, with a clear tendency towards accelerated deterioration. A small proportion of the road networks is in good condition, but even this is not likely to remain so for long. The vicious and expensive cycle of road construction, lack of conservation, collapse and reconstruction is daily bread in road matters. Some countries have made efforts to overcome this pernicious situation, but even when they have succeeded to some degree it seems unlikely that these achievements can be sustained.

To radically modify such negative expectations it is necessary to make important changes in the way road networks are presently managed. The present institutional setup conspires against bringing road conditions to a reasonable level and does not permit harboring of hope of reversing this negative trend in a full and sustainable way. Any change must be directed at eliminating the two basic causes of the present bad situation. Without a clear understanding of these causes there is not only the risk of failing now, but also of discrediting later attempts to bring about the necessary changes.



PROBLEMS WITHOUT END

Roads present many problems which give rise to countless complaints from varied circles. Over the last decade a move from relative complacency to noticeable dissatisfaction with roads has been made. Why has this change occurred? How do road users and the general public perceive our arrival at this situation?

The impression today is that significant road sector progress made over past decades is receding rapidly. For example, travelling today in Brazil between São Paulo and the cities of Curitiba and Porto Alegre requires coping with difficulties and dangers, making the drivers subject to a state of permanent tension. Fifteen years ago it was much easier to travel the same route. Is this a false impression or an isolated case? Not at all. Objective analyses made in various countries using reliable instruments and methods corroborate with this perception.

Besides the general road deterioration, the fact that fewer new roads are constructed adds to the annoyance. The great road building impulse of earlier decades seems to have disappeared without substitution by a clear desire to preserve what was achieved. The situation is insurmountable: road networks are deteriorating with giant steps because adequate conservation of the road networks is not being carried out.

At periodic meetings of road engineers and technicians the same long list of complaints about the problems of road conservation is always heard. The list of complaints is usually the following:

- lack of funds for road conservation
- deficient execution of maintenance tasks
- lack of maintenance planning
- lack of maintenance equipment and machinery in working condition
- deficient maintenance of maintenance equipment
- bureaucratic and administrative bottlenecks
- low salaries and low motivation in the road agencies
- low average qualification of maintenance department staff
- loss of qualified personnel to private enterprises for salary reasons
- excess of personnel in the road agencies
- maintenance budget largely spent on staff-related costs
- low level of efficiency in the road agencies

- repetition of the eternal cycle of construction-lack of conservation-collapse-reconstruction
- lack of understanding of the true meaning of a healthy conservation policy, sometimes even by senior staff members of road agencies
- and many more.

This book would be far too long if all the problems mentioned were discussed. Instead, we shall concentrate on what has been done to overcome these problems and to improve the management of road networks.

ATTEMPTS FOR SOLUTIONS

There have been two types of attempts. First, some countries have attempted to solve the problems by their own initiative and means. The other type of attempt has been made by foreign agencies, mainly international development banks and technical assistance programmes which have promoted the technical and institutional development of road agencies, sometimes using highly qualified foreign personnel for prolonged periods. Some of these financing agencies have evaluated their attempts and projects, sometimes officially but normally unofficially, for their own internal use.

Conclusions from these evaluations are quite uniform: virtually no project resulted in a sustained long-term improvement of the road network in any country or part of a country. If improvements were achieved, they were only temporary. Shortly after each project ended (along with the end of foreign funding, and after the departure of well-paid foreign experts), roads returned to the same bad condition they were in before, or even became worse.

Results obtained by countries who undertook the task of improving road management on their own initiative were not much better. Their successes were usually lost with changes of government or the replacement of those senior employees who fostered the improvements with most dedication.

What is the cause of the limited success of these attempts? Among other things, certain basic procedural errors:

- In many cases, it was tried to eliminate only some problems, while other problems remained unsolved.
- When positive decisions were taken, they were shortly afterwards modified or annulled for administrative or political reasons; no thorough reform of road management or the decision-making process was made.
- Usually only problems and their consequences were attacked, leaving their basic causes unresolved.

THE BASIC CAUSES

The severity of the situation makes it obligatory to discover why the problems mentioned have persisted for so long. Here we postulate the thesis (which we shall attempt to prove in the following sections) that all the problems earlier mentioned have their main origin in two fundamental causes:

THE FIRST CAUSE: AN INADEQUATE SYSTEM FOR FINANCING ROAD CONSERVATION

It is impossible to base guaranteed, stable and long-term financing for road conservation on funds which need to be allocated from the general government budget, especially if the decisions on this allocation depend on the annual political budget debate.



Financing for road conservation does not need to be reconsidered and discussed every year. It is inconsistent and clearly against public interest to decide in favor of the construction of roads and then permit their destruction. Adequate road conservation is implicit in the earlier political decision to build roads.

Experience shows, however, that projects with significant political impact, such as large new infrastructure works or social programs, are clearly preferred in general budget discussion. Road conservation is not very attractive politically and therefore does not get much attention, and finally falls victim to the inconsequence described above.

Moreover, "emergency situations" are always cropping up, natural disasters or man-made catastrophes, which require urgent financing to alleviate their consequences. In many cases, the already insufficient budget for road conservation is cut; it is one of the most convenient source of emergency funds. Experience shows that this practice is common and difficult to modify.

THE SECOND CAUSE: AN INADEQUATE ORGANIZATIONAL SETUP OF ROAD MANAGEMENT

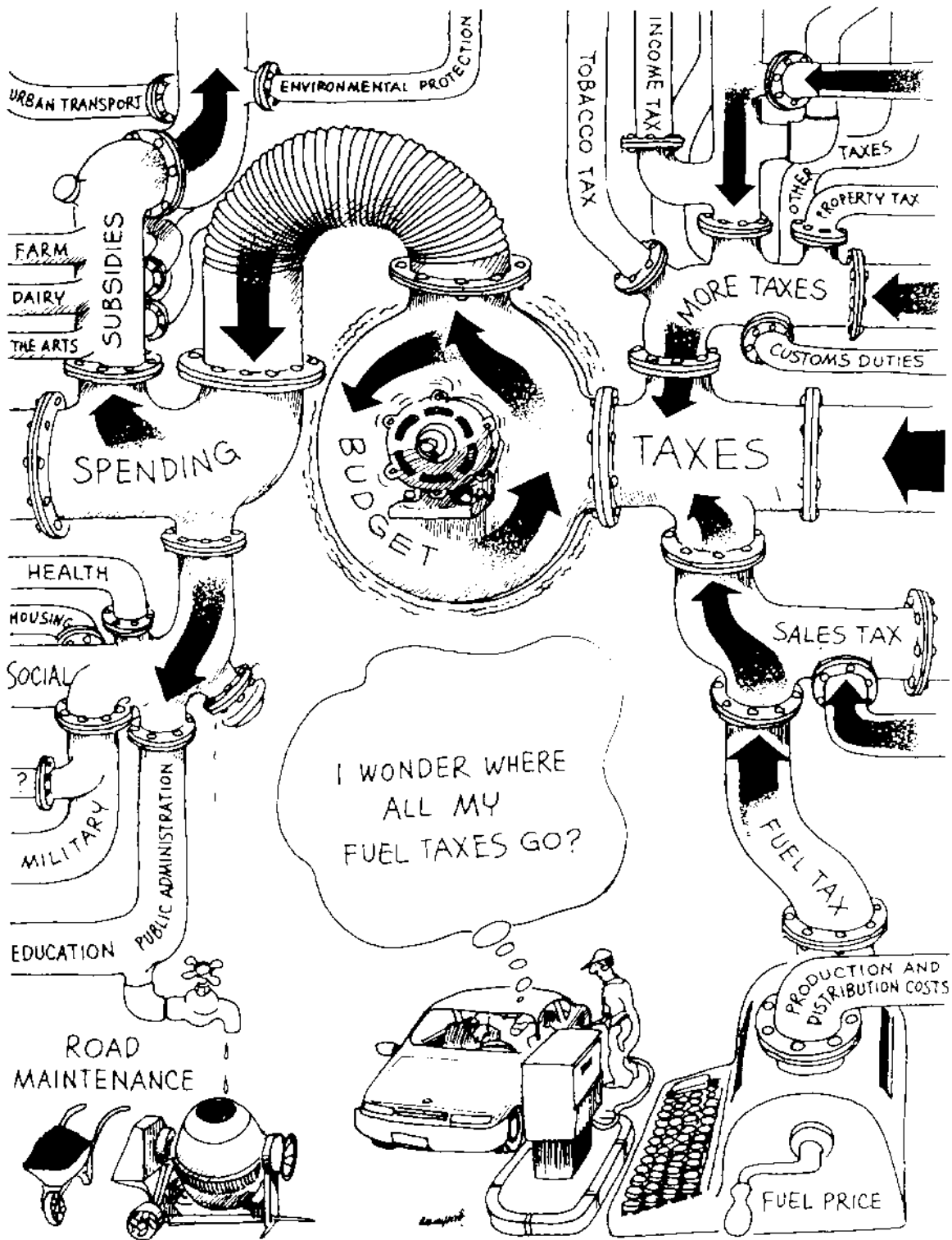


It is practically impossible for a government ministry (with all the consequences this implies) to efficiently manage the road network of a country. In spite of the good intentions of many of the public employees responsible for road administration it is not possible for them to resolve the innumerable problems which have persisted for such a long time.

In Latin America and the Caribbean, the management of existing roads (which today is better called “road administration”) is almost exclusively in the hands of departments within government ministries, for example Road Departments in Ministries of Public Works. In some countries, parts of physical conservation works are contracted out to private companies, although this practice is more common for new construction, rehabilitation or reconstruction. But even in these cases tasks are carried out under direct control of the ministry responsible.

The appointment of a large percentage of the persons with decision-making power is based not only on professional or technical criteria but also on political considerations. Thus, many of the important decisions adopted are for paying past “political debts”. Certain attitudes, criteria and loyalties prevail in the decisions which are not consistent with the principles of efficient organization and management. The most well-known consequences of these attitudes are massive hiring of superfluous personnel at election time, lack of discipline, corruption and absence of true incentives to bring about improvements. Attempts to improve things sometimes even lead to sanctions for those who try. It seems highly unlikely that road conservation can be substantially and sustainably improved maintaining the currently prevailing system.

On the premise that these two basic causes are the origin of poor road conservation, it is necessary to profoundly reconsider the financing and organizational aspects of both road management in general and road conservation in particular. To make room for a new system it is necessary to eliminate these two basic causes simultaneously. If only one of the two causes is attacked it is not likely that reform will be successful. In the following sections we show that by simultaneous elimination of both of these basic causes, the multiple problems mentioned earlier can be solved much more easily.



6. FINANCING ROAD NETWORK CONSERVATION

Previous sections of this book describe present road sector inadequacies. This section begins another group of sections, proposing a new approach to the road issue, including a series of changes indispensable to successful road sector reorganization. This section deals with the financing of road conservation; section 7 presents solutions for the institutional and managerial aspects of roads. Section 8 details some of the more global aspects of the changes suggested.

RATES FOR A SERVICE AS OPPOSED TO GENERAL TAXES

Roads provide a public service, meaning they can be compared to other public utilities such as water, electricity or telecommunications. The users of these services pay a rate which makes up an income for the utility company. That income may be used by the company in a way most suited to its purposes, with few restrictions. Consequently the State or a government currently in power cannot interfere with how these funds are used.

In this respect, rates for services are very different from taxes, which usually form part of general government revenue and are not earmarked for any specific type of expenditure. For example, when a person pays the value added tax (VAT) it is virtually impossible to know what specific government expenditures will be financed with this payment. Contrary to what many people believe, fuel taxes paid by vehicle drivers are not specifically for expenditures on roads, except in a few countries which have installed road funds. This situation is relatively new; in the past many countries in the region did have an effective link between fuel taxes and road spending.

What then is the essential function of taxes? Taxes finance certain sectors or activities deemed essential by society; but as they cannot generate sufficient revenue for self-financing, they require subsidies. Typical and traditional subsidy sectors are basic education, basic health, defense and public administration.

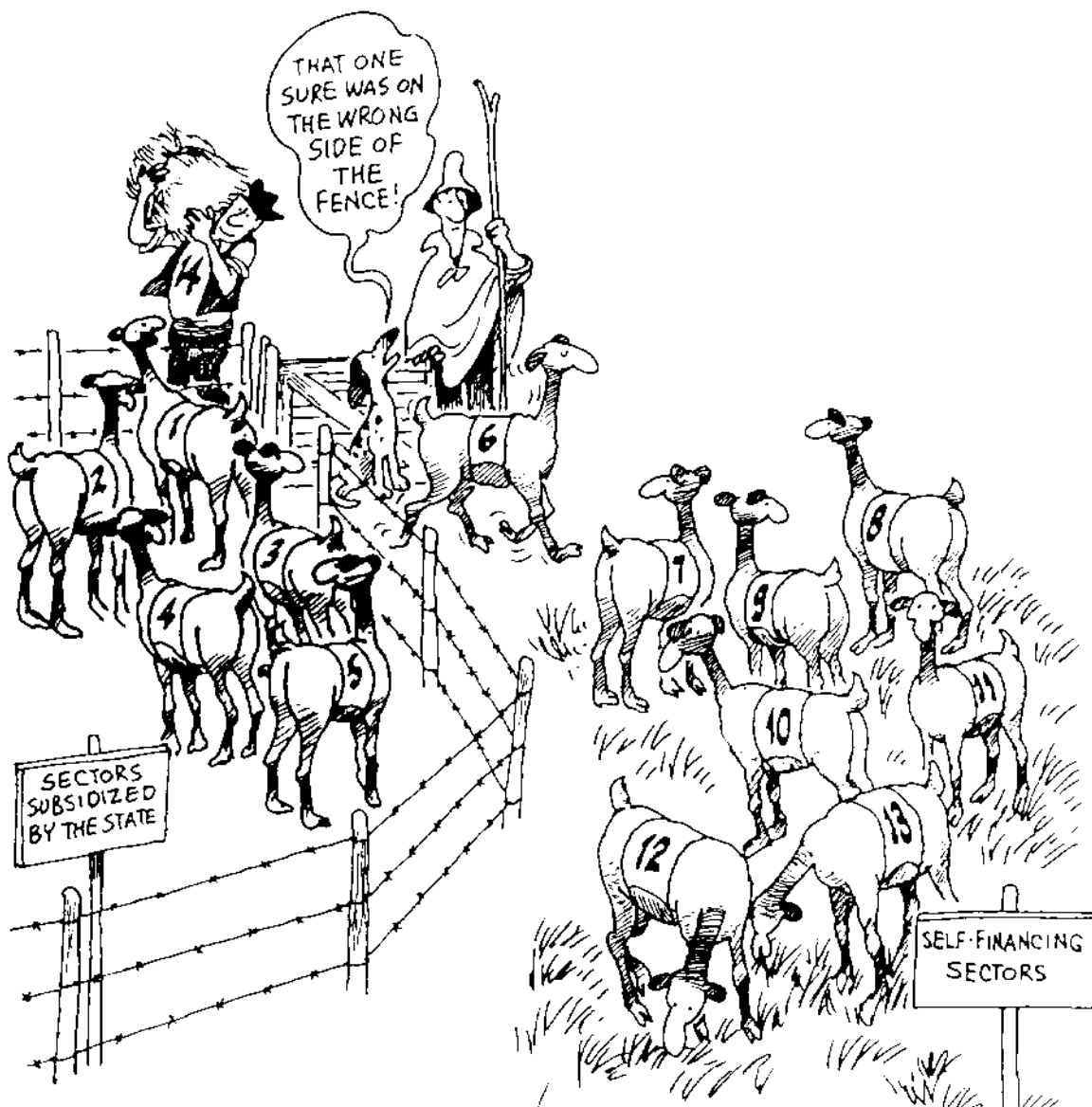
Some countries, especially those with centrally planned economies, have considerably increased the number of subsidized sectors by incorporating, for example, urban transport and housing. However, most developing countries who have fallen victim to prolonged financial crisis recognize today that many sectors cannot continue to be subsidized from general tax revenue. Also, the collapse of many state-owned enterprises has imposed the need to privatize services and charge users rate levels which allow to cover costs.



The conservation of the road network can be financed through rates, paid directly by vehicle owners or operators, who are members of an income group that generally does not need subsidizing. To continue considering the road transport system a subsidy sector, i.e. dependent upon funds to be generated in other sectors of the economy, would be a mistake. Once again, the experience of electric utilities is a useful example: service is financed by rates paid by users according to the amount of electricity they consume.

The absence of a direct link between road spending and taxes paid means that both road agencies and users have the tendency to ask for a growing amount of money for roads. It also prevents both groups from seeing the need to ensure a more efficient and effective use of allocated funds. The situation is made worse as these demands are not echoed by senior government officials or politicians who prefer to use tax revenue for purposes they consider more attractive.

Financing road conservation by charging rates, whose level is periodically adapted to conservation needs, forces road users to be aware of the connection existing between road conservation spending and the level of the user rate. Consequently, implementation of a road user rate system could lead road users to place emphasis on greater efficiency in road management.



- 1 DEFENSE
- 2 EDUCATION
- 3 THE ARTS
- 4 PUBLIC ADMINISTRATION
- 5 URBAN TRANSPORT
- 6 ROAD TRANSPORT SYSTEM
- 7 INDUSTRY
- 8 COMMERCE
- 9 EXPORTS
- 10 ELECTRICITY
- 11 WATER SUPPLY
- 12 MINING
- 13 SERVICE INDUSTRIES
- 14 THE STATE

CREATION, DOWNFALL AND RESURRECTION OF ROAD FUNDS

Several decades ago many countries introduced a number of taxes directly related to specific uses. For example, during the 1930s and 1940s it became necessary to guarantee stable financing of large-scale road network expansion. On the basis of road sector tax revenue mainly derived from taxes on fuels, specific road funds were created which financed the construction of large segments of existing road networks.

By the 1970s and 1980s many countries' road networks were close to completion and the massive construction boom began to slow down. As a result, it became necessary to adapt road funds to a new reality and shifting emphasis from the construction of new roads to the conservation of existing roads. Nevertheless, what was done in practice was to eliminate road funds, along with most other earmarked taxes. What caused this change in policy?

The earmarked taxes levied for specific purposes were often absurd, lacking a logical coherency between the good or service taxed and the final use of funds generated. Many governments ran into a growing number of obstacles in making changes in their general policy and spending patterns. This occurred as a large amount of tax money was tied to specific uses by old laws that no longer bore any relationship to the needs of the day. Finally, a world-wide campaign started up, with the support of the International Monetary Fund (IMF) and other international organizations, to eliminate earmarked taxes and create general budgets. The success of this campaign can be measured when one considers that over the last 15 years almost all countries in the world have eliminated earmarked taxes.

The world-wide campaign against earmarked taxes took off exactly at the moment when the road networks began to need greater financial support for their conservation. The elimination of earmarked taxes was, as a general measure, positive. However, it made road conservation funding even more precarious than it was before. The end result was a disaster for the road transport system. What should have been done was to eliminate the old conceptual error of financing road conservation through general taxes instead of user rates. While earmarked taxes and road funds existed this conceptual error was covered up.

In the case of roads, the old debate over earmarked taxes has resulted in considerable damage and confusion. For many economists in Latin America and the Caribbean, the abolition of earmarked taxes is seen as a great achievement since they did not result in an optimum allocation of funds in many instances. The merits of doing away with earmarked taxes is widely recognized. So it came as a great surprise to many when they read, in the most recent publication of the World Bank on the subject² that there is "a clear recognition that most of the governments cannot continue financing roads out of general government revenue", together with suggestions (however timid) that some type of road fund will be indispensable. In our opinion, continuing to argue about earmarked taxes in relationship to road conservation makes no sense; the idea of financing road conservation with taxes (be they general or specific) is simply not appropriate for today's situation. On the other hand, a road conservation fund seems to be necessary not only to guarantee stable financing of road conservation, but also to ensure good road network management.



EFFICIENT COLLECTION OF USER RATES

Apart from the purely financial contribution it makes, the basic idea of a road user rate is to create a clear relationship between the use of a service and how much must be paid for it. In this respect, user rates tend to encourage the efficient use of the service, because inefficient use results in higher rates for the user. The subject of efficiency comes up again when looking at the different ways of charging rates.

For roads, as we shall see, it seems that the most efficient way of charging users is to include rates in the fuel price. This charging mechanism should provide the main source of financing for road conservation. Various organizations (including the World Bank) have studied diverse ways of charging for road use. The results of these studies show that including the charge in the fuel price is by far the most economical method because the collection cost is less than 1 percent of the amount collected. This mechanism also has an additional advantage in that it is almost impossible to evade; that it covers the entire network and that it is based on the close relationship between the amount of fuel consumed and the amount of "road service" used.

Tolls are much less efficient. To begin with, charging tolls is only reasonable on roads with an average traffic volume of above 1500 vehicles per day. With less traffic, the revenue is too low to justify the high fixed costs of a toll collection system, and

collection costs may, in some cases, exceed the revenues collected. On roads with traffic above 1500 vehicles per day, the costs of collecting the toll (equipment, personnel, etc.) are between 10% and 30% of the amount collected, assuming that the amount charged is adequate and the system well managed. However, there are cases in the region where the toll charged is so insignificant that the amount collected scarcely covers the costs of the system itself, meaning no funds are generated to pay for road conservation or anything else. Tolls also are disadvantageous because it is impossible to charge them over the entire road network. Furthermore, roads with an average traffic above 1500 vehicles per day constitute less than 6% of the total Latin American and Caribbean network.

At first sight the “electronic toll” seems very attractive. There are various technical variations on this novel system. One type uses computerized devices installed at the roadside to recognize and register every passing vehicle. The amount charged to the user increases every time his vehicle passes a registration device and the user is charged automatically by means of an account in a central database. The first versions of this system, still in the experimental stage, are being tried out on some suburban superhighways in the United States and Asia. In Latin America and the Caribbean, however, given the low average daily traffic on most roads, the overall installation of that or a similar system is clearly not viable for several decades to come.

In the absence of other viable methods, charging via fuel price is the most efficient way of collecting road user rates. Tolls can only be a solution for some sections of the network which have been built to a high technical standard and have heavy traffic. Specifically, tolls may be useful in cases where new road infrastructure must be financed, or where road congestion and contamination problems need to be alleviated.

Now, how would the proposed charging mechanism work in practice? Although there are various possible answers, the best would be to use the system which is presently used for charging the fuel taxes, that is, to include the road user rate in the price of the first sale of the fuel in the country. What is the “first sale”? If the fuel is refined in the country itself, the first sale is when the oil refinery sells to the fuel distributors. In this event, collection of the tax (and, in the future, a road user rate) is done by the refinery, which periodically transfers the tax collected to the Ministry of Finance, through a special bank account. If the fuel is imported in refined form, it is usually the customs service which collects the tax from the importers, usually at the time when the fuel leaves the storage depots in the port of arrival.

With the system we propose, there would be a separation between the collection of general taxes and the collection of road user rates. The oil refinery would continue to sell fuel to the distributors, and the wholesale price charged would contain three elements: first, the production cost of the fuel sold, which includes profits and overhead costs for the refinery; second, taxes levied by the government which are used for purposes not related to roads; and third, a road user rate which would have the sole purpose of financing the conservation of existing roads. The refinery would continue to transfer the fuel tax collected (maybe a somewhat lower tax rate) to an account held by the Ministry of Finance. However, the portion corresponding to the road user rate would be transferred to another bank account corresponding to the road conservation fund, to which the Ministry of Finance would not have access. (The issue of how to control the road conservation fund is dealt with in section 7.)

USER PRICING

Road user pricing has been one of the favorite subjects of a whole generation of economists who have worked in the area of roads over the last thirty years. It would be too pretentious to review the entire discussion on road user pricing here. It suffices to point out that generally the numerous studies have finally converged on the theoretical concept of short-run marginal cost pricing.

However, the general agreement reached in most of these studies has not been very useful to professionals who are looking for a practical way of setting the user charge. This is either because they do not have the necessary data for applying the formulas these studies suggest, or because there are various ways of interpreting the texts, or simply because political currents have developed which are opposed to any change in form or amount of the user charge.

Confusion gets worse when one reads, in the most recent publication of the World Bank on the subject, that in virtually all countries the application of the short-run marginal cost price would lead to a financial deficit, meaning that an important part of necessary road spending could not be financed.

It would be a mistake to come to the conclusion that the entire short-run marginal cost pricing concept is useless. There is no doubt that in theory it is effective in achieving what it was specifically designed to do, that is, to optimize the use of funds in a national economy. The problems countries are presently facing in relation to roads are of another type, and are much more



related to the need for stable financing for the conservation of the road network. Therefore, the key is to find a way of guaranteeing financial equilibrium between necessary road maintenance expenditures and payments made by road users. In this task, the concept of short-run or even long-run marginal cost pricing does not provide useful answers. Consequently, setting the road user rate will require establishing a new base. As a point of departure, the following questions should be clarified:

- **What exactly is the road user rate meant to finance?** In the present situation, the most urgent need is the conservation of the existing road network. At least initially, the use of the rate should be limited to this task. In a second stage the financing of new road infrastructure could also be considered, for expanding the network or improving it. Financing both road conservation and construction simultaneously from the start could make things too complicated and is therefore not recommended.
- **What part of the road network should be conserved with the rates collected?** Significant sections of road networks in the region have a very low volume of traffic, and it is legitimate to question whether it is just to oblige all vehicle owners in a country to pay for their conservation. We have already mentioned the extreme case of roads where only one or very few individual users are interested in their use. It is therefore recommended to divide roads into two categories. The first category should include all those roads whose conservation can and should be entirely financed through road user rates (these roads make up what we later call the “viable” network). The second will include roads with a very low volume of traffic, whose conservation should only be carried out if the directly interested individuals or groups contribute some of their own funds (the “non-viable” network).
- **How much spending is required annually to conserve the “viable” part of the network?** In-depth knowledge of road network characteristics permits the definition of annual spending requirements for conservation. In this sense, it is indispensable to have information on the technical specifications of each road, in other words, a good road inventory. However, under the present system of public road administration, this information is often not available. Required spending estimates for the road network will be more or less precise, depending on the quality of information in the road inventory. Road conservation experts throughout the world agree that, as a general rule, adequate road conservation has an annual cost of between 2,5 % and 3,5 % of the replacement value of the road to be conserved, depending on climate and traffic volumes. This estimate is based on the assumption that the roads are in “maintainable” condition and do not need to be rehabilitated or reconstructed first. In accordance with the two categories of the network identified above, the annual financial needs for road conservation should be calculated separately for “viable” and “non-viable” roads. To compensate for yearly variations, an average estimate over the medium term should be made.
- **What is the approximate quantity of vehicle fuel consumed over the entire road network?** This question is related to the possibility of using fuel consumption to indirectly quantify the amount of traffic on the road network. In practice, the direct measurement of traffic volumes on all roads of the network is almost impossible, because it would require constant vehicle counting throughout the network. Measuring the amount of fuel consumed by vehicles, in liters or gallons, is an acceptable substitute for the direct measurement of total traffic flow, because there is a sufficiently close relationship between the two parameters.

Finally, our procedure proposes that determining the rate to be charged for a certain year is simply the result of dividing the total amount of funds needed for conservation during that year by the quantity of vehicle fuel expected to be sold in the country over the same year. Thus, the rate is simply a specific amount of money for each liter or gallon of fuel sold. This rate has to be adjusted in two ways: in the short term, according to inflation indices, and in the medium and long term, according to changes in the overall conservation needs of the road network.

The value of the road user rate and the adjustments which may have to be made to it can be expressed in a rate formula. The elaboration and compulsory application of formulas for setting rates is a normal procedure in many public utilities and services in Latin America and the Caribbean as well as in industrialized countries. For example, in the case of electricity, rates are adjusted according to a series of parameters. These include the amount of rainfall because in case of drought there is a drop in the amount of electricity produced by hydroelectric power plants. The world price of petroleum also has an influence, because it affects the cost of thermoelectric production of electricity. Other factors are, for example, salary levels in the country, the volume-relationship between hydroelectric and thermoelectric production, the price of energy from other sources, and the degree of efficiency which is supposedly standard in managing electricity companies.

The formula for defining electricity rates is the result of a process in which all groups interested in the functioning of the service participate, or at least should participate. The various groups interested in roads have been mentioned in an earlier section of this book. If these groups could come to an agreement on the road user rate formula to be applied, a great step forward would be taken in the process of reorganizing road network management.

In this book we have repeatedly referred to the need to guarantee efficient road management and the way to arrive at this efficiency. It must be stressed here that the introduction of rates is only recommended when the problem of efficiency is solved simultaneously. Otherwise, if the degree of inefficiency increases, imposing a user rate system would mean a penalty for users. Simply changing the form of financing, that is, replacing general tax revenues with a road user rate, is neither a solution in itself nor an incentive for better efficiency in road management.

DIFFERENTIAL RATES FOR LIGHT AND HEAVY VEHICLES

All vehicles cause a certain amount of damage to the roads they use. The damage caused bears a clear relationship to vehicle weight. Under normal conditions, heavy vehicles, together with the effects of water, are the principal cause of road deterioration. This is due to road surface deformation caused by their heavy weight. It must be asked, therefore, if it would be fair to charge all road users a uniform rate.

It is true that heavy vehicles consume more fuel per kilometer and for this reason alone will automatically pay more than light vehicles. For example, a regular car consumes approximately ten liters of fuel for every 100 kilometers, while a truck easily consumes three to five times more over the same distance.

However, various studies carried out over the last few years have clearly demonstrated that the damage caused by heavy vehicles is much higher than this proportion; the passage of one (over-) loaded truck can cause as much damage to the road as the passage of several hundred light vehicles. Keeping this in mind, it would be difficult to defend the setting of a uniform rate for all vehicles. This leads to the next question. How can a differential rate be applied to light and heavy vehicles?

The answer lies in the types of engines and fuels used by the two classes of vehicles. Almost all heavy vehicles use diesel fuel, and light vehicles usually use gasoline. Since heavy vehicles cause most damage it would, therefore, be logical to charge one rate for diesel fuel and another, much lower rate for gasoline. If, however, there is too much difference in the overall price of the two types of fuel, there is the risk that gasoline engines will be installed in trucks, even though diesel engines are much more efficient for heavy vehicles. Consequently, establishing too great a difference in the overall price of the two fuel types would not be a good idea in practice because it would encourage an inefficient use of fuel.

To clear up this idea, we will have a look at the various components of the final selling price of fuel, that is, the price users pay at the service station.

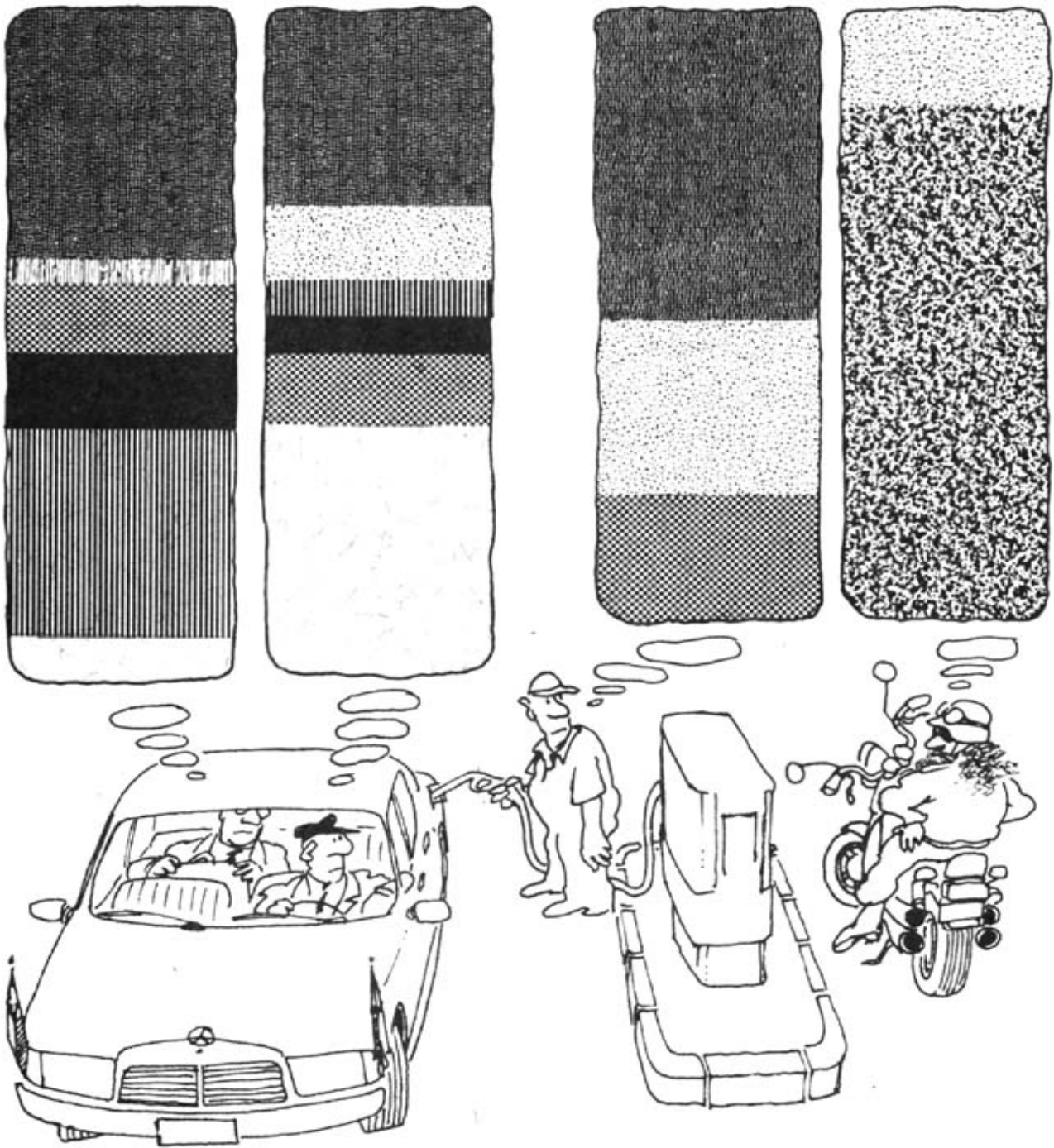
THE COMPOSITION OF FUEL PRICES

When a road user drives to a service station, fills his tank and pays the price shown on the pump, the amount he pays can be divided, essentially, into three components:

First, he pays the cost of fuel production and distribution (including the cost of all the intermediate steps such as crude oil exploration, extraction, refining, transport, etc.) as well as the profits of the companies carrying out these processes. In most countries of the world, the value of this first component is approximately US\$ 0.25 to US\$ 0.30 per liter.

Second, a certain amount is paid for financing the construction and conservation of the road infrastructure. A fraction of the specific fuel tax is allocated to this purpose in spite of the fact that there is no binding legal relationship between the specific fuel tax and spending on roads.

WHAT DO YOU THINK YOU ARE PAYING FOR WHEN YOU BUY FUEL?



ROADS



WELFARE



DEFENSE



HEALTH AND
EDUCATION



THE ARAB SHEIKS



GOVERNMENT
FAT CATS



YANKEE IMPERIALISM



OTHER NONSENSE

Third, through the fraction of the specific fuel tax not spent on roads, the user is paying for other government spending not related to roads, which could be for anything included in the national budget.

It should be noted that the sales tax or value added tax (VAT) is a general tax applied on almost all products, including to the price of fuel. It is therefore different in nature from the specific fuel tax, which is charged in addition to VAT and has more in common with other specific taxes, such as "luxury taxes" on tobacco or liquor. However, in the context of this book the general sales tax or VAT on fuel is considered out of the context and is not treated any further.

The amount of the specific fuel tax varies considerably from one country to another. The oil-producing countries, like Ecuador and Venezuela, have traditionally had very low taxes on fuel, which is sold practically at or even below the cost of production and distribution. In Western Europe, on the other hand, the specific fuel tax can be as high as almost one dollar per liter. But most countries are somewhere between these two extremes.

Under present circumstances, the fuel purchaser does not normally know that he or she is making three payments at the same time. In any case, as long as the total price of fuel remains relatively stable, the purchaser is probably not very interested in the matter, either.

To what extent, then, can the government influence the price of fuel? In Latin America and the Caribbean, the government normally has little influence on the production and distribution cost of fuel, unless it is an oil producer. It can, however, play with the specific fuel tax, increasing or decreasing it. In addition, it can reduce spending on roads to leave more funds for other purposes or, the reverse, increase road spending and lower the amount for other areas. In fact, governments are often very flexible in the way fuel taxes are spent.

Returning to the problem of differential rates for heavy and light vehicles, it must be asked how a high charge for diesel and a much lower charge for gasoline could be applied, without excessively altering the present relationship between the final sales price of the two types of fuel. In practice, this could be managed by differentiating specific fuel taxes and user rates. In the case of diesel fuel, this means applying a high road user rate per liter but, on the other hand, a low specific tax or even no specific tax at all. Inversely, for gasoline, a rather low user rate and relatively high taxes could be applied.

THE USE OF MONEY PAID FOR FUEL

The three following figures show the flow of financial resources which are paid by vehicle operators when purchasing fuel. The first figure shows the present typical situation and the second and third show the flows that would occur if the solution proposed here were applied (Gasoline and Diesel).

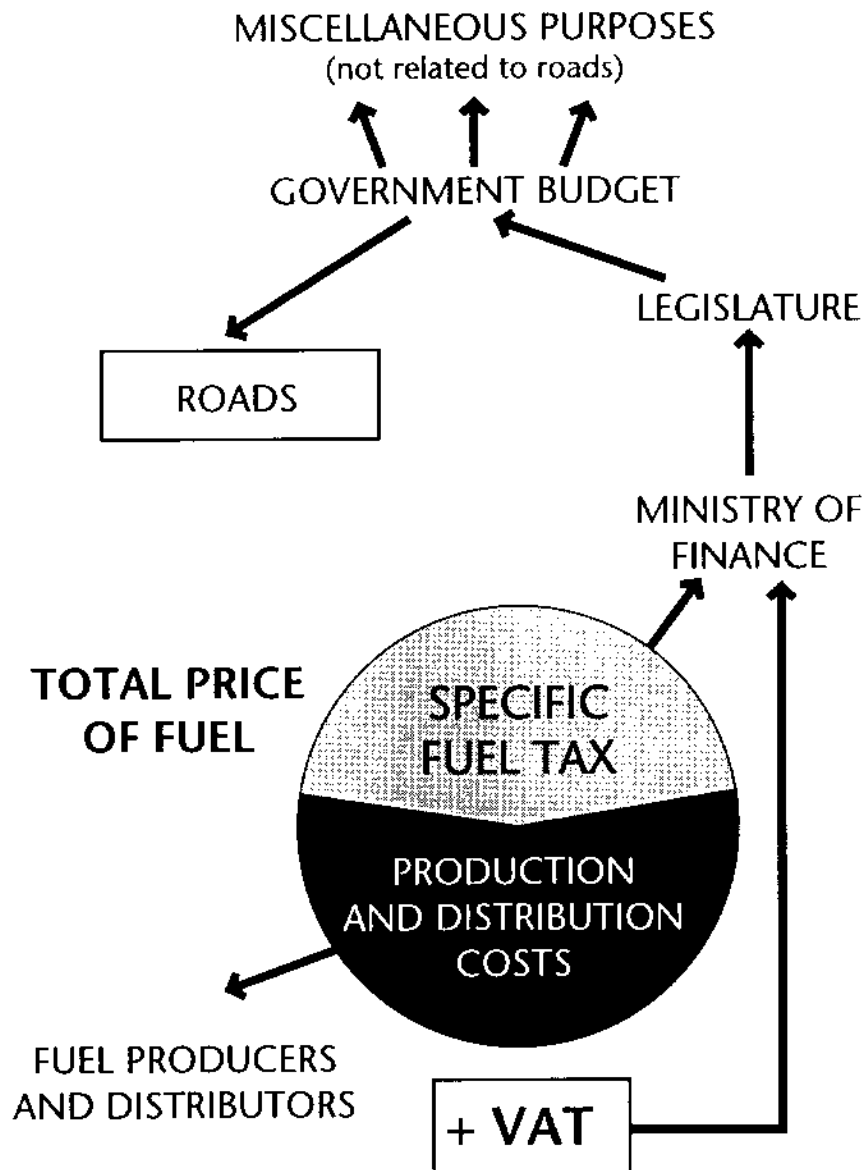
Some flows remain the same in all figures. For example, fuel is produced and distributed by specialized companies and they receive their proportion of the total sales price. Also, the general sales tax or Value Added Tax (VAT) is a tax which affects almost all products equally, for the purpose of generating general revenue for the national budget.

The change occurs in how the specific fuel tax is presently handled. In most countries, the both VAT and specific fuel tax bring in general revenue for the central budget and are not earmarked to finance specific purposes. The change consists in clearly dividing the present specific fuel tax between i) taxes, for general government purposes and not related to road conservation, and ii) a road user rate to be used specifically for conserving existing roads and later possibly for financing or co-financing new road infrastructure.

The outcome of these proposed changes would be to separate road conservation financing from the annual budget debate, as road conservation financing would become totally independent from the government budget. How is this separation justified? It is certain that the decision whether or not to build a new road is a political decision, because the funds involved could alternatively be applied to other types of investment to maintain that road, from the onset, in order to make sure it provides service over a long period of time. It would be a very wasteful use of funds and other resources to construct a road and then not maintain it. Therefore, it is not necessary to begin a new debate over the allocation of funds for road conservation every year.

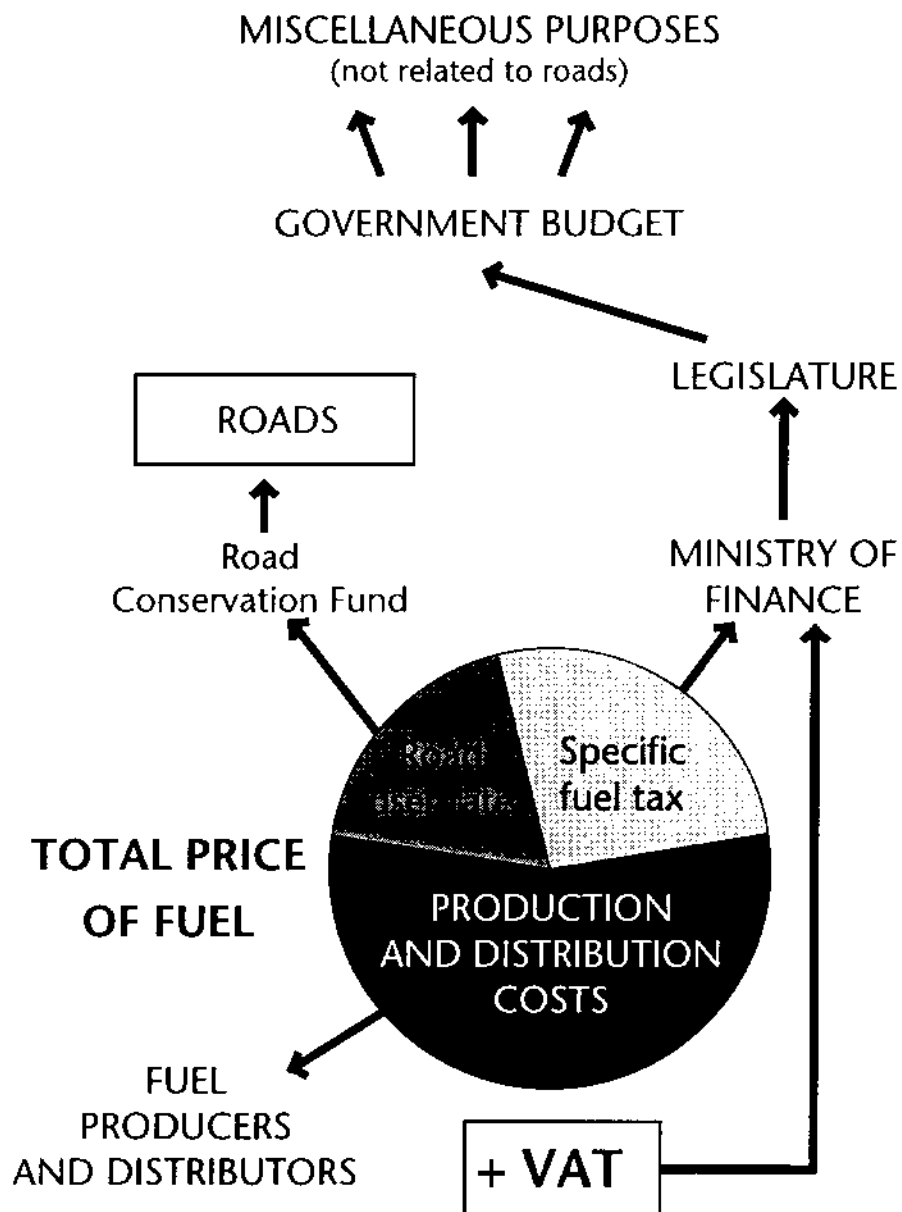
THE USE OF MONEY PAID FOR THE PURCHASE OF FUEL

PRESENT SITUATION



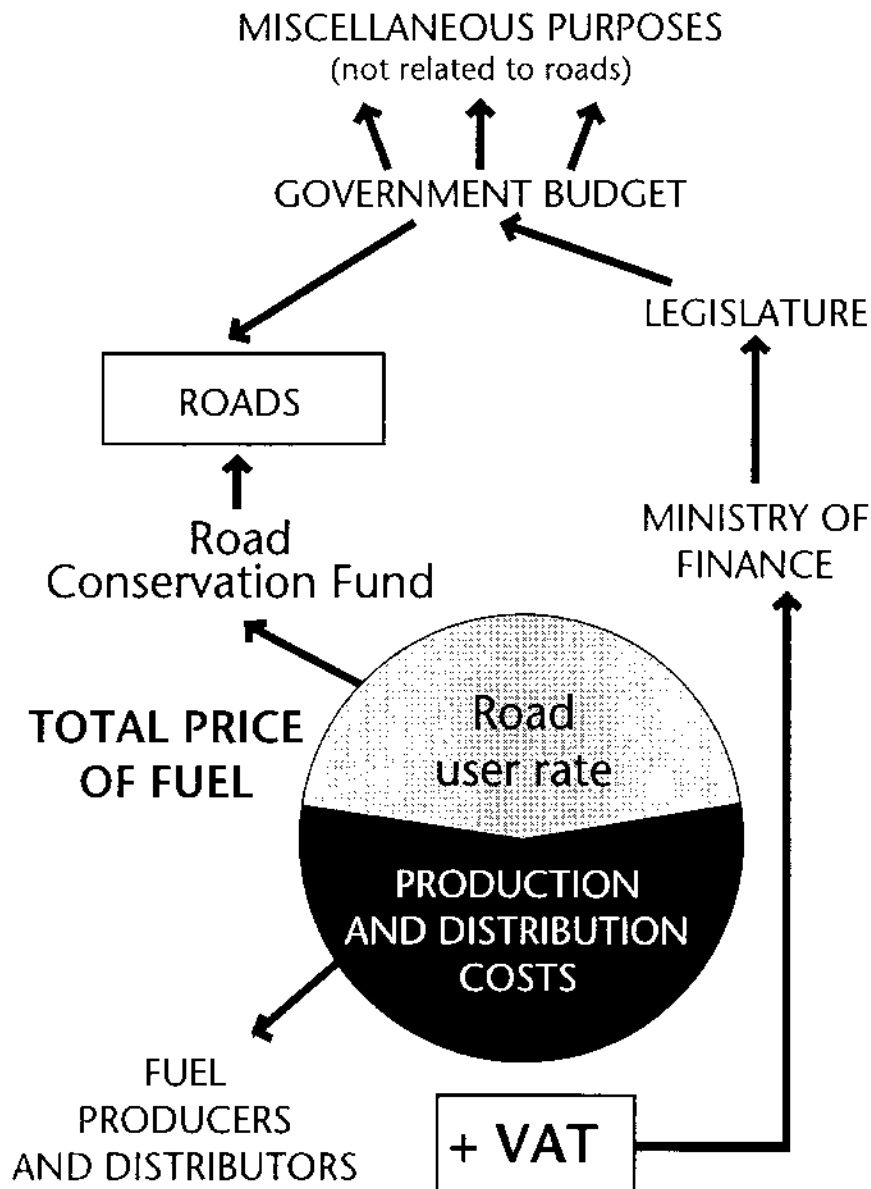
THE USE OF MONEY PAID FOR THE PURCHASE OF FUEL

FUTURE SITUATION [GASOLINE]



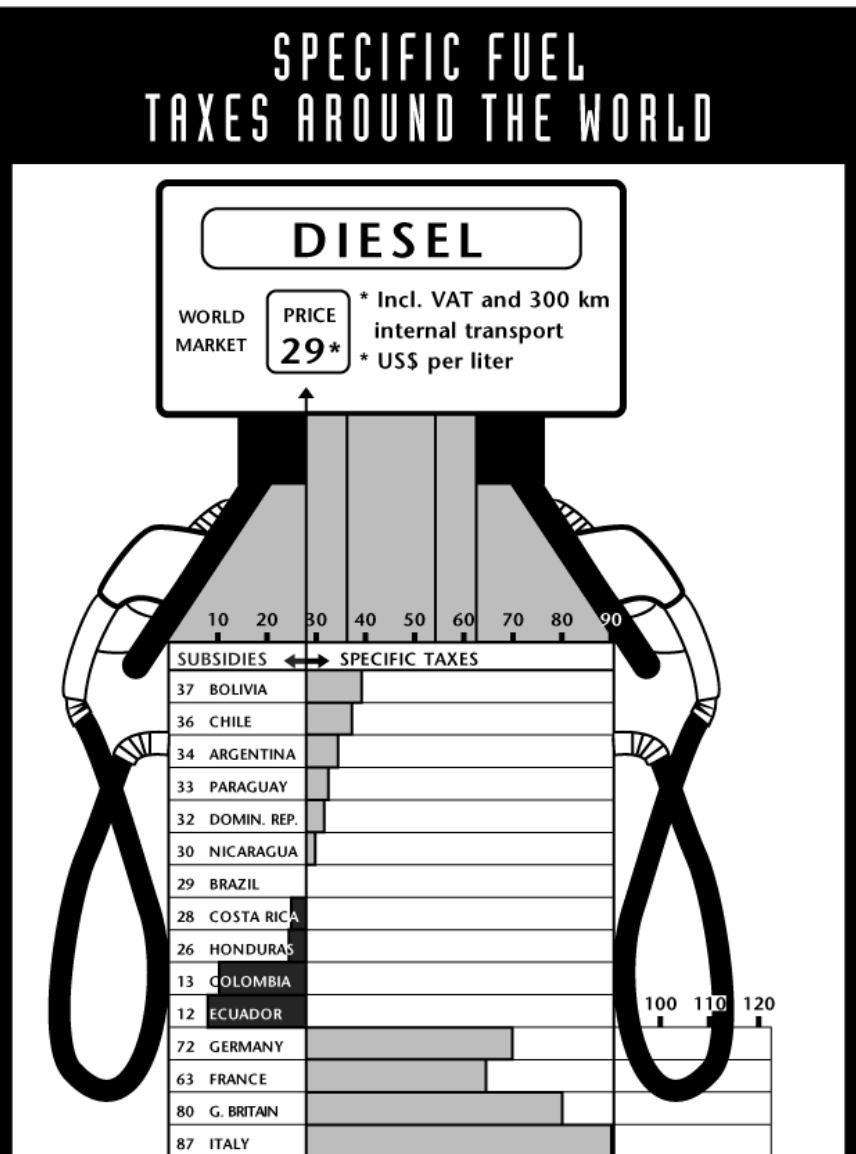
THE USE OF MONEY PAID FOR THE PURCHASE OF FUEL

FUTURE SITUATION [DIESEL]



SPECIFIC FUEL TAXES AROUND THE WORLD (A COMPARISON OF SELECTED COUNTRIES)

The two following figures are an attempt to highlight the wide differences between the levels of specific fuel taxes collected from each liter of fuel sold. The basis of comparison is the sum of i) the average price of fuel on the world spot market, plus ii) general sales tax and iii) an allowance made for the cost of storage and distribution within the country. This "base cost" is rather similar throughout the world, and presently is situated around US\$ 0.29 per liter of diesel, and US\$ 0.31 per liter of gasoline. If the actual service station sales price is higher than the "base cost", it is assumed that the difference results from a specific fuel tax levied by the government. In the opposite situation, it is assumed that the government is subsidizing fuel cost for road users.



Source: German Agency for Technical Cooperation (GTZ), March 1992.

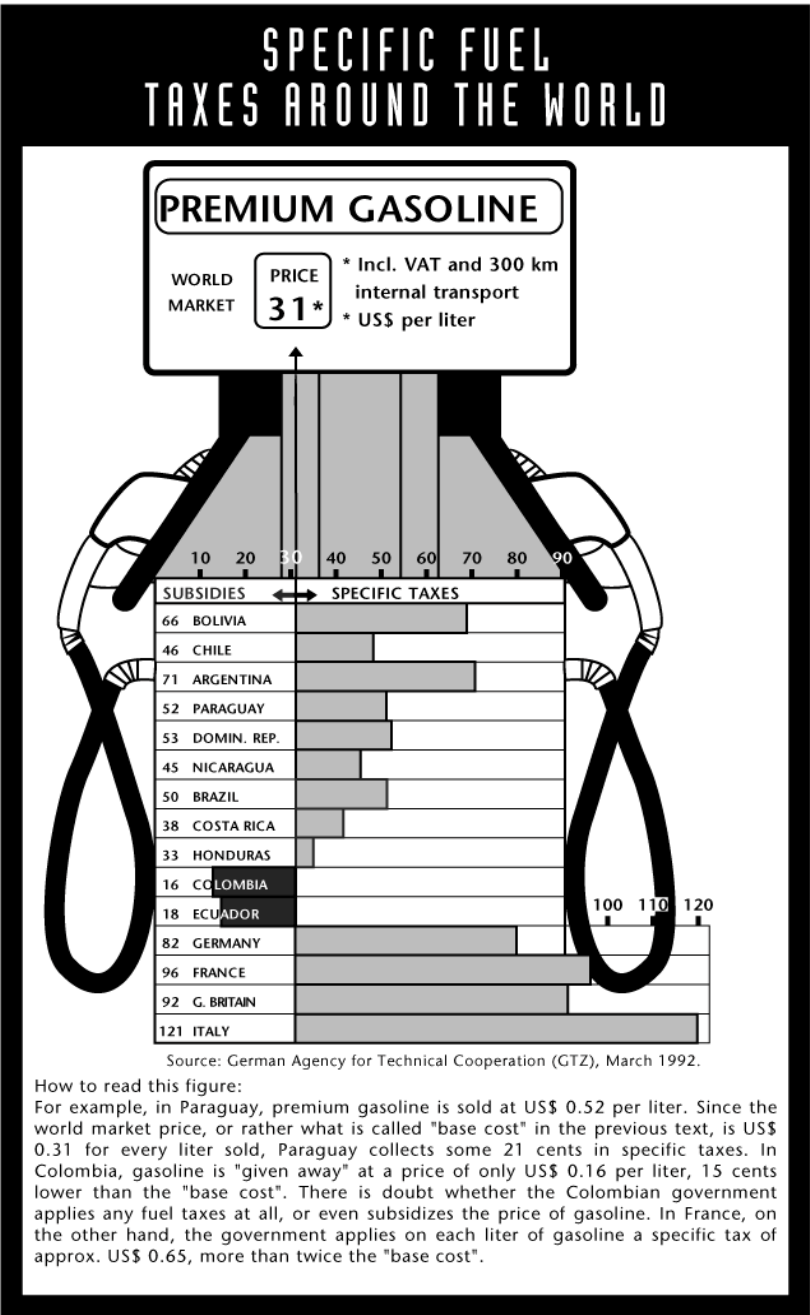
How to read this figure:

For example, in Bolivia the sales prices of diesel fuel is US\$ 0.37 per liter, 8 cents higher than the world market price, or rather what in the previous text is called "base cost". It is therefore assumed that the Bolivian government applies a specific fuel tax of approx. US\$ 0.08 per liter. In Ecuador, an oil exporting country, fuel is "given away" at the price of only US\$ 0.12 per liter, 17 cents lower than the "base cost". There is some doubt as to whether the Ecuadorian government applies any fuel tax at all, or even if it subsidizes the price of fuel. In contrast, the Italian government applies a specific tax for each liter of diesel sold approximately US\$ 0.58, which is almost twice the "base cost"!

Obviously, this mode of comparison is somewhat simplified since the world market price does not always coincide with the cost of production and distribution inside certain countries, particularly the oil-producing countries. However, the comparison permits highlighting the enormous difference between the level of specific fuel taxes prevailing in Latin America and in Europe. This is food for thought for those in Latin America who complain about the "high price of fuel". On the average, the sales price of fuel in Europe is about twice as high as in Latin America. Within the totalsales price per liter, the tax share is approximately three to four times higher than in Latin America. It is no coincidence that in Europe there are normally sufficient funds for road conservation, in spite of the fact that governments use a large part of specific fuel taxes collected for purposes which are not related to roads.

The two figures presented illustrate that over the medium and long term, Latin American and Caribbean countries cannot indulge in the luxury of collecting so little taxes (and/or rates) from road users. If one wants to have well-maintained roads and also expects that road users should help to finance the general government budget,

European fuel price levels will need to gradually be introduced.



This procedure has the additional advantage that it conforms to the public perception, certainly subjective, of tax "justice": A high percentage of light vehicles are an alternative to public transport for society's higher-income members, or are used mainly for individual recreation. It seems "fair", then, to tax "rich" people who can afford to have a private car.

Heavy vehicles, quite to the contrary, are used to distribute goods needed by the population, or to provide mobility in the form of public passenger transport. Commercial transportation constitutes a basic element of the distribution chain and satisfies elementary needs of the population. Transport companies, like any other commercial enterprise, pay taxes that apply to general business activities, such as sales tax on all materials they purchase as an input for production, and taxes on profits made.

It is, however, highly questionable whether commercial transport activities should be charged specific taxes on fuel, in addition to the general taxes they have to pay like all other business activities. Diesel fuel is one of the principal inputs for the production of commercial transport services, just like leather is a basic input for the production of shoes. None would think of introducing a specific "leather tax" to confinance the general government budget. In consequence, it is not clear why commercial transport should pay a specific tax on diesel fuel. This does not mean that diesel fuel will be cheaper than it is today. Quite to the contrary, the introduction of a rather high road user rate in the price of diesel fuel will more than compensate the elimination of the specific fuel tax for diesel.

“VIALE” AND “NON VIALE” ROADS

To answer the question of who should pay for road conservation, a distinction has to be made between “viale” and “non-viale” roads. What do these terms mean?

It is obvious that the operation cost of a vehicle travelling over a well-maintained road is lower than that of one using a deteriorated road full of potholes. Travelling on a well-maintained road therefore brings a relative saving to the vehicle operator.



In the context of road conservation, an existing road is considered “viale” when the cost of conservation is less than the combined savings to all road users resulting from travelling over a well-maintained road as compared with travelling over a bad road.

Meeting this condition depends on road traffic. If the road is used by a very low number of vehicles, the combined savings achieved through reduced vehicle operation costs will also be rather low. In this case, it is probable that the cost of keeping the road in good condition is higher than the sum of savings. A road with these characteristics is “non-viale” in the context of road conservation.

Consequently, maintaining a “non-viale” road in perfect condition would mean subsidizing the few individuals who use it. This would be, to say the least, a questionable practice. It could be argued that many roads which are “non-viale” according to the definition given here, can in fact generate other types of benefits to justify their conservation by society. For example, a road could promote agricultural development in isolated rural areas or be the only access to a hydroelectric power plant high up in the

mountains. It could also be the only road to a local indigenous community which should not remain isolated for humanitarian or cultural reasons. Without denying the general validity of these arguments, we believe it is necessary to give some more detailed attention to this question.

The serious crisis of public finances in the region has revealed the urgency of redefining the ways in which various economic sectors and social programs are financed. In many countries it was commonplace for successive governments to accept the existence of a multitude of state-owned companies with monstrous deficits; companies that were maintained on the assumption that, in the national context, deficits in some sectors could be compensated by surpluses in others. The dilemma was that no one clearly identified which sector would provide the surplus and how. Today, the catastrophic consequences of this policy are well known. Governments now recognize that the crisis can only be overcome by, among other measures, making the financing of the various sectors transparent. This includes self-financing of activities such as the administration of ports, airports, railroads, industries, etc.

Once again, it must be stressed that road conservation is one of the activities which can and must finance itself, always given that it is clearly understood who pays for it and why. To illustrate the point, we turn to the example of a road which leads through remote mountains to provide access to a hydroelectric power plant. A route of this kind is very little travelled and serves almost exclusively the electricity company operating the power plant. Although open for public traffic, the road does not necessarily serve road users in general. Therefore it seems obvious that the electricity company should pay at least a major part of the road's conservation costs, considering this cost as part of the total cost of electricity production.

It would not be “fair” to finance the conservation of this road entirely from the proposed road conservation fund provided by all the road users in the country. Such practice would mean that road users spend more on this road than the total savings achieved by having the road in well-maintained condition instead of bad condition. Paying for the road's upkeep would also mean that the country's road users subsidize the users of electricity.

Somewhat different is the case of urban streets which are used for a wide variety of purposes. Apart from vehicle traffic, important sections are used for parking, by pedestrians, as formal or informal bus stops, as a space for installing water and sewage pipes, electricity, telephone and television cables, for garbage collection and for many other purposes. Consequently, the conservation of urban streets should be financed from various sources of funds. For example, the provision of parking places could be paid by installing parking meters and through the annual municipal license charge. In the same way, urban passenger transport companies may be charged for the use of bus stops.

The question of whether a road is viable or not usually arises in connection with very low-traffic, unpaved rural roads. Nevertheless, that type of road may make up as much as 30% of the total road network in some countries of the region. Various estimates have shown that the shady borderline between “viale” and “non-viale” roads may be between 20 and 50 vehicles per day depending on conditions such as climate, soil, the type of road surface, etc. These figures, however, are only a rough approximation for defining the “viale” network.

In practice, defining the “viale” road network is a process in which technical, economic and political criteria are combined. At first glance, one could say that conservation of the “viale” road network should be paid for entirely through the Road

Conservation Fund based on road user rates. Meanwhile the “non-viable” roads may only be partly financed with that fund. Any “non-viable” road should only be maintained if directly interested parties contribute financial or other resources. Directly interested parties may be individuals, companies, or identifiable local groups. In some cases, the interested party could also be the government who, referring back to an earlier example in this book, may want to safeguard road access to the living area of a local indigenous group. In that example, the government would pay its contribution from a special item within the general budget, which may be called “indigenous group subsidies”.

LOANS FOR ROAD CONSERVATION

On the following pages we question the practice of using loans to totally or partially finance road conservation. Before this question can be answered, some basic related concepts need to be considered.

Current cost and new investment: Road management includes two types of expenditures: current cost and new investment. The first is used to maintain the existing road network. In most countries, this is made up of hundreds of individual road sections, each one requiring specific forms of conservation. Conservation spending for a specific road section will vary considerably from one year to another because the more expensive items, surface renewal for example, are only done every so many years and therefore are an extraordinary expense for this individual section. However, in an entire road network it is necessary to carry out surface renewal on different sections every year, and this makes that expenditures for surface renewal are no longer extraordinary. Given that the sum of expenditures for conservation of an entire network remains more or less constant they can be called current costs.

Current cost also has the characteristic of contributing no new quality or capacity that the road network did not already have before. Neither does current spending provide any new user benefits or result in increased income for the agency managing the road network. Road conservation implies rather stable and continuous current spending, at least in a well-managed network.

Unlike current cost, spending on new investment increases the physical capacity of the road network and introduces other useful qualities that were not present before. Examples of such new investment are the construction of a new road, the substantial improvement of an existing road, the paving of a gravel or dirt road, the introduction of road safety devices, the replacement of a narrow bridge with a wider one, widening a road, or giving it more lanes. New investment is made in the hopes of providing users with additional benefits. Nonetheless, the road agency managing the new or improved infrastructure should also make sure that it will have additional revenue to maintain the new investment.

New investment in a network usually causes irregular flows of funds, that is, large outlays in some years and relatively modest spending in others. For this reason, and to level out the payment for these investments, it is reasonable for road agencies to take on loans, either on domestic or foreign capital markets.

Sources of financing for the road network: When discussing the sources of financing for road networks, one should keep in mind that today it is generally recognized that most public services like electricity, telecommunications, and water supply have to finance themselves by charging rates for the use of those services. This awareness has resulted from the unfortunate experiences made in many countries of huge financial deficits of public utility services, which in turn were caused by low revenues and high expenditures.

The provision of roads is also a public service and it seems perfectly reasonable to expect as well that it can finance itself, using charging mechanisms similar to those used by other public services mentioned. The agency responsible for the road network should, therefore, collect funds by charging vehicle operators for the use of roads. The total volume of funds collected should at least be sufficient to consistently and adequately finance the conservation of existing roads. Depending on the strategy adopted, the road user rate may also be set at a higher level, providing finances for additional investments in road infrastructure. (Please note that the authors recommend a clear separation between financing of conservation and new investment; this is explained in earlier sections of this book.)

It may be that for some reason the road agency is not able to collect sufficient funds to cover its costs. Potential causes must be identified and corrected. These causes could include the following:

- The user rate is too low.
- The rate is adequate, but funds collected are allocated to uses not related to the road network.
- The existing traffic volume does not justify the large extension of the road network.
- The road agency is inefficient.
- The volume of new investment is too large and cannot be justified.

It must be kept in mind that in many countries the various types of taxes collected by the government from vehicle operators are more than enough for the conservation of the road network. No distinction, however, is made between road user charges, on the one hand, and general taxes, on the other. In practice, more than half of the funds collected from road users are usually allocated to purposes unrelated to roads. Thus, vehicle operators are really paying for government spending in other areas. On the other hand, the government allocates funds from other non-road related sources for road conservation. Loans are one of these sources. It is easy to see that road financing is not transparent, which makes a rational discussion between interest groups difficult.

From project loans to sector loans: Large international development and cooperation organizations such as the International Bank for Reconstruction and Development (IBRD), the Inter-American Development Bank (IDB) and many other multilateral and bilateral organizations, give large-scale road sector loans in all the continents of the world. The annual volume of loans granted by these institutions for major inter-city road networks is close to US\$ 9 billion. A similar figure is loaned for rural and urban roads. In total, about 30 % of the total financial aid granted by these organizations is for roads.

In recent years, however, significant changes have occurred. In the past, most loans were directly related to clearly identifiable new road projects, or for the reconstruction of certain existing roads, but usually not for road maintenance. In fact, big development banks were generally opposed to loans for road maintenance, considering precisely that road maintenance is a current cost which should not be financed through loans. Today only very few national or international development banks still follow this policy.

In recent years a gradual shift can be seen from individual project loans to overall road sector program loans. As the name implies, these relatively novel loans are granted with the purpose of co-financing a complete program of road spending, including both new investment and conservation.

Leaving financing aside for a moment, the mere fact that road sector programs are being developed, is a significant step for developing countries, as such programs create a broader vision of the state of road networks and their problems. Overall programs for the road sector specify everything that should be done to the network of a country, over a specific period of time. It is possible to separate conservation activities from those which are definitely new investments, in order to see whether the program emphasizes construction or conservation. Since a number of countries of the region are close to having completed their road networks, it is natural that these programs tend toward conservation, which generally accounts for about 65% of these program funds.

Overall program expenditures are usually financed both by government funds and through loans granted by international development banks specifically for this purpose. International bank loans cover a percentage of the total cost of the program, without specifying which proportion of each loan is assigned to conservation and which is for new investment.

In the few road sector programs which have been undertaken in Latin America and the Caribbean the percentage financed with government funds has gradually diminished. When such programs commenced, governments financed about 50% of the road program with own funds, but in more recent operations this figure has dropped to the 30% level.

Although many do not wish to admit it, loan funds inserted in road sector programs are mostly used for road conservation and therefore to finance current costs. To illustrate this we use the example of a road sector program which allocates 70% of its resources to road conservation and 30% to new construction. Let us also suppose that 70% of the entire program is financed through loans. The result is that loans cover at least 57% of the cost of road conservation, on the assumption that all new investment is financed entirely through loans.

In general terms, it seems reasonable that loans should only be used for financing genuine new investment. In the previous example, this would imply that the loan should cover no more than 30% of the total program cost.

There is a difference of opinion among those who work in the field about the issue of loans for road conservation. Some justify and accept these loans as a normal, routine operation, while others warn about the implicit “danger”. The question must therefore be asked whether road conservation should or should not be financed through loans.

Advantages and disadvantages of loans for road conservation: In order to identify the advantages and disadvantages of using loans for road conservation, one needs to distinguish between two types of institutional environments related to road management. The first type is characterized by the predominance of the traditional institutional setup, without serious attempts to introduce systemic changes. The second type is an environment in which profound institutional reforms are being made with an eye on overcoming past and present deficiencies.

In situations where there is an absence of institutional reform, governments and road agencies are not introducing the serious change needed to promote effective road management and a “healthy” situation in the future. In this case, road management and conservation remains within the traditional framework of an “Authority” or a “Department” dependent upon a government ministry. (A change in the organization chart of a ministry should not be mistaken for institutional reform.)

In the first case (absence of institutional reform), loans may have the following advantages:

- They allow to carry out more road conservation, which is undoubtedly better than no conservation as a result of lacking of funds.
- Loans may, to some extent, lead to a change in agency orientation, placing more emphasis on conservation.
- They also assure a rather high rate of return on the spending for road conservation. In fact, various World Bank studies have shown that the rate of return on routine conservation spending is usually between 50% and 100%. For periodic conservation, typical rates of return are between 30% or 50%, extraordinarily high figures compared with other loans.

On the other hand, contracting loans as a normal way of financing road conservation has the following disadvantages:

- Loans can be an easy way out of an unsustainable situation, since new money covers up the fundamental shortcomings affecting the efficiency of road agency and the financing of the “road service”; the loans make it possible to continue operating in spite of the defects and deficiencies.
- They are contrary to the principle of transparency, by submerging problems which would otherwise be easy to spot in the anonymous mass of the “foreign debt”.
- Loans tend to reduce pressure to make badly needed changes.



To illustrate the disadvantages of loans, let's refer back to the electricity example again. It is highly unlikely that an international development bank would grant a loan to an electricity company to carry out routine generating plant maintenance, considering that electricity rates should guarantee adequate financing of the system. If the electricity company cannot cover maintenance costs, there are two possible explanations: either rates are too low and need adjustment, or the company is too inefficient and operates at excessively high costs. In neither scenario do loans present an adequate solution. The situation is very different when profound institutional changes are being made. In this case, loans obtained by the road sector for overall programs, including conservation, can be very useful as long as they are a transitory measure accompanying fundamental organizational and financial reforms. Loans may be useful specifically for:

- supporting the institutional changes and promoting greater efficiency and effectiveness, including the creation of “public-private partnerships” and a new definition of the role of the state and the private sector;
- providing temporary financial support for the new institutional structure, since initially it may be difficult to get financing from other sources;
- helping to restructure spending on roads, shifting the emphasis from construction to conservation.

During the transformation and transition period, the need to contract new loans could arise to make the road network “conservable”, that is, rehabilitating and reconstructing those roads that collapsed as a result of poor management in the past. Loans for reconstruction should only happen if effective management and conservation seems likely in the future.

Once institutional transformation has occurred, public-private partnerships are established and consolidated, and road network rehabilitation is completed, the need for loans to finance road conservation should disappear along with chronic financing problems. In a well managed and conserved road network reconstruction jobs are infrequent. Today, however, road rehabilitation and reconstruction accumulate precisely as a result of inadequate conservation.

Finally, continually resorting to loans for road conservation is tantamount to transferring the costs of bad management to future generations, knowing full well today that they will not enjoy the benefits of the loans. Its like having a good time in a restaurant and expecting your children to pay the bill later. For this reason, both governments and development banks should consider carefully whether they really want to take on the responsibility implied by loans for maintenance, since these loans could also prolong the regional foreign debt crisis.

ROAD SECTOR PROGRAM LOANS: A CASE STUDY

We want to describe an actual case of a South American country which has put integrated road sector programs into practice. Starting in 1986, this nation received significant help from an important international development bank, both for program development and financing. A second regional development bank, an Asian import-export bank and to a lesser degree several other international institutions, also collaborated in the financing.

THE PROGRAM

The country's first overall road sector program, which extended from 1986 to 1989, budgeted total spending of about US\$710 million. Approximately one third of the total amount was allocated to new investment such as bridges, urban streets, new pavement and the construction of roads in areas which had previously been inaccessible. The remaining two thirds were for current expenditures, oriented towards keeping the network functioning without increasing its capacity. Current expenditures included maintenance, surface renewal and the rehabilitation and reconstruction of existing roads.

The second road sector program, now being executed, covers the period from 1990 to 1993, with total expenditures of US\$906 million. The funds are being distributed in much the same way as the first loan, with one third for new investment and two thirds for current expenditures.

FINANCING

The Government financed almost half (47%) of the total cost of the first program using its own funds. In the second program, that proportion was reduced to approximately 32%. Remaining financing came from loans contracted with the already mentioned organizations.

COLLECTION OF FUNDS FROM ROAD USERS

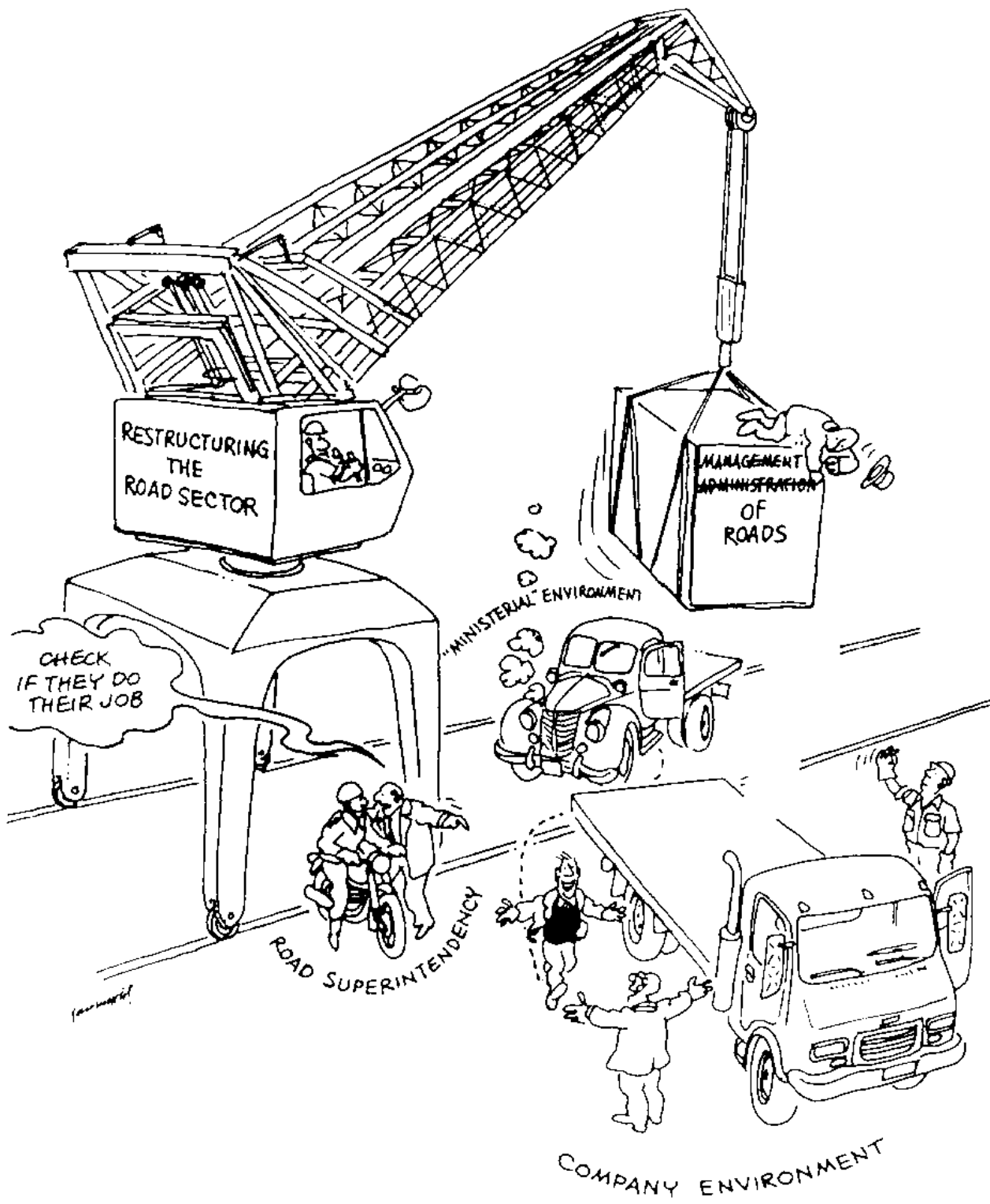
Various estimates indicate that funds collected by the government through various types of road user taxes are approximately 2.5 times the total amount spent on the road program. Only 25% of the taxes collected from road users are allocated to the road sector program by the government. The government uses the remaining 75% for financing non-road related spending, of which about 60% are social expenditures.

REAL EFFECTS OF THE LOANS

Loans are primarily used to pay for new investments, and remaining loan funds are applied to current expenditures such as road conservation. What percentage of the loans are being used to pay current expenditures? Our calculation shows that in the first program the government financed approximately 38% of road conservation with loans, a percentage that increased to 52% during the second program.

The tax revenue collected by the government from road users and by tolls could easily cover the total cost of road programs. So, we must ask: What do road sector loans really finance? Are they spent on social programs, national defence, or perhaps some other government expenditure? Given the lack of transparency in this area, we probably will never find a clear answer.

For governments in general it is relatively easy and non-controversial to get loans with a high rate of return for road maintenance and construction. Once the loan is approved and formally contracted, a large part of road sector tax revenue can be made available for other uses. When we really come down to it, this type of loan is a convenient way to finance some types of expenditures that banks would not be willing to finance under their real name.



7. THE MANAGEMENT OF ROAD NETWORKS

The main purpose of this section is to describe the necessary characteristics of a what we call a "suitable environment" for the efficient management and conservation of road networks.

The section begins with a description of the environment in which road administration takes place today in the region, and its most dominant characteristics. Then, we shall identify some prime reasons why it is extremely difficult to reach a satisfactory degree of effectiveness and efficiency under the present system. Next we describe the three basic functions which must be performed if road infrastructure is to satisfy the needs of society rationally. The first function is the management of the road network; the second is the physical execution of necessary works and the third is safeguarding public interest in roads.

In the substantive part of this section, necessary conditions are outlined for carrying out these three basic functions effectively and efficiently. The move away from the "road administration" of today and toward "road network management", which is our goal for the hopefully not too distant future, implies a real qualitative change. The section closes with the proposition of various possible options for reorganizing the road sector, including a description of advantages and disadvantages of each one.

A distinction is also made between managing interurban networks and managing rural roads with very low traffic volumes.

The overall concept of road management presented here provides a base for a reorganization of the road sector. This reorganization must, as we saw in the preceding section, also include a reform of the system for financing road network conservation.

TODAY'S ROAD AGENCIES

According to the legal arrangement in most countries of the region, public roads are owned by the State, who in turn represents the citizens of the country. An essential characteristic of these roads is that they are open to be used by anyone without discrimination and with the only condition that traffic law and other rules established must be respected.

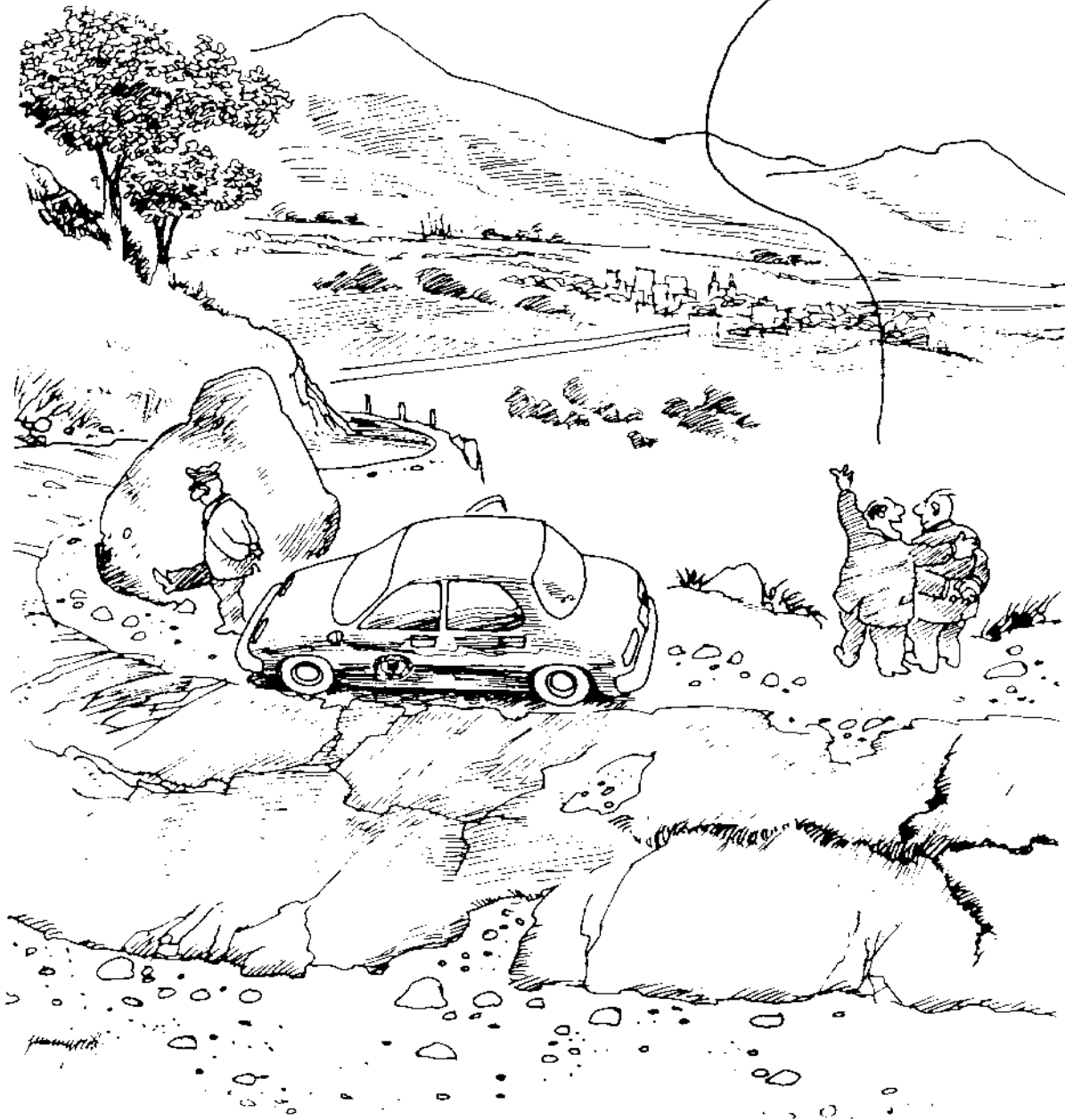
The State exercises its dominion over public roads through one or several road agencies, often called Road Departments or Highway Authorities, which are normally related to the Ministry of Public Works or the Ministry of Transport. Road agencies have direct authority over roads and execute directly or through contractors anything related to the study, design, construction, conservation and general administration of the road network. Only very few roads, whose administration has been delegated to private companies through concessions, are exceptions to this rule; in any case, even those road concessions are normally supervised by a government road agency.

The road agencies are usually not autonomous since they are not legally constituted as companies but belong to a government ministry. The type of authority they exercise over roads is similar to an administration agreement with a superior client (the State or government), in which the ultimate decision is always made by the client. In carrying out this administration, the road agency:

- **proposes measures and policies, but has no power of decision; the final word belongs to the government;**
- **is subjected to exhaustive and restrictive financial and administrative regulations;**
- **receives its financial resources from the government, which assigns those resources to specific uses;**
- **accounts for the use of funds allocated, but not explicitly for the condition of the roads or for the value of road assets.**

The road agency carries out its tasks in an environment of complex rules and regulations typical to public administration. Those rules define and restrict what it is supposed to do, how it should be done, and what it is not allowed to do. This regulatory framework has been dictated over several decades and largely originates in an effort to prevent fraud and illegitimate use of public funds.

TO SPEND OUR ANNUAL BUDGET BEFORE
THE END OF THE YEAR, WE'RE GOING TO
CONSTRUCT A MONUMENT IN HONOR OF
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The almost inevitable consequence is the heavily bureaucratic style found in virtually all areas of public administration, in which taking any decision ends up being a monumental task. This can be observed in many road agencies of the region where administrative hurdles make it very difficult to even spend the funds allocated and available. Spending tends to demand excessive time and effort; and when it is finally accomplished, it is not clear whether operations were done at a reasonable cost, or whether the overall goal of improving or maintaining the road network was reached.

The fact that road agencies lack autonomy means that their work programs, priorities and important decisions are subjected to what their "superiors" dispose. What these "superiors" usually want is what is commonly understood as progress, that is to say, new roads or clearly visible improvements. As far as possible, they try not to spend money where it does not show, for example on merely conserving what already exists.

Conservation in many countries is affected by this attitude. The idea is to spend as little as possible for road conservation. Spending is reduced to what appears to be absolutely necessary in order to fix defects which have occurred, and little emphasis is placed on preventing road deterioration. Obviously, government expects the road agency technicians to propose what is best for roads. If this proposal does not coincide with the government's perception, the road agency has ultimately no alternative but to accept the government's decision because of financial dependency.

The ultimate duty of the road agency is to correctly and routinely spend funds allocated, without diverting them from their stipulated purposes or permitting undue appropriation. Government judges the efficacy of a director of a road agency by his ability to spend the funds "well", since they are public property. "Well" usually means that budget funds are actually spent on the items stipulated and within the prescribed time frame. There is usually little concern with obtaining the best possible return from the funds spent.

EFFICIENCY AND EFFECTIVENESS

Efficiency and effectiveness, two concepts which are used in this book, are often confused. They are in fact quite different concepts whose meanings need to be clarified.

- **Efficiency** is the good use of resources by obtaining the best possible results with the limited resources available. Waste and misspending are contrary to efficiency. In road management, efficiency could be described as spending as little as possible to carry out certain tasks deemed necessary on the road network.
- **Effectiveness** is related to meeting targets. If we refer to a road agency, effectiveness could mean being successful in keeping the road network in good condition and being able to rehabilitate roads which have deteriorated.

These concepts are not necessarily achieved at the same time. Financial authorities typically try to reduce spending to a minimum and are only satisfied when they are convinced that any further reduction is impossible. This conspires against effectiveness since road deterioration cannot be avoided without required funds; consequently roads gradually deteriorate. If, for lack of funds there is insufficient road conservation, lack of effectiveness in conserving road networks also becomes inefficiency, since it results in expenditures for road rehabilitation which could have been avoided.

The challenge for road agencies is to be both efficient and effective by always keeping road networks in good condition at the lowest possible cost. This can be achieved through good management and the use of adequate technology.

Theoretically, the main goal of public administration is to ensure that resources are used legally. A large share of existing regulations are designed to avoid leaks through which public funds could disappear. The result is that there are many obstacles to spending funds even legally. Action is delayed by all sorts of controls, counter-controls and controls over the controls. In some countries, the road agency has reached a level of operational paralysis which is incredible.

The accounting system of a road agency is reduced to registering income and expenditures and comparing those to the budget which has been approved. Nowhere is there any reference to the condition of a road network or to the value of a road network as an asset. Roads are not considered an asset, and the only assets recognized by the road agency is the equipment it might have. Usually there is no procedure for measuring the return on expenditures or for quantifying "services" which have been provided to road users at a certain spending level.

One of the basic causes of road deterioration in Latin America and the Caribbean is the low efficiency and effectiveness of agencies responsible for their administration. Unquestionably, we do not want to say that all road agencies are inefficient. In this respect there are significant differences from one country to another. For example, while in one Latin American country some 90% of the road budget is spent on physical road works, there is another country where 70% of the road budget is used exclusively for paying salaries to an excessive number of employees. Or, while in one country the road agency has a relatively small volume of equipment in good condition, others have huge cemeteries of equipment which cannot be used because of lack of spare parts or equipment maintenance.

The degree of efficiency and effectiveness reached by even the best road agencies of the region is unsatisfactory compared to the efficiency of some companies which provide public services and manage impressive assets. Electricity, water and telephone services can be given as examples. The companies providing those services are similar to road agencies; they have thousands of employees, manage investments above one billion dollars and offer services which cover large geographical areas. These companies however use technology which is much more complex than that used in the road agencies.

How can the good performance of some of these public utility companies be explained, compared with the meager results of most road agencies? The usual answer is that the private sector works better than the government. However, this is not a satisfactory answer because it is not a question of comparing the public and the private sector, nor of arbitrarily dividing functions into those which should be government responsibilities and those which would be better be privatized. In fact, some public service companies which are government property or at least partly government owned, are at the same time quite efficient.

BASIC CAUSES OF INEFFICIENCY

What are the typical characteristics of road agencies in Latin America and the Caribbean, and which of those are likely to be causes for unsatisfactory performance? What is the prevailing atmosphere or environment of these administrations, and what, in spite of goodwill and positive efforts at all levels of staff, prevents them from being more efficient and effective? The answer is not simple nor presumed to be fully answered in this book. However, some of the obvious causes can be identified, and their elimination would be a decisive step forward to substantial improvement in efficiency and effectiveness of road network management and conservation.

In almost all countries of the region the working conditions of public employees are similar. **One common characteristic is the salary level which in many countries is so low that even the most basic needs for human survival cannot be met. Consequently, the low salary level is hardly a strong incentive for good performance. It is common that road agencies lose good employees because they find better pay elsewhere.** This happens especially in the case of young professional staff who gain experience in road agencies and after some years receive attractive offers from private companies.

It is also common that public employees find it necessary to have a second job outside the government agency because public service salary does not meet the cost of supporting a family. Consequently, more attention is given to the better paying outside job than to their public service work.

Public service does provide job security, however. Normally the only way to lose the job is by unethical or criminal conduct, and that such conduct can be proven legally. Mediocre or bad performance is never a justification for firing a public employee.

Among the higher ranks in road agencies, there are a certain number of positions filled by the government in power by people of their confidence, who are deemed suitable to implement the specific policies of that government. They can be replaced if their performance does not meet the expectations of the government which appointed them. At first sight, the government seems to have a function similar to the owner of a company who chooses the managerial staff required to meet his objectives. This raises the question of the expectations and interests which motivate a government to choose senior road agency officials, and of the difference between the interests found in a political environment and those prevailing in a competitive commercial environment.

Perhaps it is easier to identify the motives absent in the ministerial environment: There is no fear, as is the case of companies, of losing an investment made. Employees of road departments do not own roads nor is their income generated through returns on capital invested in roads. A road department employee's well-being is rarely threatened by inefficient management of road networks. Given the low salaries of employees, there is little material or financial incentive for improving performance. In addition, because of a combination of the two previous reasons, senior

officials in public service are not very demanding with their subordinates and, given the job security, the latter are not afraid of losing their jobs or incomes.

Usually a person is named to a senior position in a road agency because of loyalty, real or pretended, to the ideas and interests of the government. This is not always a guarantee of professional capacity for the job. On the other hand, the dismissal of a senior official does not necessarily mean that professional performance has been poor. As we have already shown in section four, political motives do not always coincide with technical or professional criteria.

What motivates public service employees to perform well professionally? Usually, they wish to rise in the hierarchy of the institution. This, besides a better salary, brings prestige and access to other benefits. The present practice in many road agencies is for promotions to be based on several criteria among which professional performance is not the first priority. A large number of public employees whose performance is very good find their promotion ambitions frustrated; showing good performance and striving for excellence may lead to envy among colleagues or may threaten superiors. Promotion decisions are often also based on strictly administrative criteria which are not necessarily related to work quality. For example, after a certain number of years, a public employee has the right to promotion because of personnel regulations.

THE TASKS TO BE DISTRIBUTED

A reorganization of the road sector largely consists in redistributing the three fundamental tasks related to roads: a) management of the road network; b) physical execution of works; and c) safeguarding of public interest in roads. Before going into the issue of who should do which task, it should be made clear what each task actually means.

ROAD NETWORK MANAGEMENT

Road network management consists of finding and optimizing the answers to the following questions:

- At what points or in what sections of the road network is it necessary to carry out physical works?
- What specific type of works are necessary at these points and how should it be executed?
- When should the road works be executed?

The success or failure of road network management is measured against certain target parameters determined at the beginning of a management period; they are normally related to a desired physical condition of the road network.

Management therefore includes a series of tasks which can be listed as follows:

- planning, which consists in identifying and programming physical work;
- contracting the physical work and supervising the quality and volume of work carried out; and
- constant evaluation of the results of the management, in order to adapt methods and techniques to changing needs and to learn from errors committed.

It must be emphasized that road network management is basically an intellectual activity; the persons involved are almost exclusively specialized professionals such as highway engineers and technicians, economists, accountants and lawyers. It includes virtually no manual labour on the roads except what is necessary to collect data and generate information required for good management.

Road network management needs to be organized in such form that it can respond in the best possible way to i) the specific and particular conditions of the road network, ii) the public interest in roads and iii) the needs of road users.

THE PHYSICAL EXECUTION OF WORKS

The physical execution of road works, which some road agencies call "production", is directed and controlled through road network management. In this area there is little room for decision making, because road works must be executed strictly in accordance with precise technical specifications. These define not only the desired results but also the procedures which must be followed in the execution.

In almost every country in the world there are companies which specialize in the execution of physical road works. The decision on whether to use labor-intensive methods or more equipment depends largely on availability and cost of labor. Physical execution of works requires not only workers, but also specialized professionals and technicians.

SAFEGUARDING PUBLIC INTEREST

Safeguarding and protecting public interest in roads is an important task and an issue which requires a more profound treatment.

Every person has individual interests and tries to defend them against threats. When there are many individuals with similar interests they tend to form groups and agree on a joint defense of group interests. The assumption is that such joint defense will be more effective than isolated efforts of individuals. Examples of this type of agreement are trade unions or production associations. The State is also an organization of this type, although much broader, whose purpose is the defense of public interest mainly within the specific geographical boundaries of a country. The government also has the task of pursuing common desires of the majority of its inhabitants. To act effectively, the government has various powers and authorities.

There are varying opinions about the degree to which the State ought to represent society. Generally, there is little doubt that the State should organize and regulate national defense, basic education, justice and other fundamental services. During the past centuries, however, much controversy has arisen over the degree to which the State should intervene in other areas such as production of goods and services or regulation of their prices.

The concept of government as a means of defending public interest is still valid today as it has been for centuries past. Democracy is a means of bringing predominate public interests into clear focus. It is also the form of government which induces the State to respond relatively quickly and flexibly to ideas and perceptions prevailing in society.

After numerous negative experiences in recent history the dominant idea today is that the State must limit its size and direct influence to those areas where its presence is indispensable. In all other areas, it is commonly accepted that the State should limit itself to organizing systems and providing a general legal framework with specific codes and regulations. However, management and principal actors of those systems should be provided through the private sector. The State should watch and intervene only to ensure that those codes are followed. If the system functions well and public interest is safeguarded, there is no need for the State to intervene at all; it should only intervene when systems do not function or public interest is threatened.

Another objective of democracy is to encourage private participation in areas where the government retains decision making power or where the authority of the State is necessary to achieve specific goals. For example, in many countries governments have created ways and means for direct citizen participation in government decision making, beyond the mere election of representatives. Public service committees are an example; in these committees citizens can directly participate in debates on the development of services such as electricity, water supply, telephones, etc. It is also increasingly common to find consumer protection organizations which test the quality of goods and services and are sometimes empowered to sanction abuses committed by manufacturers.

To achieve greater public participation in government decision-making it is necessary for government to create an organizational framework and the necessary mechanisms for bringing forward the ideas and opinions of individuals and groups. Once these mechanisms are functioning, the government assumes the role of a catalytic agent, that is, a relatively passive role.

What role have governments played with respect to roads? Governments have played decisive roles in recent decades in the development and construction of road networks in almost all countries of Latin America and the Caribbean. This gigantic task probably would not have been possible at lower levels of organization. Identifying road needs, organizing financing, setting technical standards, selecting the best projects and constructing major road infrastructure are all tasks which require tremendous impulse. It should not be forgotten that most parts of the road networks in the region were built at a time when the level of economic and social development was much lower than it is today. In the 1990's it is possible to finance construction of new roads with private capital because of international capital markets. However the access of Latin America to these markets is still quite recent and limited.

One of the fundamental tasks of the State is to safeguard public interest. Public interest in the existing road network can be summed up as follows:

- roads should be used in an appropriate, orderly and safe fashion;
- there must be an efficient road network management system including adequate and "healthy" road conservation;
- there must be an adequate system to finance road conservation; and
- the negative effects of roads and road traffic on the environment should be minimized.

As for modifications to the road network, public interest can be summed up as follows:

- the need for construction of new roads or improvement of existing roads must be identified with precision;
- projects must be developed to satisfy these needs;
- the negative effects of new road infrastructure on the environment should be taken into account;
- financing must be procured for constructing new roads or improving existing roads;
- the projects selected for execution should be those which bring most benefit to the public; and
- the physical execution of works should be well organized.

PENSION FUNDS AND ROAD INVESTMENT IN CHILE

Among the profound transformations that occurred in Chile during the 1980s was the radical change in the social security and pension system. The change was from a distributive system, in which the government collected contributions made by the working population and distributed them to the retired, to an individual accumulative system managed by private companies. Each individual affiliated with the new system deposits monthly pension fund in an individual account held in the private pension fund administration firm of his or her choice. Payments accumulate in the name of the member and are invested by the firm, through various financial market instruments, in government bonds and shares of national or even foreign companies. The dividends or profits generated through investments are distributed among the pension fund members and deposited into the individual accounts. Every member is regularly informed about the state of his account.

In the few years that the new system has been functioning, overall funds of more than US\$ 12.5 billion have accumulated, a figure which increases every day as more and more mostly young people join the work force and begin making pension fund contributions.

The effectiveness of the system is supervised by a government agency called the Superintendencia de Administradoras de Fondos de Pensiones. This agency can only intervene if laws or regulations governing these funds are violated. For example, there are strict restrictions on the type of business in which the funds are allowed to invest. Generally, the investment must be low-risk and long-term in order to avoid losses. As a result of these restrictions, members of pension funds are presently owners of a significant proportion of many public utility companies, especially in the area of electricity generation and distribution.

One of the serious problems facing these funds is the lack of investment opportunities in Chile, in enterprises which meet conditions stipulated by the regulations. Pension fund companies are now increasing pressure on the government to create opportunities for investment in public infrastructure such as roads, ports, tunnels and airports. Given their particular nature, roads are an obvious candidate for investment by these funds. In Chile, however, there are few projects to construct new road infrastructure which look profitable from a strictly financial point of view. The task at hand, then, is to find a way for pension funds to invest in the existing road infrastructure.

Other Latin American countries which are now adopting the accumulative system for various areas of social security will soon be in the same situation as Chile is now. Overcoming the present difficulty appears to be a great opportunity for introducing or organizing efficient systems for road management.

In almost every country in the world, the State has set up road agencies specifically for road construction. Some decades ago, these agencies used their own means and personnel to carry out almost the entire planning and design, and also important parts of road construction. Over time, however, it has become more and more frequent to contract private companies for the construction of new roads, primarily because of advances made in such companies, and also because of the critical examination of the efficiency of construction when carried out by public administration. Today, road agencies in many countries are even contracting out some types of road maintenance activities, while retaining for themselves all maintenance planning and programming.

Pressure on government representatives has led to their admitting that it may be appropriate and even necessary to change their approach. The convenience of contracting specific tasks to private companies capable of doing them well and more efficiently than public administration is gaining acceptance. The speed in which this approach is generally accepted will

depend on how the public perceives its interests and whether it puts pressure on the government to continue outside contracting.

In essence, we believe that the State should in the first place establish a system of road network management which satisfies public interest in the best way possible. Once the system is functioning, the State should limit itself to supervising its correct functioning and to modify the system in case this should become necessary. In organizing the system the State should take care to create the necessary conditions for the development of a working environment which stimulates an effective and efficient operation.

The effectiveness and efficiency of a system is a result of a set of very specific conditions. What are the conditions necessary for effective road network management? What type of environment is conducive to effectiveness and efficiency? How can public interest be defended and respected in a road network management system? The following pages propose an answer to these questions.

THE SEARCH FOR A SUITABLE ENVIRONMENT

In this section we have already examined various characteristics typical to the environment of road administration in many countries of the region today. Given that the goal is to substantially raise the level of efficiency and effectiveness of road network management, we must now identify ways to create a more appropriate environment.

What type of characteristics and attitudes should prevail in future road network management? How can the desired environment be created? The first question can be answered simply by describing the environment. There is, however, no simple answer to the second question. Every country has different conditions and therefore each country will have to approach the creation of this new working environment in its own way. The application of a specific formula could be successful in one country and a cause of failure in another. Nevertheless, as we shall see in section eight, no matter how change is attempted, there are some general conditions which must be kept in mind in order to be successful.

The following pages outline characteristics which should prevail in the future road network management environment. This "ideal" situation may be reached after a transition period during which the specific characteristics of each country are defined and the measures necessary to reach this objective are gradually applied. The duration of this transition process could vary between one year and a decade, depending on the starting point and the degree of determination of the country.

To meet the objectives of effectiveness and efficiency, the future road network management system will require the presence of the following targets:

FIRST TARGET: THE PREDOMINANCE OF TECHNICAL AND PROFESSIONAL CRITERIA IN DECISION-MAKING

In future decision-making technical and economic arguments will prevail and decisions will be made by professionals who are well-prepared and specially trained in road network management. Political criteria will be taken into consideration only for designing the future system of road network management, especially when defining general objectives and establishing the legal framework. Once the new system is operational, political influence will be limited to a general responsibility for the effective functioning of the system and for any modifications to be made in response to changing needs. Road network management will not be subject to short-term political interests with respect to decisions on the following points:

- Road conservation versus new investment: To facilitate and optimize decision-making, there should be a complete separation between management and conservation of existing roads, and new investment. New investment includes construction of new roads and major improvements on existing roads. Separate agencies should be responsible for these tasks, each with different sources of financing. It is imperative that management and conservation be self-financed, by charging road user rates, thus avoiding dependency on allocated funds from the annual government budget.
- Where and when to carry out road conservation: The likelihood of reaching optimum decisions about where and when to conserve depends fundamentally on the existence of a professionally elaborated conservation program with adequate and stable financing. It is essential that the program be long-term so that all predictable future operations can be programmed. For

example, for a new paved road in perfect condition to remain in that condition, it is not only necessary to carry out routine maintenance operations but also to apply surface treatment such as fog seals, etc. after four or five years and to strengthen the pavement after ten or twelve years. These future projects must be considered already today in the future work program. Naturally, the program will have to be updated at least once a year on the basis of observations of actual traffic volume and real road conditions, and the latest projections on the probable evolution of these parameters, that is, future traffic volumes and the speed at which roads are likely to deteriorate. If this procedure is followed, the program will always predict quite exactly the physical works to be carried out over the next year or two. For periods further ahead in the program the predictions will be less exact.

Finally, a formula to allow the participation of organized road users in drawing up the conservation program and ensuring its application should be created.

SECOND TARGET: ACCOUNTABILITY AND TRANSPARENCY IN ROAD NETWORK MANAGEMENT

Accountability and transparency are indispensable for efficient road network management. What exactly is the meaning of accountability and transparency?

Accountability means being responsible for meeting the demands of the marketplace and being answerable to customers when these demands are not fulfilled. Translated into road context, this means that the organization responsible for road network management is obligated to satisfy the demand for "road services" and needs to respond satisfactorily to users and the general public if this demand is not met.

For road management to be efficient, managers of the system must be accountable. This means in practice that there must be concrete and verifiable objectives for the road network. The main objectives should be the following:

- **Physical road condition:** For each type of road, minimum conditions can be established which must be met at any time. Also, an average condition should be standardized for the normal condition of the road network as a whole.
- **A maximum level of expenditures on the existing road network:** Assuming a certain degree of efficiency and effectiveness in road network management, a maximum financial amount can be established for the conservation and general management of the road network. This amount will enable the road agency to provide itself with the human and material resources necessary for meeting its obligations. As a general rule, the annual amount necessary lies somewhere between 2.5 % and 3.5 % of the replacement value of the road network to be conserved.

The achievement of the first objective can be verified through a system of constant or periodic evaluation of road conditions. The achievement of the second objective can be confirmed by periodic auditing by an outside auditing company. If road network management is transferred into a company environment, as proposed in this book, the achievement of the second objective is almost automatic, because continued overspending results in eventual bankruptcy of the company involved. Management can be considered successful if both objectives are achieved; if not, those in charge of management must give explanations which satisfy road users and the general public. Unsatisfactory explanations must result in the replacement of the individuals responsible and in a termination of the management contract or concession (see further ahead in this section).

Accountability is only possible in a transparent environment. **Transparency** is established through a flow of information, making it possible for road users, special interest groups and the general public to judge whether their interests are being duly protected and whether the benefits they receive are in an adequate relation with the payments they make. In the system we propose, payment will come in the form of rates charged for the use of roads.

In a transparent system the following aspects must be clearly defined: who should inform and who should be informed; what type of information is required; how should the required information be collected and presented (especially information about the state of the road network and traffic volume); and how can information from different time periods be compared.

In other words, a transparent environment implies a well defined and applied information system. There is detailed bibliographic material available on this subject. (For further reference we recommend the World Bank document written by William D.O. Paterson and Thomas Scullion and published in 1990 under the title "Information Systems for Road Management: Guidelines on System Design and Data Issues").

THIRD TARGET: INCENTIVES AND SANCTIONS IN ROAD NETWORK MANAGEMENT

Efficient and effective road management can only be achieved through good professional performance by those responsible. Good professional performance is the product of various types of incentives received by individuals. What incentives provide a basis for good performance? The following are among the most common:

- an attractive salary;
- benefits, such as medical insurance, pension funds, etc.;
- possibilities for advancement in the organization or the company, accompanied by raises in income and social prestige;
- a pleasant work environment including decent offices and up-to-date equipment;
- a good public image of the agency or company
- a positive work atmosphere;
- the existence of a team of qualified personnel, and friendly competition among them.

In efficient companies and organizations personnel decisions are based on a permanent evaluation process which identifies outstanding employees in both the positive and the negative sense. Those who are outstanding positively are usually given the chance to advance in the company. On the other hand, measures are taken about those whose performance is not up to the position they fill. If the performance deficiencies are caused by lack of knowledge, there is always the possibility of training through professional courses. If deficiencies are based on a general negative attitude or unethical conduct, the normal procedure is to remove the person from the company.

In most modern organizations, the basis of employee performance evaluation is a written job description. Managerial staff is measured against compulsory achievement targets, such as desired profit levels, market share increases, etc. To create incentives for both executives and regular staff members, cash payments and company shares are usually offered for target achievement. To stimulate employees and executives it is fundamental to associate career opportunities and income to professional performance.

If road network management is transferred to companies, either through concessions or management contracts, the mechanisms for ensuring efficiency and effectiveness must be created simultaneously. In a company environment efficiency can be achieved by consistent attempts to minimize costs and simultaneously comply with conditions defined in the contract. The lower the costs, the higher the company's profits - if the physical condition of the road network is kept within fixed standards.

FOURTH TARGET: THE CREATION OF A CLIMATE OF CONFIDENCE AND COOPERATION AMONG ROAD CONCESSIONAIRES, CONTRACTORS, AND GOVERNMENT AGENCIES

Reorganization of the road sector means a redistribution of responsibilities for specific tasks. In most cases, this redistribution will result in public-private partnerships. Through contractual arrangements, there will be a delegation of certain responsibilities from government agencies to smaller units. These units would normally be companies, but may also be regional and local public agencies. The main reason for this delegation is to increase efficiency and effectiveness; a transfer of tasks and responsibilities should only be done if those smaller units are in a better condition to do specific jobs. This means that government may have to retain some functions as smaller units may not be capable of performing them. A prime task which must remain with the central government is safeguarding public interest in roads.

How do these changes affect the relationship between government and smaller bodies? In the traditional system of road administration, the government is undoubtedly the main actor. In some countries (for example in Costa Rica and Guatemala) a specific Government Ministry carries out almost all tasks related to the road network, with the sole exception of constructing new roads. In this case there has not been any need to establish communication or cooperation relationships with other units. However, this also means losing the chance to take advantage of the potential contributions these smaller units could make for achieving a higher degree of efficiency and effectiveness. In the traditional bureaucratic system, rigid procedures and multiple obstacles in decision making have often been stumbling blocks for awarding contracts or paying contractors on time. This becomes a serious obstacle when trying to arrive at mutually advantageous cooperation between government and private sector.

The redistribution of tasks will lead to a series of changes in contractual and legal relationships among various institutions, agencies and companies who will participate in road management. These changes will affect:

- central government agencies (for example Ministries of Public Works);
- regional and local public agencies, such as provincial and municipal administrations;
- non-governmental agencies, such as road user and producer associations;
- road management companies;
- investor groups;

- construction companies; and
- contractors specializing in road conservation.

The well-functioning of the "new order" of the road sector will depend on the degree of cooperation and communication reached between government and other units involved. It is essential that interested persons and groups show a willingness to make the new system work. This also requires a new legal framework and regulations for enforcing fulfillment of contractual agreements, which must be sufficiently flexible to allow adjustment for changing situations.

FIFTH TARGET: AN ADEQUATE DEGREE OF REGIONALIZATION

The Latin American and Caribbean region is made up of more than thirty countries, each of which has different characteristics of size, geography, topography, population distribution, economic prosperity, means of communication and land transport needs. For example, the region includes countries as big as Brazil and as small as Barbados. These differences affect the design of a suitable system of road network management, especially in relation to the degree of decentralization necessary. While it might seem reasonable to manage all roads in Barbados from a single central agency or company, this would not be reasonable in Brazil.

Economy of scale in road management is essential. For instance, it is more rational and economical for a single company to manage a network of twenty relatively short roads than to manage these roads through twenty different companies. However, the size of the network managed by a single agency or company cannot be extended indefinitely without management becoming increasingly inefficient and thus producing inadequate decisions.

Given the different characteristics and purposes of roads, an additional way of guaranteeing effectiveness is to divide large networks into several sub-networks, then transferring the management of each sub-network to regional or local units or companies. The optimum size of a sub-network would depend on specific characteristics of each country and each sub-network. It may be in the range between 500 kilometer and 3000 kilometer. By doing this, it should be ensured that the management center of each sub-network should be physically close to the road sections managed. Another benefit of smaller networks is active user participation in decision-making and control of road conditions. Subdividing the network may also help to reduce risk of general collapse of the entire network, in the sense that one should avoid "putting all the eggs in one basket".

ALTERNATIVES FOR REORGANIZING THE ROAD SECTOR

Decision-making requires an overall view of the alternatives available and the real significance of each alternative. This is what we attempt to do here in relation to the reorganization of the road sector. We will describe the principal alternatives and list their advantages and disadvantages. First, however, we shall look at a series of general aspects which will serve as criteria for defining advantages and disadvantages of individual alternatives.

The central question is: Who should be responsible for road network management? Certainly, there have been various answers to this question. The traditional case in most of the world is that road administration is done by government ministries and specifically by a department

within a ministry. Those who generally work on road management are public employees governed by regulations typical of ministries. In the traditional form of road administration the ministry may delegate certain physical works to contractors through public tender, while retaining all decision making power over place, timing and specification of the works to be carried out. This traditional alternative can also be called "ministerial", as the principle decision-making is done by a ministry.

Serious and accelerated deterioration of the road network in the region raises doubts about the capacity and effectiveness of this traditional or "ministerial" way of administering roads. Today, one cannot continue to blindly accept the validity of a model which was developed to meet the needs of a more or less distant past. It is also not permissible to accept the traditional model with resignation "because it has always been that way" or "because that is how it is done everywhere". Quite the contrary, it appears convenient to do a performance analysis of the agency which traditionally has been responsible for road administration. This analysis should be made strictly with technical criteria, trying to establish the aptitude of the existing agency to manage roads and to prevent a continuation of the present deterioration process. Using the diagnosis as a basis, the type of organizational setup should be identified which promises the best possible results for the

future. In some countries of the world this process has already begun and various alternatives to the traditional formula are beginning to be applied or studied.

An extreme solution is for the State to sell the road network to private investors, completely abandoning all pretensions of intervening in management. Without totally dismissing this solution, it must be admitted that this option contains a set of adverse characteristics which make it not very viable. Among the most serious problems of this solution is the difficulty of protecting public interest in roads.

There are other more moderate solutions, however, with good prospects of producing positive results. Among these are the various forms of public-private partnerships, which include the transfer of actual road network management from the "ministerial" environment to a company environment. In practice, these public-private partnerships could materialize through public tendering of road management contracts or concessions, in which the State retains the fundamental task of protecting public interest in roads.

RISKS AND RISK PROTECTION MECHANISMS

Transferring road network management to companies has certain risks. For example, the road management company in its attempt to maximize profits, may reduce spending to an extent that the roads deteriorate to a condition below the standard defined. Such behavior is against the conditions of the contract and will later require heavy investment for rehabilitation. When deterioration can no longer be concealed and costly road rehabilitation becomes necessary, the company could simply withdraw from the contract or commit fraudulent bankruptcy, having previously withdrawn profits accumulated over years. To avoid this type of risk it is necessary to create protection mechanisms, no matter which alternative for reform is finally adopted.

Traditional protection mechanisms for this type of risk are the following:

- **The establishment of contractually agreed fines.** Fines, whose level could be fixed in management or concession contracts, could be charged to the road management company if it does not meet established road condition standards. This mechanism, however, does not protect the public from possible losses if the company goes bankrupt, as the company would not be able to pay the fine. Moreover, there could be problems in the practical application of fines, especially in relation to who would have to trigger their application.
- **The deposit of a bank guarantee by the road management company or the concessionaire.** The bank guarantee would be partially or totally lost, if the established road condition standards were not met. This mechanism would solve the problem of the availability of funds for paying possible fines, but it does not solve the second problem, that is, controversies on the practical application of the fines.

It therefore appears that none of the traditional protection mechanisms would be suited to the needs. However, we propose a new mechanism which may prove to be much more effective:

- **The sale of long-term negotiable contracts for road management or concessions:** By purchasing a management contract or concession from the State (or from a company that previously held the contract) a company would make quite a large investment. Buying a road management contract actually means buying a future stable cash flow revenue in the form of road user rates, but also imply expenditures to maintain the road network in the previously defined condition. In effect, the contract means an expected net cash flow for the company. The present value of that expected cash flow should normally correspond to the market price of the contract. Naturally, the company would have a strong interest in protecting the value of the road management contract, which has become an important asset to the company and which may be sold if desired or necessary. If the company has allowed the road network to deteriorate, any potential buyer of the road management contract would realize that significant investments are needed initially in order to bring the network back into good shape. Obviously, initial expenditures reduce the present worth of the expected net cash flow, and therefore the market price of the contract. Any "gain" of the company from not spending much on the road network is offset or overcompensated through the loss of market value of the contract.

On the other hand, if the company keeps the road network in good and solid condition, applying adequate conservation procedures and using high-quality materials, a potential buyer will be prepared to pay a higher price for the contract, because there will not be any rehabilitation needs; he would simply have to continue regular conservation measures.

In the two cases mentioned, revenue expectations are basically the same, as they are the road user rates defined in the contract.

Of the three protection mechanisms the sale of negotiable long-term contracts is the most sophisticated. It combines a series of characteristics, which make it attractive and promising, especially in countries where local capital markets are looking for safe long-term investments.

PUBLIC-PRIVATE PARTNERSHIPS, THE COMMON DENOMINATOR OF PROPOSED ALTERNATIVES

The alternatives for reorganization of the road sector presented below consider different ways and degrees of transferring certain tasks and responsibilities. There are two types of transfer. Either the government delegates part of its responsibilities to regional or local units; this process is called regionalization. The other type is the transfer of tasks from public agencies to private companies; which is called privatization. All the alternatives presented constitute a transfer of tasks and responsibilities from the "ministerial" environment to the company environment. Their financing will not depend on the allocation of general taxes from the government budget, but on rates for the use of "road service" and the creation of a road conservation fund. These two fundamental types of changes are indispensable elements of any road sector reorganization. The specific alternatives proposed and described in this book are:

- **Alternative 1: National Road Management Corporation**
 - **Alternative 2: Regional or Municipal Road Management Corporations**
 - **Alternative 3a: Road Management Contracts (negotiable and fixed period)**
 - **Alternative 3b: Road Management Contracts (negotiable and indefinite period)**
 - **Alternative 4a: Temporary concessions (negotiable)**
 - **Alternative 4b: Permanent concessions (negotiable)**
 - **Alternative 5: Sale of road infrastructure**
-
- **Alternative for "non-viable" roads: Road User Associations**

There is another characteristic common to these alternatives: the safeguarding of public interest in roads continues to be a task which the State cannot delegate. It is unlikely that any organization besides the State will recognize and protect better the interest of society in road infrastructure, limiting as much as ever possible the mingling of public interest with the private interest of individuals or specific groups. **None of the alternatives presented in this book are outright privatization as they all constitute public-private partnerships.**

In many countries there are state organizations with the task of safeguarding public interest for services such as water supply, electricity and telephone services, the banking system, the stock exchange, etc. In most cases these organizations are rather small and staffed with highly qualified personnel who receive attractive salaries; they are relatively independent from short-term politics and enjoy considerable public prestige. These organizations are sometimes called "Superintendencies" or may have other names. In the United States, for example, electricity or telephone services are supervised through "Public Utility Commissions". In some countries, banks are supervised by the "Banking Examiner's Office". Or there may be a "Water Authority" which supervises the use of water resources. None of these organizations provide direct customer services, but make sure that the (private) companies which do provide the public services, work within the laws and regulation established.

BLUE VALLEY ROAD MANAGEMENT COMPANY

A (still) fictitious story.

Blue Valley Road Management Company (called **BlueVal**) has just been awarded a contract with the **State Road Superintendency**. BlueVal had offered to pay the State the sum of US\$ 10 million for the 25-year contract to maintain in good shape at all times a well-defined 3000 km road network. The BlueVal offer was the highest bid; other competitors had offered lower sums for the contract.

The bid was based on several expectations:

1. **Revenues:** In the first year, the State **Road Conservation Fund** will pay the winner of the contract the sum of US\$ 11.2 million, to pay for the service to be provided, that is, to ensure good road conditions throughout the network. In the following years, the annual payment will be adjusted according to traffic growth. Expected

traffic growth is 2 percent per year. This information permitted BlueVal management to calculate the expected revenue flow during the 25-year contract period.

2. **Expenditures:** Considering the acceptable condition of the road network included in the contract, BlueVal engineers have calculated that under present traffic conditions, the average annual cost for ensuring good road conditions would be US\$ 10.5 million. They have also calculated that at a traffic growth of 2 percent per year, maintenance costs would increase by 1.5 percent per year. This knowledge permitted to calculate the expected expenditure flow during the 25-year contract period.
3. **Return on capital:** BlueVal's shareholders, which are mainly institutional investors, such as life insurance companies and pension funds, expect a return on capital of approximately 10 percent per year.

With this information on hand, it was now rather easy for BlueVal management to calculate the **present value of the contract**, which turned out to be US\$ 10 million. The lower bids presented by other companies may have been generated by their wish to have higher returns on their capital, or because they assumed a lower efficiency in their operations. In the end, BlueVal's proposal was the best choice for the State Road Superintendency. The cash-flow figure on the previous page was produced during the preparation of the proposal.

It should be mentioned that BlueVal is not a newcomer in the field, but has managed roads for more than ten years. Therefore, their assumption on how much it would cost to maintain the 3000 km network was based on a good knowledge of the roads involved, climate, maintenance technology, materials and working procedures. Risk is considered low, also because the Road Conservation Fund ensures a stable financing source, independent of short-term political hiccups.

CONCEPTS AND TERMS RELATED TO ROAD MANAGEMENT

Before describing the alternatives we propose for reorganizing road management, we would like to define some terms which are not yet very well known, but which are important for understanding the general concepts of this book. The definitions given below should avoid semantic confusion in further discussion of road management concepts.

What is a Road Management Contract? It is an agreement between the State, as owner of the road infrastructure, and another party, which may be a road management company or similar organization. By this agreement, the State transfers to that party the responsibility for the management of one or various existing roads, or of a road network. This also includes responsibility for actually carrying out any physical works required to keep the road infrastructure in good condition. Physical works may be contracted out to third parties.

What are the principal elements of a Road Management Contract? The contract stipulates a minimum standard for the physical condition of each road included in the contract, leaving broad freedom to the road management company on how to make sure that these standards are met. The contract may also stipulate an average condition for the entire set of roads included. It also sets the method and form of payments to be made to the road management company in regular intervals. The payments would normally come from a Road Conservation Fund, but may also be budgetary allocations, especially during a transition period. Payment could be made as a fixed annual sum, or could vary according to various criteria included in a payment formula, for instance the volume of traffic and the rate of inflation.

It is important that the payment to the company is performance-based; this means that it regularly receives defined payments, as long as road conditions are good and in conformity with the contract. The company does not receive quantity-related payments in relation to the volume of physical works carried out, as this would only lead to the company carrying out as much work as possible, and of dubious quality. Road maintenance contracts based on quantity-related payments are unlikely to bring about any significant savings, and run the risk of encouraging the rise of corrupt practices.

What is a "negotiable" Road Management Contract? It is a contract, usually very long-term or even without time limitation, whose special characteristic is that it can be purchased and sold at market price, or even be traded in the form of bonds or shares. The purchase of a negotiable contract (or shares of it) is an investment which guarantees the buyer a more or less steady revenue

flow, in the form of regular payments received from the Road Conservation Fund. Negotiable contracts carry an obligation to maintain roads included in the contract according to technical standards defined in the contract.

Negotiable contracts or concessions are common in the transport sector. Examples from the air transport sector include "landing rights" for airplanes at airports. These "landing rights", which one company can sell to another, are mechanisms allocating scarce airport capacity according to market rules. Another example is concessions for public passenger transport, mostly urban, which can also be sold between companies at market prices. A common characteristic of negotiable contracts is that they are not related to the ownership of a good. For instance, an airline can buy a landing right, but it still has to provide an airplane to make use of this right.

In the ultimate sense, a Road Management Contract may end up being equivalent to a public service or utility company, whose owners may change through the trading of the company's shares.

What is a Road Concession? A special type of road management contract characterized by granting the concessionaire the right to directly collect rates from road users, usually in the form of tolls. The concessionaire runs the risk of a possible drop in traffic. There are, however, concession contracts in which the government guarantees a certain volume of traffic. One of the advantages for the concessionaire in this system is guaranteed rate or revenue collection, thus avoiding the risk of the government not being able or willing to make agreed payments. There is also the possibility that the concessionaire has a higher revenue than originally estimated if there is more traffic than expected. Part of this additional revenue may be transferred to the State. The disadvantage of concessions is the high cost of collecting tolls, which may be between 10 and 40 percent of the amount collected, depending on the traffic volume.

How are Road Management Contracts awarded? A very important element in initially awarding these contracts is competition among several interested parties. For this reason the use of public tenders to identify a bidder with the most favorable economic terms and prospects for success is recommended. An important parameter for awarding the contract is the amount of payment offered for "purchasing" the contract.

How long can Road Management Contracts last? A Road Management Contract can last a specific number of years, but we firmly believe that contracts for an indefinite unlimited period provide much better chances for success. If the contract is fixed term, the company's responsibility for management and physical condition ends at a certain point of time fixed in the contract. There is a serious risk that in the last few years of the contract little or no investments or physical work will be made which last longer than the contract itself. Soon after the expiration of the contract, heavy expenditures will be required to avoid or remedy rapid deterioration. Who will become responsible for those expenditures? Maybe the government or maybe the next owner of the contract. But who wants to buy a contract which requires heavy initial expenditures and hence a negative cash flow over years?

If a Road Management Contract covers an indefinite period, the responsibility of the owner (or owners) of the contract is permanent. A particular owner could only end responsibility by selling the contract or the share he holds, or through an agreement with the State. The contract could also be revoked at the request of one of the parties involved, through a mutually agreed mediator, if one of the parties involved is seriously at fault in contractual obligations. Such fault may either be made by the company, for not meeting road condition standards, or by the Road Conservation Fund for not paying the agreed amount to the company.

Short-term Road Management Contracts have serious disadvantages and are not recommended. Many physical works related with road conservation have a long duration. For example, asphalt pavement overlays for surface strengthening may easily last 10 years. Strengthening works for concrete pavements last even longer. Drainage works may stand up 30 years or more. Only a long-term view allows for significant cost reductions in road conservation. Contracts with a duration of less than 15 years do not allow for achievement of the full possible savings. An exception are contracts which only include unpaved roads where shorter periods may make sense; however never less than 5 to 10 years. By definition, any fixed-term contract has a built-in flaw at the end of the contract period.

What is a Road Management Company? It is a commercial entity formed for the purpose of managing and conserving roads. The company's basis of operation is one or several management contracts which were either awarded by the government or purchased on the market. With those contracts, management and conservation of one or several roads (which may or may not form a road network) is transferred to the company by the government. The operation of the company is subject to laws governing any business operation in the country. Income stems mainly from payments made by the Road Conservation Fund which collects rates from road users. The company could also receive other income from tolls. Expenditures are mainly for physical conservation

works which may be carried out by the company or may be contracted to other companies. Other expenditures are for management and general overhead costs.

For the company to make profits, it is necessary not only for revenues to be greater than expenditures, but also for the company to meet physical road standards agreed to in the Road Management Contract.

What is a Road Management Association? A group of individuals or entities who have a common interest in the conservation of specific roads. Road Management Associations are usually non-profit organizations and are usually interested in roads with a very low traffic volume. They can be very effective for protecting the interests of relatively small user groups who depend on specific rural roads which have been described as "non-viable" earlier in this book.

DESCRIPTION OF SPECIFIC ALTERNATIVES FOR ROAD NETWORK MANAGEMENT AND CONSERVATION

Specific alternatives proposed for reorganizing road management and conservation are described below. Not all alternatives are equally beneficial; their description includes the principal advantages and disadvantages of each alternative.

ALTERNATIVE 1: NATIONAL STATE-OWNED ROAD MANAGEMENT CORPORATION

Main characteristics: The management of a road network including the responsibility for physical works is transferred by law from a government ministry to a newly-formed state-owned Road Management Corporation or Company. The safeguarding of public interest should remain in the hands of the government ministry or a Superintendency of Roads. The state-owned Road Management Corporation may carry out physical road works with its own work force and equipment or contract private companies for those tasks.

ADVANTAGES:

- The responsibility for Road Network Management is transferred from the "ministerial" environment to a company environment;
- gives more flexibility for adapting to changing situations;
- introduces obligatory use of various accounting instruments which may lead to improvement in management;
- makes dealing with outside contractors more flexible;
- breaks the rigid public employee salary scheme which often forces to pay very low salaries; allows to offer attractive and competitive salaries;
- allows the application of an adequate personnel policy, offering incentives to employees and executive staff which may lead to an increase of efficiency;
- may have the effect of significantly reducing the interference of short-term political interests; and
- facilitates changing the financing system from a tax-based to a user rate-based system, since in many countries current law prohibits ministries, but not corporations or companies, from charging rates.

DISADVANTAGES:

- A state-owned Road Management Corporation would not have to compete against anyone; therefore this alternative lacks an important element for stimulating efficiency and effectiveness;
- experience from many countries shows that state-owned corporations are often subject to heavy influence and pressure from the political scene; and,
- there is serious danger that a state-owned Road Management Corporation could end up operating in a manner similar to a government ministry; the problems rooted in the "ministerial" environment may not be solved.

COMMENTS: This alternative does not imply increased decentralization and is therefore not suitable for large countries. It allows a certain degree of privatization, because of greater flexibility in contracting certain tasks to private companies. It could perhaps be recommended in smaller countries where the law and actual practice gives state-owned corporations real independence from short-term politics. Specifically, this alternative would be useful as a first step or transition phase in the long-term process of more thorough reorganization.

ALTERNATIVE 2: REGIONAL OR MUNICIPAL ROAD MANAGEMENT CORPORATIONS

Main characteristics: The management of the road network and the responsibility for physical works is transferred by law from a government ministry to various regional or municipal Road Management Corporations. Protection of the public interest may continue in the hands of the ministry or may be transferred to a Superintendency of Roads. Regional or municipal corporations may carry out physical works themselves or hire contractors.

ADVANTAGES:

- All the advantages of alternative 1, and also
- decentralizes road management; decisions are taken close to the geographical location they refer to, and
- facilitates participation of road users and the general public in controlling the efficiency and effectiveness of the system.

DISADVANTAGES:

- There is not much competition; some limited degree of competition may exist because the results of one regional or municipal corporation can be compared with the results of corporations in other regions or municipalities;
- experience in some countries shows that there is a great danger of regional or municipal corporations being subject to considerable pressure from the political scene, and
- there is also the danger that regional or municipal corporations end up operating in a manner very similar to the public administration, and the problems which stem from this type of operation and are not necessarily solved.

COMMENTS: Alternative 2 is very similar to alternative 1, except that it offers the possibility of regionalization.

ALTERNATIVE 3A: ROAD MANAGEMENT CONTRACTS (NEGOTIABLE AND FIXED TERM)

Main characteristics: By means of Road Management Contracts, the State transfers responsibility for road management including physical works to one or various smaller units, usually private companies created specifically for this task. Physical works may be executed either directly by the Road Management Companies or can be contracted to third companies. A contract is awarded through competitive public bidding to the bidder who offers the highest chances for success and the highest initial payment to the State. The duration of each contract is limited in time and defined in the tender documents, with a minimum that should not be below 10-15 years. At termination date all responsibilities return to the State which may offer a new contract for tender. The State keeps the responsibility for safeguarding public interest in roads. Payment to the Road Management Companies would normally be made through the Road Conservation Fund, according to clearly established mechanisms.

ADVANTAGES:

- All the advantages of alternatives 1 and 2, as well as the following:
- implementation would most probably remove interference of short-term political interests in road management;
- introduces competition through the bidding process on contracts;
- where the network is divided in sub-networks, it encourages competition among the companies managing different sub-networks, as each one tries to show best results;
- financial losses are likely in those companies who do not meet their obligations, this is a strong incentive to comply;
- the contract can be canceled rather quickly if either party does not meet its obligations; this may help to avoid a paralysis under circumstances which need quick corrective action to avoid serious road deterioration;
- creates important new business opportunities.

DISADVANTAGES:

- There is the risk that only "cosmetic" works will be done as the contract nears its end because the company has no incentive to spend money on works which last longer than the contract itself;
- unless the Road Management Company has deposited some kind of bank guarantee of a significant amount, there is always the risk of fraudulent bankruptcy of the company, especially as the end of the contract nears.

ALTERNATIVE 3B: ROAD MANAGEMENT CONTRACTS (NEGOTIABLE AND INDEFINITE PERIOD)

Main characteristics: This alternative differs from the previous alternative, as this type of contract has no expiration date. The government sells contracts by public tender to the highest qualified bidder. The purchase price of each contract will probably be higher than in the case of limited fixed-time contracts, but in any event much lower than the replacement cost of the infrastructure covered by the contract. This sale would mean significant revenue for the State. Later, the owner of the contract can sell it, either entirely or in shares, to other qualified entities or companies. As in the other alternatives, the State remains responsible for

safeguarding public interest in roads, probably through a Superintendency of Roads. If the owner of a contract does not fulfill its conditions in a serious way and during a prolonged period, the contract may be revoked without compensation to the company. In this event, the government would have to offer the management contract for tender again. The contract would normally maintain its financial market value as long as the road network condition is in accordance with the contractual stipulations.

ADVANTAGES:

- All the advantages of alternatives 1, 2 and 3a, and also
- introduces a strong incentive for the owners of contracts to keep the network in permanent good condition, because if the company decides to retire from road management it will be able to recuperate the full value of the original investment, as the contract has probably maintained its market value;
- avoids last minute "cosmetic" works described under alternative 3a, because the contract has no termination date;
- the sale of the contracts generates significant initial revenue for the government;
- provides safe and long-term capital investment opportunities suitable for institutional investors such as pension funds, life insurance companies, etc.
- may eventually open investment opportunities in the context of "people's capitalism" where large numbers of small investors buy shares of public utility companies.

DISADVANTAGES:

- Given that the contracts will probably be sold at rather high prices, alternative 3b could only be put into practice in countries where capital markets exist or which have access to foreign capital markets.

ALTERNATIVE 4A: TEMPORARY CONCESSION

Main characteristics: A temporary concession is a variation on alternative 3A (negotiable and fixed period Road Management Contract), whose specific characteristic is that the concessionaire directly charges user rates in the form of tolls. This system is usually only used for roads with a high traffic volume where charging tolls is viable. It cannot easily be used for low-traffic roads since important parts of the revenue of the concessionaire would be needed to pay for the cost of toll collection. This alternative introduces a significant risk to the concessionaire, in case if traffic volumes are lower than predicted. There is also the possibility that traffic volumes and revenues are higher than predicted. The government may guarantee a minimum amount of traffic, thereby reducing the risk to the concessionaire, and receiving in return a share of that part of the revenues which exceeds projections.

ADVANTAGES:

- All the advantages of alternatives 1, 2 and 3a, and
- may be applied even before a general reform of road user charges, which would introduce user rates included in the fuel price.

DISADVANTAGES:

- Direct charging by a private company may initially not be well received by road users;
- charging tolls is expensive and therefore not an efficient charging mechanism;
- toll alternatives cannot be a solution for the large percentage of roads with medium or low traffic volumes.

COMMENTS:

This alternative is often used in relation with the construction of new roads, bridges and tunnels according to models such as BOT (build-operate-transfer) or similar, a system in which the private sector finances and builds the infrastructure, manages it for a specified period, charges user rates, and later hands the infrastructure over to the State. Mexico makes extensive use of this alternative. In Argentina, some 10.000 kilometers of main highways are managed under this type of arrangement.

ALTERNATIVE 4B: PERMANENT CONCESSIONS (NEGOTIABLE)

Main characteristics: This alternative is similar to alternative 4a, with the difference that no time limit is placed on the concession. As in various other alternatives, the government initially sells the concession by public tender to the highest qualified bidder, who in turn may later sell it to a third party.

ADVANTAGES:

- All the advantages of alternatives 1, 2, 3b and 4a.

DISADVANTAGES:

- Given that concessions will sell at a rather high price, this alternative can only be put into practice in countries where a capital market exists, or where there is access to foreign capital markets.

ALTERNATIVE 5: SALE OF ROAD INFRASTRUCTURE

Main characteristics: The government sells part or all of the road network by public tender. Roads become property of private institutions with all the resulting consequences. Sales transactions must be subject to conditions like the obligation to keep roads permanently open and the guarantee that user rates are set according to clearly defined formulas. Depending on the restrictions and obligations imposed, this alternative could end up being very similar to alternative 3b (negotiable Road Management Contracts of indefinite period) or to 4b (permanent negotiable Concessions).

ADVANTAGES:

- It has all the advantages of alternatives 1, 2, 3b and 4b.

DISADVANTAGES:

- Unless an excellent legal framework is established, public interest may not be satisfactorily protected.

COMMENTS: This alternative could be used in the case of roads which have alternative routes available. Realistically, given the marvelously overgrown legal jungle in many countries of the region, it is probably rather difficult to actually sell the entire road network of a country. However, it should be remembered that the sale of entire long-distance highways has already become reality in the United States.

ALTERNATIVE FOR "NON-VIABLE" ROADS: ROAD MANAGEMENT ASSOCIATIONS

Main characteristics: The State entrusts the management of one or more local roads, whose conservation appears "non-viable" from the economic point of view, to a non-profit road management association, made up of individuals or entities which have a common interest in those roads. The members of the association would have to contribute resources (financial or material) to maintain the roads. The Road Conservation Fund could co-finance conservation, contributing an amount equivalent to the rates paid by those who use these roads.

ADVANTAGES:

- Those directly interested in specific roads (usually very little travelled) take over their conservation. Consequently, physical works executed and related costs would probably be rationalized and correspond very closely to the real needs of users.
- Users would look after these roads, avoiding practices which deteriorate them.

DISADVANTAGES:

- Associations may find it difficult to acquire and apply adequate road technology.

COMMENTS: In various countries of Latin America and the Caribbean some organized groups of road users already contribute to financing the conservation of roads in which they have an interest. User groups generally contribute materials or labor to the entity responsible for conservation and this entity provides the remaining needs, such as equipment or technology. Organizing a Road User Association or Road Management Association offers the possibility of institutionalizing direct user contributions and establishing permanent procedures for cooperation.

THE GUATEMALA SUGAR PRODUCERS ASSOCIATION PROMOTES CONSERVATION PROGRAMS FOR ROADS IN WHICH THEY HAVE A SPECIAL INTEREST

There is an interesting case of effective road user participation in Guatemala, where the sugar producers participate in the development of conservation programs for the roads they use. The government's serious financial problems have led to an important reduction of conservation spending in recent years. Many roads are in bad condition and some have become unusable. The Sugar Producers Association decided to take action in the face of the urgent need to move sugar cane from the fields to the sugar refineries, and refined sugar to domestic and international markets. Therefore, they proposed to contribute resources to make conservation possible on public roads, both paved and unpaved, used by association members. In the agreement with the national road authority, the association agreed to supply materials such as gravel, asphalt, tools, and spare parts for repairing equipment and vehicles. They also agreed to contribute their own personnel and equipment. Finally, the necessary elements for road conservation were brought together. By common agreement, an on-site inspection system was set up to assure that donated resources were in fact applied to roads of interest to the donors. This cooperation between the private sector and the road agency made improvement of several roads possible, and is considered a "good deal" by the sugar producers since savings in transport costs are greater than the value of their contributions.

8. The Reform Process

The reform of road network management and conservation is one of the major tasks many Latin American and Caribbean countries need to face in the coming decade. The way this reform is carried out may vary considerably from one country to the next and final results achieved may also vary. This book does not presume to show THE one and only method for making necessary changes since there is no single solution but rather an array of alternatives.

The reform process requires certain basic elements and concepts which, if taken into account, increase the chance of success, by effectively eliminating the basic causes of chronic sectoral problems. On the other hand, ignoring these elements would make it very difficult to bring about a successful reform.

The two previous sections present the principal alternatives for financing and organizing road network management. This section discusses aspects related to the process of reform which, if taken into account, may greatly facilitate this difficult task.

8.1 Origin, Objectives and Measures of Reorganization

When embarking upon the task of reorganizing the road sector, one needs to be very clear about three points: First, why do we want to reorganize? Second, what objectives do we hope to achieve through reorganization? Third, what practical measures are needed to bring about reorganization? From the onset of a reform process, the final situation desired must be visualized, the elements and conditions which need change pinpointed, and the means and measures for reform decided upon. From the beginning, one should know that for a reform to be successful, agreement among key groups on these three critical points is essential.

It is then important to identify the groups affected by the present situation as well as their interests, expectations and perhaps, apprehensions regarding reform. Different interest groups may perceive the type and scale of problems differently. For instance, road users may have other grievances than employees of the Ministry of Public Works, who will in turn emphasize issues different from those considered important in the Ministry of Finance. Active participation of various interest groups in the reorganization process is highly recommended.

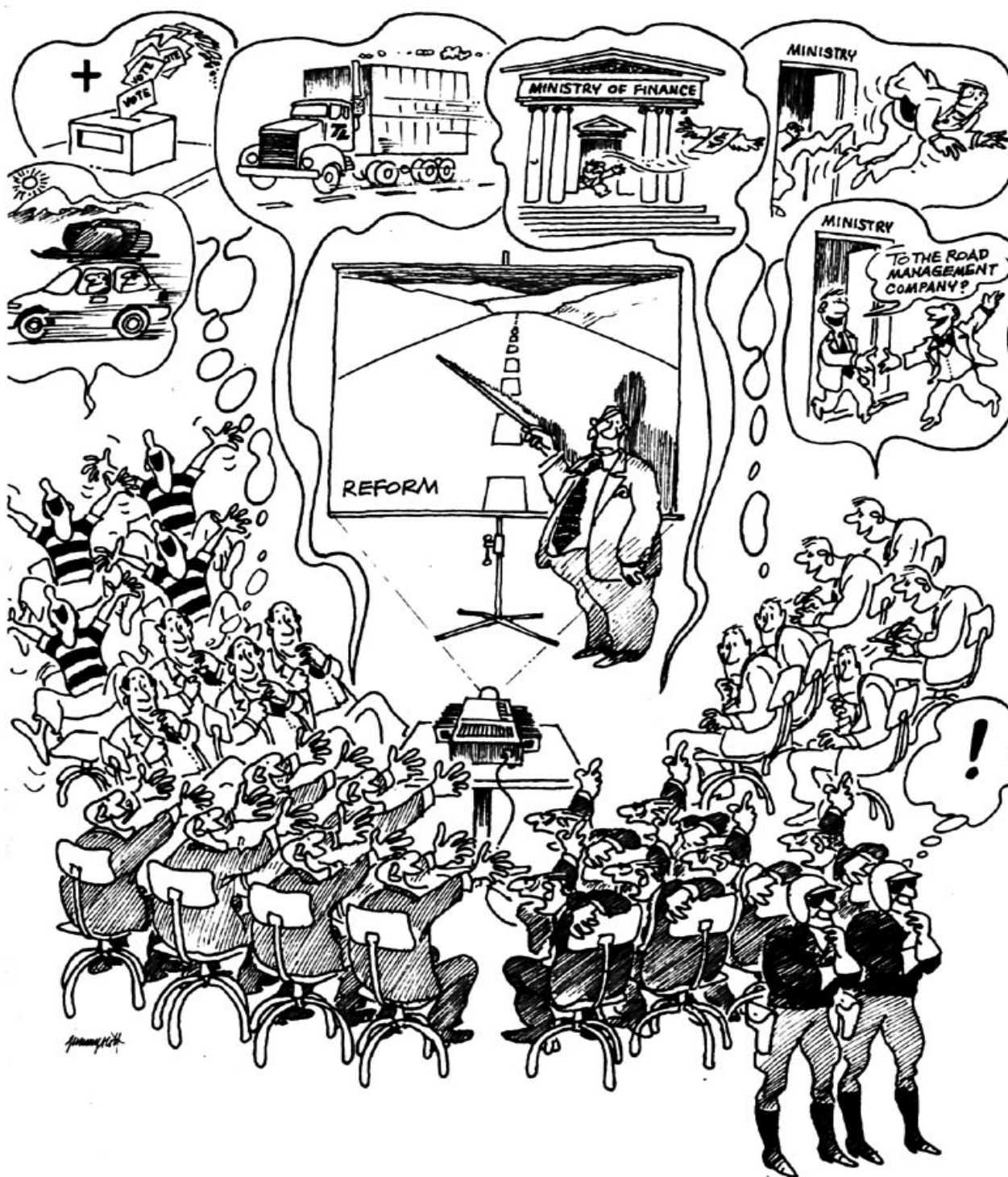
It is also essential to establish cause-and-effect relationships between existing problems. For example, a shortage of machinery in good working condition could be the result of other problems, like slow and bureaucratic procedures for purchasing spare parts. By analyzing the objectives to be pursued it is possible to establish a hierarchical relationship between goals to be reached and the means of achieving those goals. For example, removing road conservation financing from the annual political budget debate is a means toward stable financing. This, in turn, is a means for guaranteeing adequate road maintenance, which, for its part, is a means for achieving an efficient road transport system. This, in turn, provides a country with a greater competitive advantage on international markets. When analyzing means and goals, the participation of the different interest groups is again necessary, to avoid neglecting some elements which could be indispensable means for achieving greater ends. It is particularly necessary to include government officials and politicians from different political parties, since road sector reform is closely tied to national objectives and priorities.

The reform process consists in adopting and carrying out a strategy, that is, a defined series of measures and steps for bringing about change in an unsatisfactory environment. Defining the concrete steps towards change requires a previous study of various alternatives available for reaching the desired objectives. For example, drafting new legislation on road user rates and the eventual approval of this legislation by parliament, are concrete steps towards guaranteeing stable financing for road conservation.

Here also, it is important for different interest groups to arrive at a general agreement on the strategy for reform and the principal measures needed. Once again, politicians will play a fundamental role because they will have to decide on the political viability of the various measures proposed, and indeed, "politics is the art of the possible".

It may be valuable to complete the initial reform discussions (which could take the form of joint working committees among interest groups) by designing a reform planning matrix including all the conclusions reached. This step should take place before the actual reform process begins. Such a planning matrix is built by carefully answering the following questions:

- | | |
|--|----------------------------------|
| • Why is reform needed? | (higher objective) |
| • What effects should the reform accomplish? | (reform objective) |
| • What is the reform meant to achieve? | (results) |
| • How will the desired results be achieved? | (concrete steps and initiatives) |
| • What external factors are important? | (assumptions) |
| • How can reform success be measured? | (success indicators) |
| • Where can data for evaluating the reform be found? | (data sources for verification) |



8.2 Organized Users - The Force behind the Reform

Road users can be divided into two categories. The first includes direct users such as vehicle drivers and operators. The second category includes indirect users, whose economic activity depends on roads, although they do not necessarily have their own vehicles. Both types of road users suffer when the road network is in disrepair because they have to bear the financial and non-financial burden of this situation.

If road maintenance policy is bad, vehicle operators have to pay twice. In the short term they suffer an unnecessary increase in the cost of running their vehicles. In the long term, the taxes they pay may be destined largely to finance reconstruction of roads which collapsed precisely because of the lack of conservation.



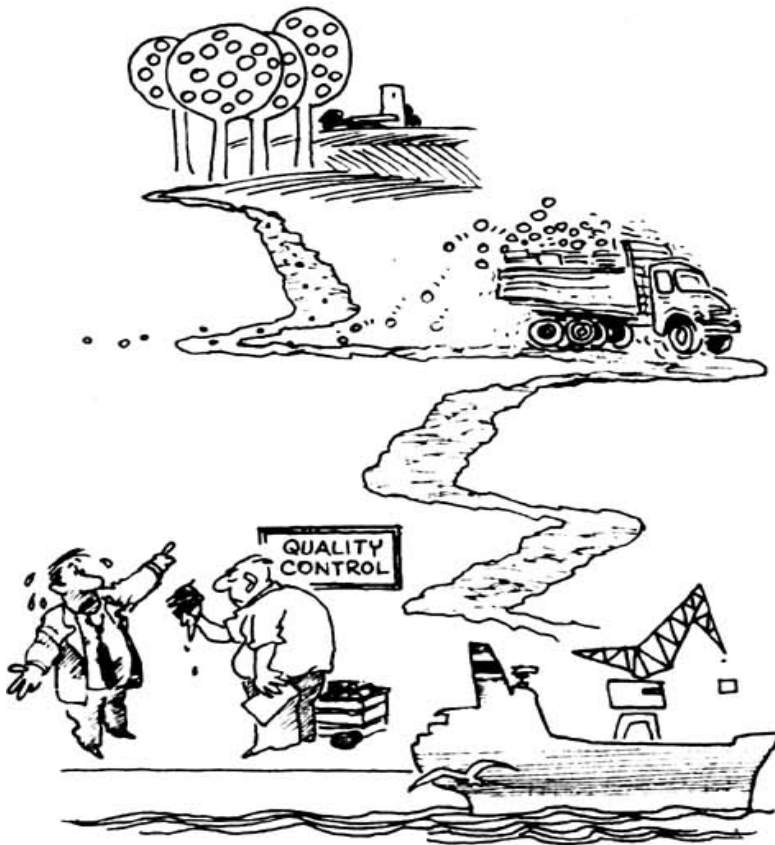
It is therefore quite likely that direct users will be interested in a reform of road network management and conservation. The potential strength of those direct road users must be kept in mind. In all countries of the region, there are millions of road users, making up a significant percentage of the total population. Many of them are already organized in, some way or another, such as in automobile clubs, trucking associations, bus or taxi owner associations, driver unions and other similar groups.

Road users are made up of various groups, mostly from the private sector, which have interests of some kind or another in the functioning of the road network. Generally, all producers of goods depend to some degree on the road network, whether for moving inputs to the production plant or for taking products to domestic and foreign markets. Domestic road quality can be a key factor for the export sector- by affecting the competitive advantage of its products abroad. A relevant example is the production of fruit and vegetables for export since fresh produce is extremely sensitive to the deterioration of roads. Bad roads have a negative effect on the quality of produce and also increase the cost -of transport. A transport company can often, pass on increased costs to the client by charging more for the service. Exporters, on the other hand, cannot usually raise the price of their products if they wish to sell on highly competitive foreign markets.

Indirect road users tend to group themselves in associations or federations which are sometimes quite powerful, like trade associations, farmer associations, chambers of commerce, etc.

The proposal to, reorganize road network management and conservation may also receive support from other potential allies. In the public sector, these allies could be found in-the halls of government offices like ministries of planning and economy, which are gene rally interested in government efficiency, the optimum allocation, of funds, and the development of an efficient economic system. Also, there are "road associations" in many countries, which bring together professionals from various sectors whose work is related to roads. These associations can also play a decisive role in bringing about t reform by joining representatives from various organizations into a single body; this could enormously facilitate the indispensable process of creating awareness about, reform, and also facilitate agreement on the measures for reform.

It must be repeated that the reorganization of road management, cannot remain exclusively in the hands of the public agencies presently responsible for roads. A reform similar to what this book proposes may interest some employees of existing road agencies, particularly professionals, because it could lead to salary increases and improve job opportunities. However, the majority of public road agency employees, including those in high ranks, have no real power to make profound changes nor do they have real incentives for overcoming the inertia of existing structures. We also know that the attempt by a public employee to make innovations can negatively affect his career in public administration. Consequently, the thrust of reorganization must come from the user organizations mentioned earlier; it is their task to provide the main impulse for reorganization.



INTERNATIONAL COMPETITIVENESS
EXPORT OF FRUIT



INTERNATIONAL COMPETITIVENESS
EXPORT OF FRUIT

Road Agency Employees and the Transition Period

Any change causes unrest among those who will be affected. The existing situation has the virtue that one knows the rules of the game and how to move. This advantage makes it easier to accept existing deficiencies, but also inherently inhibits initiatives promoting change.

Workers and employees are particularly conservative about changes in conditions of their work environment. A reform of the present system of road management and conservation, including profound institutional changes, could lead to mistrust and rejection on the part of employees in the road agency. Certainly their greatest fear would be of losing their jobs. It is even possible that the personnel association (or union) would try to block the change for this reason.

This view is damaging to the real medium- and long-term interests of the work force. Under the new institutional structure proposed, employees would have the following job opportunities:

- **Road Superintendency**

Since this is a specialized unit with relatively few, highly qualified employees, salaries could be substantially higher than in present road agencies; in addition, the work environment would most likely be much improved.

- **Road Management Companies**

Under normal circumstances, salaries paid by companies and even state-owned companies are significantly higher than in the public administration. Moreover, there is usually higher job satisfaction.

- **Private contractors and consulting firms**

Guaranteed financing for conservation will generate stable employment for these companies. Once again, the salaries will be better, both for professionals and labourers.

The new system promises better paid employment opportunities and higher job satisfaction. In some countries, the new system will create more jobs, as it increases road conservation activities in general, and because many physical conservation works are labour-intensive. A reduction of the work force will only take place in countries where the existing road agency employs a greatly inflated number of unnecessary personnel.

What will happen to those individuals who cannot adapt to the new system? Obviously, during a transition phase it is necessary to take steps to avoid suffering. Compensation payments for voluntary or early retirement could be offered. Also, the government may decide not to lay off anyone who does not wish to retire voluntarily.

The change cannot be immediate, since for a considerable length of time a new system (in expansion) will coexist with an old system (in reduction), which will alleviate labour problems during the transition period of various years.

It is likely that labour will benefit from the proposed changes. If workers understand this, union leaders and personnel associations may even support the reform instead of opposing it, trying to get the best for their members during the transition period and in the new system.

8.3 Building of Awareness, Orientation and Political Action

The process of reform will probably begin with the development of abroad awareness of the road maintenance problem. This will be followed by a period during which different interested groups study details of the problem and become familiar with the issue. Then the subject will make its way into the political debate and finally take shape through the introduction of concrete steps and measures of reform. This process may take several years. The individual steps warrant some comment.

Before interested and affected groups and organizations can promote reform, a basic condition must be met: there must be an awareness of the adverse effects a badly managed road network has on economic activities, the competitive advantage of their country in the global economy and the efficiency of the economy and society in general. This awareness must, therefore, be created.

As a first step to develop this awareness, two fundamental questions must be answered which may appear somewhat abstract, but are fundamental:

Whom are the roads for ? Who should pay for their conservation ?

Possible answers could be, as follows:

Roads have a variety of uses and purposes. In the first instance, however, they serve vehicle owners and operators who use them for their economic activity and personal pleasure. These vehicle owners can be considered members of the "road user club". As in all clubs, the "members" must pay for the infrastructure they enjoy, or at least take responsibility for finding some source of financing. For example, in a soccer club, the members must ensure funds for maintaining and renovating the stadium. This may be done through the payment of monthly membership fees, or through the sale of tickets for games. On the other hand, people who are not interested in soccer and never go to a game would not become members of the club. They obviously should not have any obligation to contribute to financing the stadium.

Roads were constructed to satisfy the needs and serve the interests of the public in general, without distinguishing between vehicle owners and persons who do not possess vehicles. Roads are necessary for defending the country and all its citizens against potential foreign enemies. They also play a strategic role since they are used for supplying goods and services to the population dispersed across the country. This makes it necessary to extend the road infrastructure into all geographical areas including those with a very low population density. These strictly "public" functions are not directly related to the particular use of roads by individuals and their vehicles. Therefore, the "public" functions of the road network should be financed by society as a whole, mainly through general taxes.

It is assumed that the State will look after the needs of both, vehicle operators and the general public by doing what is necessary to create and maintain a network of roads adequate for the two types of needs mentioned above. It is also expected that the State will establish rules and regulations for financing construction and conservation of the network. In this sense, government plays the role of the "board of directors", of the "road users club" and has to define how much each "member" should pay for use of installations. How well have the governments performed this role in Latin America and the Caribbean?

Quite well, as far as the construction of new roads is concerned, but not very well in maintaining existing roads and organizing a proper system for financing road network conservation.

Starting from the analysis and discussion of these and other basic points made in this book the process of creating public awareness can be begun. As the discussion progresses, various interest groups will need orientation and support, since most of them are not familiar with the technical and economic details involved in road management and conservation. This orientation will help the various groups to participate actively in the development of an overall project for reform. Moreover, it may help to coordinate the support of each group, so that "everyone pulls in the same direction".

Once a certain level of conceptualization of reform has been reached, the executive and political parties begin the legislative process for making the necessary changes. At this stage, politicians play a predominant role. Changing the form of financing road conservation and the institutional framework is undoubtedly a political issue. It is at this stage where decisions need to be taken and where conflicts of interests have to be resolved. Here, politicians need to play their role of governing and seek the common good of society.

The process of change may conclude with the passing of new laws and regulations which will be the legal base for the subsequent reorganization of road network, management and conservation.

8.4 Legislation on Roads as a Public Service

Reorganization of the road sector requires clear legislation which precisely establishes the practical procedures to be applied. This section defines the points which should be defined by new legislation and the fundamental changes which have to be introduced to current legislation.

The definition of roads as a public service:

It is useful to define the road network as a public service which is available, in principle, to everyone who wishes to use it. In this way, roads would be placed in the same situation as other public utility services such as electricity, water supply and telephone services. This first step is indispensable, because all remaining steps of reorganization of the road sector depend on it. It is necessary to abolish the idea prevalent in broad sectors of the public that roads are a public good provided by State free of charge.

Our view also helps to solve, at least partly, the old problem that roads cannot be compared with other modes of transport. For example, railroads need to include the cost of construction and maintenance of the track in the total cost of producing rail transport services, whereas trucking companies only partially and indirectly bear the cost of roads.

The definition of roads as a public service would also be a decisive step toward introducing transparency in their financing, independent from the allocation of general budget funds. This clears the way for setting up an autonomous mechanism to guarantee stable financing for roads based on user rates.

New legislation must permit the government to delegate road management to one or several management companies (government-owned, private or mixed) while retaining supervision over the proper functioning of the system. This safeguarding of public interest could be performed by a new Superintendency of Roads, or a similar body.

Transferring public services from a "ministerial" environment to a corporate or company environment has taken place in almost every country in the world. Electricity, water and telephone services in many countries started out under the direct responsibility of a ministry, then turned into state-owned companies and later gradually opened to private sector participation through the sale of shares, for example. This procedure was accompanied by specific legal measures which have varied from country to country.

No one seems to have much doubt about the usefulness and necessity of these changes. Generally, the majority of services in a company environment have shown continuous progress with no major setbacks. The increase in efficacy and efficiency has been more evident when the element of competition was introduced.

This contrasts sharply with the situation in the road sector which today is regressing in most countries of the region. The degree of inefficiency introduced in land transport through higher vehicle operating costs is a heavy burden on national economies and can exceed 1 % of the gross national product. This figure was estimated on the basis of data from various countries. Costs involved in reconstructing roads which were destroyed due to the incapacity of the system to avoid such destruction must be added to this figure. In spite of this, one still hears voices claiming that it is "unthinkable" to reform the road sector in a similar way as other public sectors have been reformed. However, there is no technical or economic justification for this attitude. What has been necessary in other essential sectors such as electricity, water and telephone services is also possible and perhaps even more necessary in the road sector.

Each country will have to investigate whether new legislation is actually necessary to make the proposed changes. It must be emphasized that ownership of the road network will remain in the hands of the State, so that the change refers only to moving its management from a ministry to companies functioning in a competitive environment.

Legislation for road conservation self-financing: It should be established that road conservation must be self-financing by charging user rates instead of depending on subsidies allocated through the national budget. During the transition period, some subsidy might be necessary for rehabilitating roads, thus making the road network "maintainable". The law must define how the user rates are to be charged, set up a road conservation fund and create or designate an agency to supervise the new system (for example, a Superintendency of Roads). The way in which this agency operates must also be stipulated. Moreover, the law should establish a formula for adjusting user rates to changing needs of the road network.

Legislation for road management companies: Good management of road networks is only possible if the companies responsible for it are solid, serious and have an orientation towards the long term. The participation of companies which do not meet these and other minimum requirements can discredit the whole reform process. For this reason, it is important that legislation opens possibilities for pension and life insurance funds with large numbers of affiliated members, to participate in road management. Such funds, in a small country like Chile alone, have already accumulated an investment capital of more than US\$ 12.5 billion, and are now spreading in the region.

In fact, it is not convenient for road management and conservation to remain exclusively in the hands of building contractors, because these, unlike pension funds, are oriented primarily towards short-term operations. In addition, building contractors tend to be in the hands of a few individuals, and this may raise fears among the public that those individuals could eventually control the road transport system. The participation of pension funds with hundreds of thousands of affiliates creates a different image of the type of public-private partnerships proposed in this book.



9. Calling Attention

The present section shows the tremendous importance of using and presenting information in the process of road sector reorganization. As has been mentioned at various points in this book, the active participation of potentially interested groups is indispensable to the process, and a good presentation of information is one of the means to this goal. Here, therefore, we identify the various types of information which should be available about roads and how to obtain it. Moreover, we explain how the required information can be processed and presented to incite maximum interest on the part of different pressure groups.

9.1 The Importance of Public Relations

The situation of roads in the region has become so precarious that it is unreasonable to think that circumstances can go on without making profound changes. The effort to rehabilitate the road network, without subjecting its management and especially its conservation to a radical reorganization, can only lead to repetition of the "normal" cycle of roads (construction, deterioration, destruction, reconstruction). It is necessary to break this vicious circle and that requires obtaining wide-spread public support for change. The active positive support of politicians, governments, road users, producers, press and general public opinion will create an atmosphere where reform is possible.

Reform is not likely to come from within the road agency, because this is where the most obstinate elements are often found. It is more realistic to recognize, that support from organizations outside existing road agencies is absolutely necessary. Those who are most likely to be in favour of a change are those who are negatively affected by the present state of roads and those who understand the damage this causes to the national economy.

Today, many people who would be in favour of reorganizing the road sector generally remain passive. An important share of them, however, could be persuaded to play an active role. Interest groups would act, if they were fully aware of the damage incorrect and insufficient conservation causes. But before one can have an opinion and be able to act. So it is necessary to be informed.

Many groups, potentially interested in the subject of roads, are today inactive because they lack a thorough knowledge of the damage caused by roads in bad condition. Even many habitual road users tend not to clearly perceive that damage. Even less do they appreciate the ominous consequences of deficient conservation, both in higher vehicle operating costs and in the costs of rehabilitating and rebuilding deteriorated roads, all of which, simply and plainly, means "throwing money out the window". In addition; there is the negative environmental impact caused by road deterioration, road reconstruction and by the operation of vehicles on bad roads. Forming an awareness of the seriousness of these consequences will wake many people up to a situation which they probably did not consider much before.



Properly informed and motivated, people bring stronger pressure for the changes they believe necessary. The general public can make its discontent known to the government, but undoubtedly, organized pressure groups have a greater influence and can target pressure directly on those who have the power to make decisions about institutional change.

Since there are many groups and sectors potentially interested in improving the state of the roads, it is necessary to summarize and present the information in such a way as to induce all groups to adopt the same approach to change. The starting point could be to show each group from its own point of view the importance of road conservation and why the present system of conservation management is unsustainable. This would lead to general agreement on the basic point, in spite of the diversity of interests.

Information can be distributed in many ways. Articles in newspapers and magazines, newsletters, television spots, press conferences, seminars, meetings, videos and many other media are effective. The important thing is to effectively get the message across. If some degree of public discussion on organizing and financing road conservation can be achieved, possibly the number of groups or individuals interested in supporting a reform will grow.

9.2 Collection and Usage of Road Network Information

Correct information is indispensable for credibility. When referring to roads and their physical condition, there are many variables used for description. Relevant information could be about the:

- state of the roads
- proportion of road traffic circulating on good, regular or bad roads
- cost of constructing, maintaining, rehabilitating or reconstructing roads
- cost of labour for the various types of physical interventions on roads
- vehicle operation costs
- long-term relationships between vehicle operating costs and road infrastructure costs
- value of the road patrimony or road asset
- burden to the national economy caused by roads in bad condition
- high return on road conservation spending
- contribution made by road conservation to national development
- other similar information

The information prepared may refer not only to the present and past condition of roads, but also to the future evolution of road conditions. Knowing certain variables, it is possible to predict the consequences of today's decisions and their impact on road transportation. Studies can be made to estimate future road conditions, according to whether a lot, a little or nothing is spent on conserving existing roads.

9.2.1 Data Collection

Information is generated on the basis of data obtained on the roads. Essential data include the particular specifications and characteristics of a road, its condition, its volume of traffic and the climatic conditions in the area where it is located. The quality of the information gathered will largely depend on how much is spent on its collection.

The road inventory. A road inventory is a collection of information on the roads that make up a network. A road inventory can be quite elementary, including no more than a list of the road sections making up the network, the length of each section, the number of lanes, and the width and surface type of each road. It is convenient to include in the basic information whether the road crosses flat, hilly or mountainous terrain. A more complete inventory would also include information about the various structural layers of each road from its surface down to the natural base. It is also very useful to note the thickness of pavement, as well as the physical properties of the materials used in construction, because this information is very useful in calculating the capacity of the road to support the weight of vehicles and to drain rain water.

The condition of roads. The condition of roads is an essential piece of information. All road users will have something to say on this, but their opinions will certainly be subjective. For the information to be valid, it must be based on more solid and objective grounds. In practice, the most common method used for objectivity is to train a group of people so that each one applies uniform technical criteria and evaluates the defects of each road using a standard procedure. An alternative to this basic method is to employ relatively-advanced and complex technical equipment capable of automatically measuring certain characteristics. The high cost of this type of inspection, however, makes it advisable to select technically representative road sections and to limit detailed examination to these sections.

The condition of a road changes constantly, affected by the climate, the traffic and the conservation measures applied. Inspections to establish road condition should be made at regular intervals, so that information is always up-to-date. Experience under normal conditions showed that an inspection once every year is sufficient for providing a relatively complete appreciation of the state of roads. In any event, inspection frequency depends on the type of road and the prevailing climatic conditions. So the inspection frequency has to be adjusted to individual needs.

Visual Road Inspection

Simple inspection: The road condition (very good, good, regular, bad, very bad) is established by the sensation felt by an Inspector driving over the road at a normal speed in a motorized vehicle. This method, the least objective of all methods used, allows the revision of some 300 kilometres a day.

Detailed visual inspection: Consists of a general examination and, at the same time, of an evaluation of various possible faults. It is considered optimum to inspect a 10% sample of each one kilometre stretch of the road. With this method, 30 kilometres can be inspected in a day.

In both cases the inspection requires a well trained road technician plus a driver for the vehicle used.

Equipment for Road Network Inspection

Hi-Lo: This is a mobile ruler for measuring unevenness in road surfaces. It is manually operated and yields up to 30 kilometres per day. The cost of the equipment in its country of origin is approximately US\$ 2,500. It needs a technician and a support vehicle with driver.

Mays-meter: This is a two-wheel trailer pulled by an ordinary car. It directly measures the vertical movements caused by the roughness of the road. It yields approximately 250 kilometres per day. The cost of the equipment in its country of origin is approximately US\$ 20,000. There are various types of equipment similar to the Mays-meter, with the difference, that they can be installed in an ordinary car or van. The cost of those versions is approximately US\$ 10,000. The operation requires a specialized technician and a driver.

Mu-Meter: This is a trailer especially designed to measure resistance to skidding on wet roads. It is pulled by a vehicle and carries a water tank. Its yield varies between 80 and 300 kilometres per day. The cost of the equipment in its country of origin is approximately US\$ 37,000. A specialized technician and a driver are needed for its operation.

Traffic volumes: Traffic is responsible for most of the wear to road surface and sub-structure. The most elementary information is the average number of vehicles passing every day on each section of road in the network, differentiating between light and heavy vehicles. It is better still if heavy vehicles can be subdivided into buses and trucks.

The most simple traffic counts can be made using relatively unqualified personnel. Besides counting the vehicles, a preliminary distinction can be made among cars, trucks and buses, recording information on forms. With a relatively modest additional expenditure, equipment for continuous automatic counting can be added. This equipment registers the number of vehicles passing over the road without distinguishing among cars, trucks and buses.

A more precise evaluation of the amount of traffic can be obtained using coordinated counting and weighing equipment, which automatically identifies each vehicle based on its weight and axle configuration, without any need to stop vehicles. This equipment is rather expensive, but it delivers digital information that can later be handled by personal computers.

Methods for Counting Traffic Volumes

Visual classifying and counting of vehicles: This is generally done by locally contracted personnel without special qualification. It requires a qualified supervisor and assistants with basic training, whose number depends on the volume and complexity of the census.

Stationary weighing-scales: These weigh the vehicles when they are stopped. The vehicles are classified by visual observation. Weigh-scales require a minimum of three operators, one with special training. Weighing should be backed-up by police control, to make sure that heavy vehicles actually stop at the weigh-scale. The cost of the equipment in its country of origin is approximately US\$ 15,000.

Dynamic weighing equipment (also called weight-in-motion): This equipment is quite complex. While weighing and counting vehicles in motion, it also registers the information directly on magnetic tapes or disks, etc. It needs at least four operators, one with special training. Police back-up is also recommended. The cost of the equipment in its country of origin is approximately US\$ 30,000.

Climate: Rain water and rapid changes in temperature are the climatic agents which have an important negative effect on the durability of roads. Water softens soil in the road base and speeds up deterioration of its surface, both on paved and unpaved roads. With equal traffic conditions, roads in rainy areas always have a much shorter life than those in dry areas. Absolute pavement temperatures have complex effects and definitely affect pavement durability. Climates with extreme daily temperature variations are also very damaging to roads.

Road management needs the type of climatic information usually collected for other purposes anyway, meaning that all the necessary data can most likely be obtained from national meteorological offices.

9.2.2 Information Management

How should road data be managed? If the effort is made, a road agency can accumulate a great deal of sound information about roads. This data, however, will only be useful if its volume is manageable and if various data items are mutually compatible. The saying that you should not "bite off more than you can chew" also applies. Adequate data management requires keeping some considerations in mind, which, although they seem obvious, are often ignored in practice.

- **An intelligent system should be developed for on-site data recording.** The data collected manually must be recorded on forms which only contain relevant information. Data recording should be systematic, so that in each on-site campaign exactly the same type of data is registered at exactly the same points of the road.
- **Compatible software should be used.** A good part of the equipment used for data collection and recording is operated by computerized systems. It is very important for all operating systems that the different pieces of equipment are compatible. This advice may also seem very obvious, but ignoring it has more than once caused insurmountable difficulties in using the information collected by different equipments.
- **Begin with a system which is designed in such a way that it can later be extended.** During the early stages of a data collection and recording system, there will probably be little information to be digested, especially if relatively simple collection methods are used. Nevertheless, the system must be conceived in such a way that it can continue to receive growing quantities of data, since, with the passage of time and the probable adoption of more sophisticated data collection methods, the quantity of data will undoubtedly grow. It must also be remembered, that when the quality of road management is gradually improved, more information will be required, since it will have to cover a much broader area and incorporate ever more detailed and complex data.
The quantity and quality of the data available for road management will largely depend on the size of the network and on the resources allocated to this purpose.

9.2.3 Elaboration of a Road Data Management System

Primary data on the road network is usually expressed in technical terms and difficult for the general public to understand. For example, few people will understand the information that a certain stretch of road has an "average rugosity of IRI 5". This information must be processed and translated into a language that everyone can understand. The information "average rugosity of IRI 5" combined with other primary data can become a piece of information which says, that this section of road is in regular condition and will soon be in bad condition. This is a very simple example, compared to the innumerable ways which exist for combining and processing primary data with the purpose of generating useful information for road managers, road users and the general public.

Properly collected and processed, primary data provides information not only about the present road condition, but also about its likely future development. Information can be combined and processed in many ways, some quite simple and others extremely complex, according to the objective pursued.

It is simple to quantify how many kilometres of the network are in good, regular or bad condition. This information is very useful for an overall view of the general condition of the network. A more complex analysis is used to calculate vehicle operation costs and the future evolution of road conditions; more complex because the information used in calculation varies over time, is interrelated and also depends on the quantity and quality of road conservation activities carried out. For example, one may calculate the likely effects of alternative types and methods of technically feasible conservation works. These effects will, at the same time, modify road conditions and the operation costs of vehicles using them. A very interesting piece of information concerns the amount of user savings resulting from various different conservation alternatives, compared with a hypothetical situation where no conservation is done at all.

The HDM Model

The analysis of road networks requires very complete data and sophisticated analysis and prediction tools. Among the tools available, probably the best known is the Highway Design and Maintenance Standards Model HDM III, developed by the World Bank.

The Highway Design and Maintenance Standards Model (HDM III) is a set of interconnected computer programs developed by the World Bank, which can be used as a tool for evaluating road conservation from the economic or financial viewpoint. With the HDM model, the results of different conservation policies applied during 15 or more years on paved and unpaved roads can be calculated and compared. The HDM model can be used with personal computers.

Using the model for the evaluation of maintenance effects on road networks requires that road sections with similar characteristics have to be grouped first. Relevant parameters for allocating roads to a certain group are climate, topography, traffic volume, road surface type, design standard, conservation history and present physical condition. Each of these parameters should be precisely defined, which requires a previous study. If exact information is not available, estimates can be used, but the results will be less accurate.

The model also permits the estimation, year by year for a period of up to 17 years, of future road deterioration, resulting from the effects of expected traffic volumes and climate. For each year of the period evaluated, different physical maintenance works are simulated, corresponding to each conservation policy being evaluated. The conservation alternatives may cover all technical methods presently in use. Overall, the HDM Model is very useful in simulating the evolution of future road conditions during the period analyzed.

The costs of the various conservation alternatives considered can also be calculated with the HDM model. Among the benefits of each conservation policy analyzed, it considers the savings in vehicle operation costs compared with the higher vehicle operation costs in the case of zero maintenance. Once the costs and benefits of each alternative have been calculated, the model calculates the economic and financial rate of return for each policy.

The model is capable of processing simultaneously various different conservation policies, applied over an entire road network, which makes it possible to choose the best long-term conservation policy for each type of road.

9.3 The Pilot Project for Road Network Management

In 1991, ECLAC carried out a pilot project in cooperation with a consulting firm (M.P. Servicios de Ingeniería, Santiago, Chile). The pilot project was designed to demonstrate the existing alternatives for generating useful information about the present and future of road networks. Another purpose of the pilot project was to show that even with modest funds, information can be presented in an attractive and intelligible form.

Project data used: The project was based on real data for a partial road network in Chile, specifically all main routes in the Fifth Region and the Metropolitan Region. The Chilean Ministry of Public Works provided an inventory of the network which included the physical specifications of the roads and their present condition. The road inventory is, as we know, basic information. In Chile it is brought up to date approximately every two years. The project also used real traffic levels for 1990, adjusted by a moderate increase for the following years.

Project resources: Besides the human resources, computers with various types of software were used and are detailed below.

Data Base Program: For storing data, a commonly used commercial program (DBASE III) was used. This and similar programs presently cost less than US\$ 500.

Data Analysis: To analyze the data and make projections about the future state of the network resulting from different conservation policies, the most recent version (2.0) of the HDM III model for personal computers was used. This program costs US\$ 400.

Graphics programs: To express the results of the analysis in the form of graphs, two commercially sold programs were used: One Program is HARVARD GRAPHICS (market price is approximately US\$ 400), which makes column, bar, cartesian and circular diagrams. The other program is MAPINFO, which is able to produce maps and shows the condition of roads through different colours. This program is sold for less than US\$ 1,000.

Interfaces: A simple program was developed which permits the transfer of data output from the HDM model to DBASE III. Various similar programs are now on the market at a low price. HARVARD GRAPHICS and MAPINFO include the interfaces for communicating with other standard data base programs.

Hardware: A standard IBM compatible computer with a 40 MB hard disk and a colour monitor was used. The printer was a nine needle dot matrix type, with a three colour tape. It is convenient, but not indispensable to use a digitalizing table, whose cost fluctuates between US\$ 700 and US\$ 7000.

Human resources: The pilot project needed approximately ten work months of human resource input. Some of the personnel had experience in using the HDM model, the HARVARD GRAPHICS program and databases, but no one was familiar with the MAPINFO program for automatic mapping or with transferring data between programs. The digitalization of the map took quite a long time, because no digitalization table was available, which would have speed up the work considerably.

Analysis: During the project itself, the results of three different conservation policies were evaluated and later compared:

- **A minimum maintenance policy.** This policy consists of only the most elementary routine maintenance jobs such as clearing road drainage and other equally minor tasks. Since this policy does not consider reconstruction of roads, it really has to be taken as a theoretical hypothesis, because in practice it would be necessary to reconstruct at least those roads which become impassable.
- **A "vicious circle" policy.** This policy, frequently followed in many countries, is similar to the first - except that it includes reconstruction - because it consists in carrying out only the most elementary routine maintenance tasks and omits most of the measures required in an adequate road conservation policy. The inevitable result of this policy is that roads deteriorate and entirely rebuilding them becomes imperative. This is the most expensive of the three policies analyzed.
- **The adequate conservation policy.** This is the "optimum" policy which is explained at length in chapter two of this book. Its basic characteristic is that it prevents damage to the existing structure, keeping it always intact, mainly by periodic surface reinforcement and routine maintenance.

The three policies were analyzed with the HDM model. This included a comparison of the year-by-year results achieved with the continuous application of each policy over a 17-year period into the future. 17 years is the maximum period over which the HDM model applies high-cost solutions like asphalt layers and rehabilitation.

Results: The results of the pilot project are presented on the following pages in the form of graphs. The three colours of the original figures have been converted into different shadings for reproduction in this book. In summary, the enormous difference between adequately conserving the road network and not conserving it can be seen clearly in the maps and figures. When an adequate conservation policy is applied, average network condition is much better than with the application of other policies and user costs are also significantly lower. Moreover, the costs to the road agency are also less, since good conservation almost completely eliminates expensive road reconstruction and rehabilitation. With the optimum policy, rehabilitation and reconstruction are only necessary at the beginning of the simulation period on roads that are in bad condition.

The results of the pilot project are shown below in figures which speak for themselves.

Figures 1, 2, and 3 (maps) show the road network and the condition of each road in the network

- first in the initial circumstance of 1990,
- after 17 years, during which the "vicious circle" policy is applied and
- after 17 years, during which a sound conservation policy is applied

Figures 4, 5 and 6 (bar graphs) show the average state of the road network, year by year, for each of the three policies analyzed.

Figures 7, 8 and 9 (circle graphs) show the same information for the three policies simulated, but summed up as the 17 year total.

Figures 10, 11 and 12 (bar graphs) show the annual mileage travelled by vehicles in the network, on good, regular and bad roads, for each of the three policies simulated. Figure 13 shows the same information, but summed up for the total 17 years analyzed.

Figure 14 A and 14 B (bar graphs) is probably the most interesting of all, because it shows the savings which can be made, applying a sound conservation policy, as compared with the "vicious circle" policy (only routine maintenance and later reconstruction). The upper part of the figure shows the high vehicle operating costs which their owners must bear when the "vicious circle" policy is applied, as compared with the considerably lower costs under a sound conservation policy. The lower graph is even more striking. It shows the expenses of the road agency for both cases and also shows the sum of total possible savings. For the pilot projects relatively small road network, direct savings amounted to close to US\$ 300 million during the 17-year period. Besides the direct savings calculated and indicated on the figure, there are also significant indirect effects, such as achieving greater general efficiency in the economy and increasing national competitive advantages.

Figure 1



Figure 2



Figure 3



Figure 4

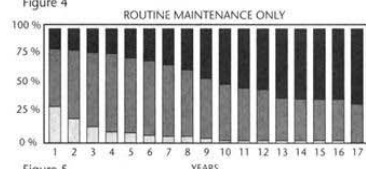


Figure 5

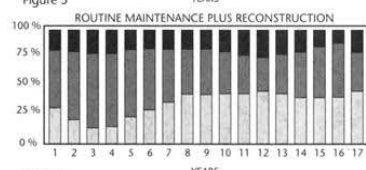
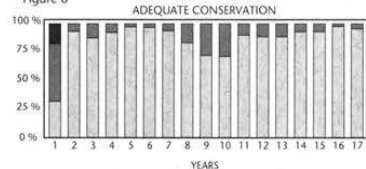


Figure 6



DURING 17-YEAR PERIOD

Figure 7

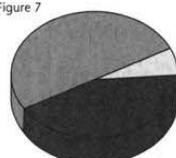


Figure 8

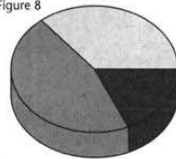
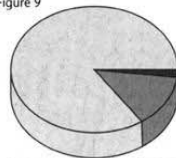


Figure 9



ON GOOD, REGULAR AND BAD ROADS

Figure 10

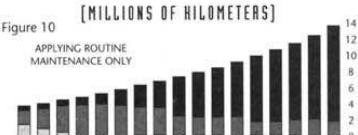


Figure 11

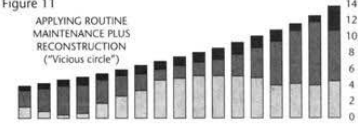


Figure 12

IN DIFFERENT ROAD CONDITIONS
[SUMMARY OF 17-YEAR PERIOD]

Figure 13

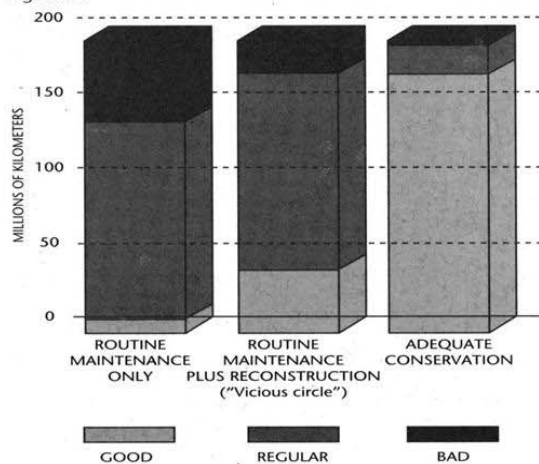
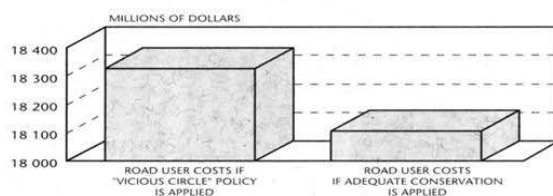


Figure 14

A. ROAD USER COSTS



B. ROAD AGENCY COST AND TOTAL SAVINGS

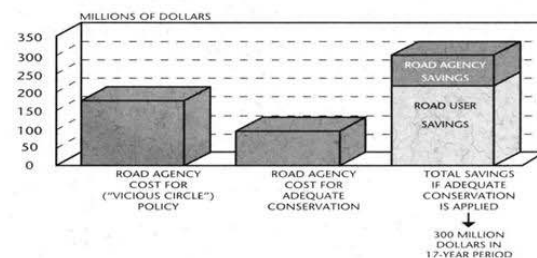


Figure 1, Figure 2 and Figure 3

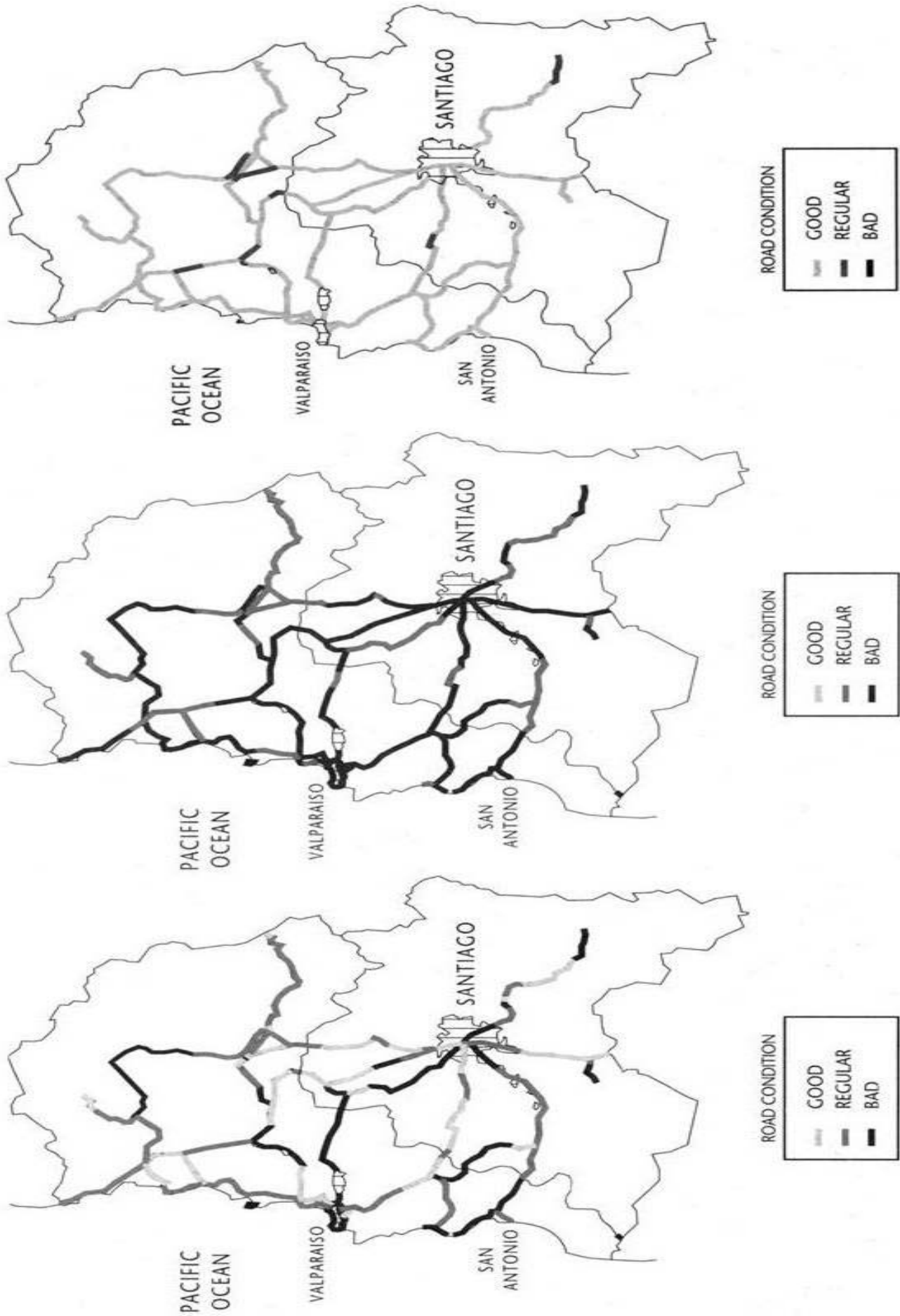
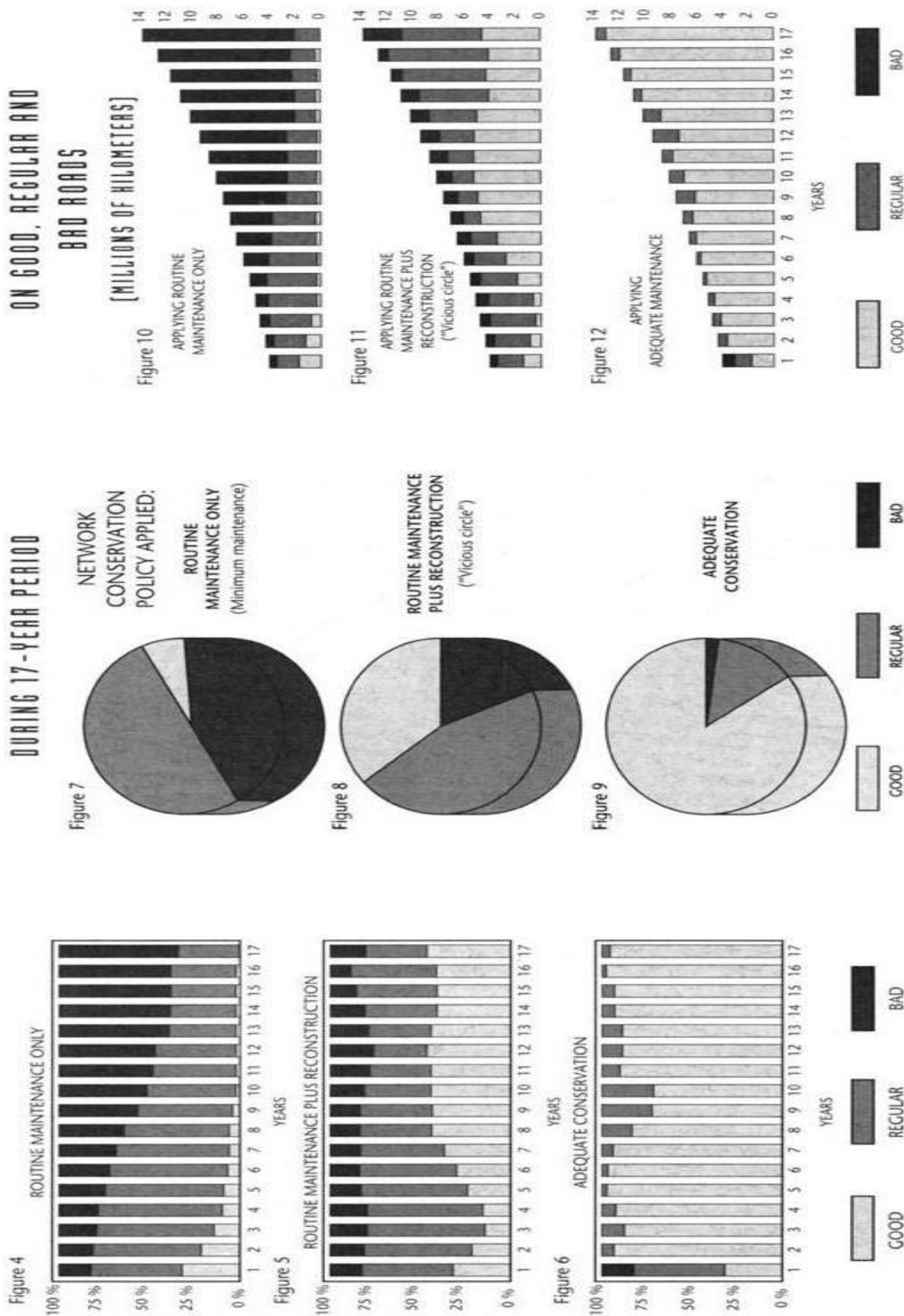


Figure 4 to Figure 12



IN DIFFERENT ROAD CONDITIONS [SUMMARY OF 17-YEAR PERIOD]

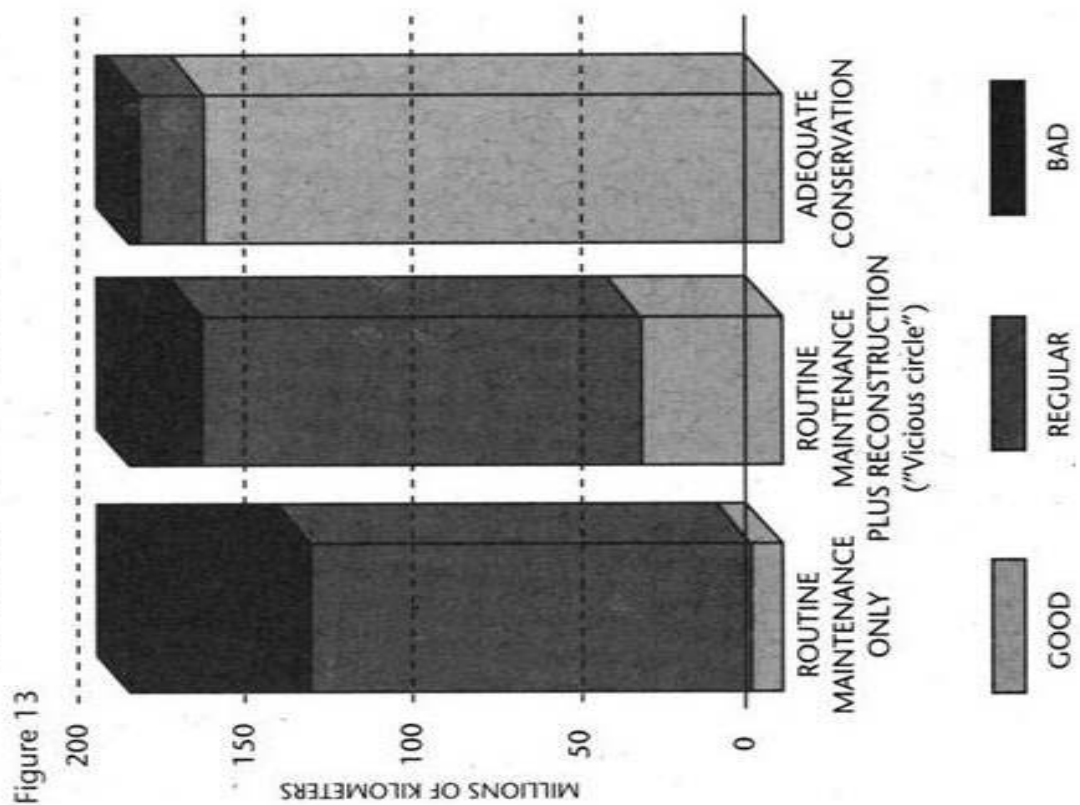
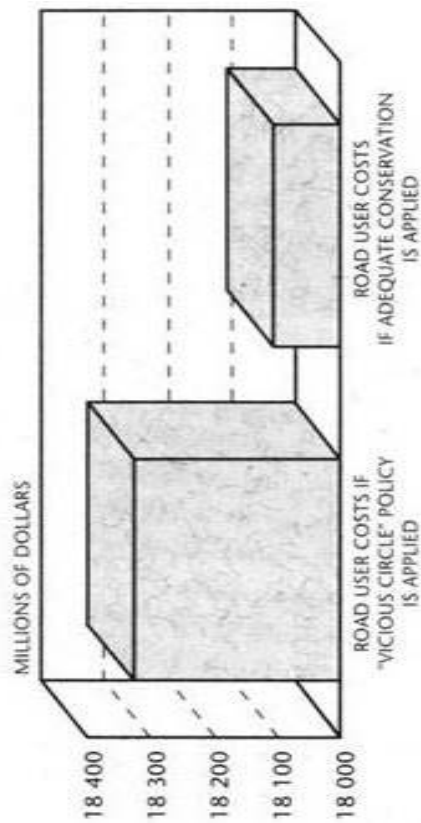


Figure 14

A. ROAD USER COSTS



B. ROAD AGENCY COST AND TOTAL SAVINGS

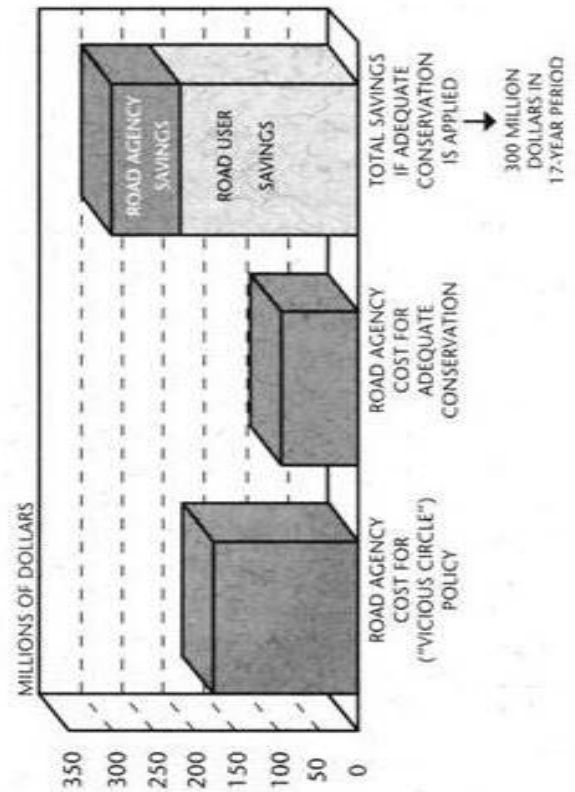


Figure 13 and Figure 14 (A and B)

10. Calculation of the Road Network Asset Value

Required Resources for Road Network Asset Calculation

The method and procedure presented here for calculating the road asset value may not be the only valid approach existing today, but we consider it to be a useful, low-cost and relatively simple tool, to use. The objective of this method is to allow a single engineer or economist with the help of a personal computer, to calculate the asset value of a sizeable road network (between 50,000 and 100,000 kilometres) in a period of three to five months.

This objective can be achieved, if the basic data on the road network is available, which today is the case in most countries of the region. It would not be realistic to design a calculation method, which is too detailed, too expensive or which demands information which are usually not available, because public agencies do not have the human and financial resources for collecting more than the usual information and keeping them up to date. In practice, the road agencies in Latin America and the Caribbean do not have sufficient resources to form a multi-disciplinary group of experts to work a year or two on calculating the value of the national road asset with scientific precision

10.1 Conceptual Bases

What is the national road network asset? It is the set of the entire road infrastructure in a country, which is expected to be of use and benefit for present and future generations. The value of the road network asset can be calculated in monetary terms.

What is a road? To better explain the concept of a road asset, we begin by explaining some very basic technical aspects of roads and the role they play in the road asset value.

A road has three main components: the Land on which it is built, the Ground Preparation works and the Road Structure as such.

The Land: The land is the physical space on which a road can be built. Before a road is built, the "right-of-way" must be assured, which usually supposes acquiring a strip of land. This strip of land should take in the width of the road to be built, plus some free space on both sides. The acquisition of land is a purely legal transaction and does not imply works of any kind. The land may have been property of the State before it is used as a space for a road. If it does not belong to the State but is bought by the State from private owners, this acquisition is a transfer from the private to the public sector; it does not constitute a change in the value of the road asset. Consequently, the land is part of the general national patrimony, but not of the road asset. The land does not wear out and never ceases to be a good which could potentially serve as a space to build some other, new road. Therefore, the value of the land can not be included in the calculation of the road asset value; this holds true not only because it would be conceptually wrong, but also because of the high chances that politically motivated manipulations and distortions are introduced.

The Ground Preparation Works: The ground preparation works are the Base on which the various layers of the actual road structure may be constructed. In order to ensure comfortable, fast, safe and economical travel, roads must comply with certain technical standards, which include gentle slopes, wide curves and good visibility, among other things. There are very few places, however, such as the pampa in Argentina or the Chilean desert, where the natural land surface is so flat, dry and firm, that it is almost ready for building the actual road structure with its various layers. Usually the land is less friendly. The normal situation is one of ravines, big rocks, steep hills, fast-flowing rivers or other natural or manmade obstacles. In such cases, significant earthworks must first be undertaken to prepare the land, such as cutting back hills, filling depressions and ravines, and building bridges, drainage works and tunnels through mountains. Thus, a platform for the actual road structure is prepared. These earthworks and structures are exposed to the wind, to the rain, and will also have to support the weight and the vibration caused by heavy vehicles. To prevent their deterioration, routine maintenance work and periodic renovation has to be done, particularly to the drainage system. If this basic maintenance work is done adequately, the earthworks have to be constructed only once and can later be maintained almost indefinitely. Bridges and viaducts with a wide span are an exception to the rule, because they wear out with use (material fatigue) and have to be replaced after a certain number of vehicles have passed over them.

The Road Structure: The road structure allows for a firm and smooth road surface that travel by motor vehicles is comfortable and rapid. The road structure consists of a set of layers which are designed to satisfy the specific needs of the expected traffic. Only the top layer is visible to the user. This top layer could be asphalt or concrete pavement, an asphalt surface treatment, or could be gravel or merely dirt. The other layers can be of different materials and thickness and are to provide support, firmness and durability to the visible road surface or pavement. The set of layers making up the road structure can be between 15 centimetres and more than 100 centimetres thick, depending on the materials used, the volume of traffic and the weight of the vehicles for which the road has been designed. Many mistakes can occur in the design of the road structure, which can lead to premature deterioration. The road structure with its different layers is usually the most expensive part of the road, and it is also the part which most quickly deteriorates when adequate conservation is absent. The deterioration depends largely on the quantity and weight of the vehicles using the road, as well as on the quality of the conservation. Most part of the conservation, rehabilitation and reconstruction works are centered on the road structure.

The top layer (usually the pavement) is designed initially to last for five, ten or twenty years; and even up to 40 years in the case of residential urban streets. If the pavement is strengthened by applying new layers (or by recycling the existing pavement) before the original design period ends, the durability of all other layers below is prolonged by several more years. This surface strengthening process implies relatively low costs and should be applied before the road surface is noticeably deteriorated. If pavement strengthening is always done on time, road reconstruction or rehabilitation will become largely unnecessary.

How does one relate the condition of a road with its asset value?

The condition of a road is evaluated by criteria which are defined in each country, according to its particular conditions. Some countries have adopted technologically complex systems of criteria, using very sensitive equipment for testing and measuring pavement conditions. Other countries use very simple check lists, which are filled in by hand by a technician who checks each road, by sections of between 200 meters to 1,000 meters. These lists have to be brought up to date from time to time, ideally once a year.

The result of this road survey is a road condition classification, which could be:
GOOD • REGULAR • BAD
or VERY GOOD • GOOD • REGULAR • BAD • VERY BAD
or another similar classification.

To calculate the road asset value, it is more useful to use the five-group classification (very good • good • regular • bad • very bad). This classification defines the capacity of the road to serve the demands of present traffic:

- **A "very good" road has same quality as if it was new.** It is, at the same time, "very apt" for serving the road user who wants to drive on it. Its asset value, therefore, is the same as that of a new road with the same specifications. If a road is not new, but in "very good" condition, it could be that it has not been used much or that it has been excellently preserved, or both.
- **A road classified as "regular" has a somewhat reduced service ability** to the user since its deficiencies cause some difficulties or make its use more expensive. Consequently; a road classified as "regular" is worth less than another road of the same type classified as "very good". The difference in asset value between the two roads is equivalent to the cost of upgrading and strengthening the "regular" road, so that it becomes "very good" again and can bear the traffic for a number of years to come. To reach this objective, it is usually sufficient to strengthen the road surface by adding an additional layer and carry out other minor works. In any case, the cost of this operation is only a fraction of the cost of building an entirely new road.
- **A road classified as "very bad" has a very low service capacity.** Its degree of deterioration is such that travelling on it is difficult and rather costly. Therefore, its usefulness is much less than that of a road classified as "very good". The difference in asset value between the two roads is equivalent to the cost of improving the "very bad" road to the state of "very good". This often means a complete reconstruction or rehabilitation of the road, at a cost not much less than the cost of building a completely new road.

What is more important: the absolute value of the road network asset or the relative change in this value over time?

One of the important reasons for calculating the road network asset value is to generate support for the defence of this asset. Such defence must be stepped up especially at times when the deterioration of the roads is serious, as is presently the case in many countries. Consequently, our main interest is the relative change in the road asset value, which in turn facilitates estimates about the magnitude and speed of the loss. It is thus necessary that the calculation will be made periodically, to be able to compare the present asset value with the value during previous periods. Knowledge of the absolute value of the road stock is of secondary importance.

When should the calculation be made?

The calculation should be made, at the very least, every 2 to 3 years. This will allow an evaluation of the success or failure of the road conservation policies applied. Ideally, the evaluation should be annual, or even continuous, although, in practice, up-to-date data is not always available.

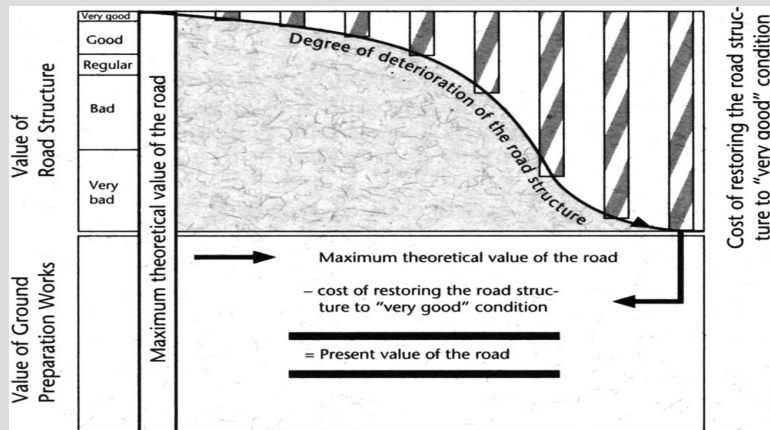
How much is a road worth ?

The value of a new road is made up of the cost of:

- **Ground Preparation Works**
(including earth moving, tunnelling and bridges)
- **Road Structure** as such
(including the various base layers and the pavement).

The cost of acquiring the land is not taken into account, because it is simply a transfer from one owner to another, and has no effect on the national road asset value.

The value of a road, which is not new, is calculated on the basis of the value it would have, if it were new (replacement value or maximum theoretical value) minus the cost of taking it from its present condition, which is deficient due to some degree of deterioration, to the "very good" condition. The "very good" condition is that of a new road, on the day it is opened to traffic. The amount subtracted, therefore, corresponds to the cost of eliminating any deficiency the road may have.



The present value of a road at a given time is diminished by the degree of deterioration. On a paved road, this deterioration is little during the first years, but increases ever more rapidly as the road passes from the "regular" condition to a "bad" and "very bad" condition.

In practice, the main deterioration occurs in the pavement and the base layers of the road structure. Under normal conditions, the deterioration in the ground preparation works is insignificant, that is, with a minimum of conservation activities, these retain their original value almost indefinitely.

10.2 The Calculation Method

For any informed decision on policies or activities related with roads, at least two elements of information are necessary:

- **An inventory of the roads in a network**, including their basic specifications. This maybe a list of roads linking geographically defined points, but much better is a detailed list of technically homogeneous road sections.
- **A description of the present condition of each road or road section**; this information is determined through a periodical inspection of the entire network.

This is also the basic information which must be available in order to be able to calculate the value of the national road network asset. If this information is not available, any attempt to plan or evaluate road management is reduced to mere fantasy and fiction.

The following calculation steps are used to study and calculate the road asset value:

- Calculation Step 1: Identification of the types of roads existing in the country**
- Calculation Step 2: Study of the cost of construction for each type of road identified**
- Calculation Step 3: Cost study of surface strengthening, rehabilitation and reconstr.**
- Calculation Step 4: Preparation of a computer spreadsheet**
- Calculation Step 5: Data summary and entry into the spreadsheet**
- Calculation Step 6: Interpretation of the results**
- Calculation Step 7: Publication of the results and their interpretation**

Each of these steps is explained below.

Calculation Step 1: Definition of the Road Types

There are different types of roads in every country. Each type reflects homogenous design specifications and therefore also homogenous construction costs. There may be various road designs:

1	One-lane roads	dirt
2		gravel
3		asphalt
4	Two-lane roads	dirt
5		gravel
6		asphalt
7		concrete
8	Three-lane roads	asphalt
9		concrete
10	Four-lane roads	asphalt
11		concrete
12	Expressways	asphalt
13		concrete

The number of lanes and the surface type are not the only characteristics which determine the construction cost of a road. The terrain they cross also has an influence. The terrain may be:

flat
hilly
mountainous

With the thirteen road designs and the three possible classes of terrain, 39 standard road types can be defined. Additional variations can be distinguished, based on the climate (dry, rainy), if marked differences in climate exist in different parts of the same country.

The main objective of step 1 is to establish, which types of roads exist in the network to be analyzed. It is unlikely that all 39 types listed above exist in a single network, and the types which are not relevant can be eliminated. On the other hand, it is possible that there are some roads, which for specific reasons do not fit into any of the standard categories like, for instance, roads in the high Andes mountain range, which are very expensive to build. These and others have to be listed in a separate, non-standard group. The types of roads existing are determined by a study of their technical characteristics, as well as by consulting the local experts, such as technicians and engineers of the road agency.

Calculation Step 2: Cost Study of New Construction

The most important question in step 2 is the cost of construction for each type of road in the network, following the classification made in step 1. More specifically, here we want to determine the medium-term economic cost of new construction. It is not sufficient to review the most recent tenders for the construction of new roads and use the prices quoted by the best bidder; what one needs to look for is the medium-term cost. Construction costs are subject to considerable variation, depending on the momentary situation on the construction market and also on the capital market. The "medium term" has to be defined in such a way as to compensate for short-term price fluctuations on the market. This makes it necessary to carry out a short historical review of the market cycles in road building. In most cases, by taking the average prices over the past 10 to 15 years, market fluctuations will probably be eliminated. The market studies carried out by the road builders associations and the asphalt and concrete institutes, found in many countries, can be very useful for the purpose.

The prices stipulated in construction contracts include various taxes, which are transfers and should therefore be excluded. For our purpose, we may accept as the "economic cost" the medium-term market prices excluding any tax components and other transfers. The costs finally identified should be unit-costs for one kilometre of road, which may later be multiplied with the lengths of individual road stretches.

In summary, step 2, includes the preparation of the following items:

- a short historical review of the market price variations for road construction
- a study of the tax components and other transfers in prices for road construction
- a list of the medium-term economic costs for the construction of the various types of roads in the network; the cost should be expressed in a low-inflation currency (for example in US\$), or in form of an index which excludes inflation.

Calculation Step 3: Cost Study of Surface Strengthening, Rehabilitation and Reconstr.

The most important task in step 3 is to calculate the medium-term economic cost of the various physical interventions required to convert a deteriorated road into one that is equivalent to a new road. These interventions are described in section 2 of this book and are:

- minor works
- surface treatment
- surface strengthening
- road rehabilitation
- road reconstruction

The cost should be calculated for all road types previously identified and expressed in unit costs per kilometre of road.

Calculation Step 4: Preparing the Spreadsheet on a Personal Computer

Calculating the road network asset value is not particularly complicated, but it involves a large volume of data and is therefore rather cumbersome to do by hand. It appears necessary to use a personal computer and a spreadsheet program. Step 4 is the preparation of the spreadsheet, into which, in a separate step, the data must be placed. It should be mentioned that the spreadsheet only has to be prepared once. That is the first time the calculation is made, then the same spreadsheet design can be used for subsequent update calculations.

Although most spreadsheet programs have a rather large capacity (which can be used if the computer has an expanded memory), it is possible that the number of road sections defined in a network exceeds the capacity of the program. Therefore, before beginning to prepare the spreadsheet, the capacity of the program and the computer should be checked. There are different ways of overcoming insufficient capacity of the program or of the computer. The simplest is to divide the road network into groups of roads; the criteria for grouping may be the geographical location of roads in certain sub-areas or by surface type (paved, gravel, dirt). This method works well with any program or computer, no matter how out of date it may be. Another possibility is to use File Linking, which allows dividing the spreadsheet into various parts; or the Database Function. Both File Linking and Database Functions are included in all modern spreadsheet programs. It is a good idea, however, to check this out carefully before beginning step 4. As a general rule, when the number of road sections on a spreadsheet is more than 300, it is possible that one may run into capacity problems. With more recent versions of spreadsheet programs and a computer memory of 2 to 4 megabyte, however, there can be more than 800 road sections on a spreadsheet without any problem.

In order to simplify the understanding of the calculation procedure, the instructions given below are on the assumption that a single spreadsheet is used.

Setting up the spreadsheet should be done by thematic sectors, which are groups of columns with information about a specific subject. The information on one road section fills a row which intersects the thematic columns.

Sample Spreadsheet:

First Part: Columns 0 - 6 Column N° →						Second part: Columns 7 - 16 Column N° →													
CALCULATION SPREADSHEET						CALCULATION SPREADSHEET													
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16			
BASIC INFORMATION ON ROAD SECTIONS						MAXIMUM THEORETICAL VALUE		MINIMUM PERMISSIBLE VALUE			DEFICIENCIES OF SECTION		CALCULATION RESULTS						
Section ID N°	Section identification		Length		Type of road	Traffic volume (ADT)	Unit value new road (US\$/km)	Value of new section (MIO US\$)	Min. permissible cond.	Min. permissible unit value (US\$/km)	Min. permissible value for section (Mio US\$)	Present condition	Unit value of deficiency (US\$/km)	Value of deficiency for section (Mio US\$)	Present value of the section (Mio US\$)	Present value /max. theoretical value (%)	Present value /min. permissible value (%)	Sections worse than economically permissible (km) paved unpaved	
	from	to	Paved (km)	Unpaved (km)															
1	San José	Riveros	14		2/asphalt	800	400 000	5.6	regular	320 000	4.5	bad	180 000	2.5	3.1	55	69	14	
2	La Laguna	Punta Gorda		23	2/gravel	260	60 000	1.4	regular	40 000	0.9	very bad	25 000	0.6	0.8	58	87		23
3	Bandera	Espinillo	29		2/concrete	1 400	500 000	14.5	regular	400 000	11.6	good	30 000	0.9	13.6	94	118		
4	San Carlos	Acarigua	38		2/asphalt	350	400 000	15.2	regular	320 000	12.2	regular	80 000	3.0	12.2	80	100		
5	Sabaneta	Mantecal		53	2/gravel	120	60 000	3.2	regular	40 000	2.1	good	10 000	0.5	2.7	83	125		
6	Esmeralda	Carenero	41		2/asphalt	280	400 000	16.4	regular	320 000	13.1	very bad	300 000	12.3	4.1	25	31	41	
7	Carora	Sta. Rosa		62	2/gravel	20	60 000	3.7	bad	28 000	1.7	bad	32 000	2.0	1.7	47	100		
8																			
Length of the paved network:			122 km		Maximum theoretical value of the network:			US\$ 60.0 million		Minimum permissible Network Asset Value:		US\$ 46.1 mill.		Total Road Network Asset Value:		US\$ 38.2 mill.		Length of network worse than permissible:	
Length of the unpaved network:			138 km															55 (km) 45 (%) 23 (km) 17 (%)	

Sample spreadsheet:

First Part: Columns 0 - 6 Column N° →						Second part: Columns 7 - 16 Column N° →																							
CALCULATION SPREADSHEET						CALCULATION SPREADSHEET																							
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16													
BASIC INFORMATION ON ROAD SECTIONS						MAXIMUM THEORETICAL VALUE		MINIMUM PERMISSIBLE VALUE			DEFICIENCIES OF SECTION			CALCULATION RESULTS															
Sec- tion ID N°	Section identification		Length		Type of road	Traffic volume (ADT)	Unit value new road (US\$/km)	Value of new section (MIO US\$)	Min. permis- sible cond.	Min. permis- sible unit value (US\$/km)	Min. permis- sible value for section (Mio US\$)	Present con- diti on	Unit value of deficiency (US\$/km)	Value of deficiency for section (Mio US\$)	Present value of the section (Mio US\$)	Present value /max. theore- tical value (%)	Present value /min. permis- sible value (%)	Sections worse than economically permissible (km)											
	from	to	Paved (km)	Unpaved (km)															Sections worse than economically permissible (km) paved unpaved										
1	San José	Riveros	14		2/asphalt	800	400 000	5.6	regular	320 000	4.5	bad	180 000	2.5	3.1	55	69	14											
2	La Laguna	Punta Gorda		23	2/gravel	260	60 000	1.4	regular	40 000	0.9	very bad	25 000	0.6	0.8	58	87	23											
3	Bandera	Espinillo	29		2/concrete	1 400	500 000	14.5	regular	400 000	11.6	good	30 000	0.9	13.6	94	118												
4	San Carlos	Acarigua	38		2/asphalt	350	400 000	15.2	regular	320 000	12.2	regular	80 000	3.0	12.2	80	100												
5	Sabaneta	Manitcal		53	2/gravel	120	60 000	3.2	regular	40 000	2.1	good	10 000	0.5	2.7	83	125												
6	Esmeralda	Carenero	41		2/asphalt	280	400 000	16.4	regular	320 000	13.1	very bad	300 000	12.3	4.1	25	31	41											
7	Carora	Sta. Rosa		62	2/gravel	20	60 000	3.7	bad	28 000	1.7	bad	32 000	2.0	1.7	47	100												
8																													
Length of the paved network:						122 km		Maximum theoretical value of the network:						US\$ 60.0 million		Minimum permissible Network Asset Value:		US\$ 46.1 mill.		Total Road Network Asset Value:		US\$ 38.2 mill.		Length of network worse than permissible:		55 (km) 45 (%)		23 (km) 17 (%)	
Length of the unpaved network:						138 km																							

The following explanation refers to the sample spreadsheet presented:

Sector A: One should begin with the columns containing the basic information on each road or road section. These are the characteristics that usually do not change with time. Most roads agencies have information not only about entire roads, which may stretch over very long distances, but also about different sections of a road which have different technical specifications. Sector A should include the following information for each road section:

- Column 0: Identification number
- Column 1: Identification by name of the beginning and end points
- Column 2: (a and b): Length in kilometres. The column is divided into two sub-columns:
one for paved roads and one for unpaved roads.
The sum of the values in column 2 is the length of the entire network.
- Column 3: Type of road and type of terrain (see step 1)
- Column 4: Average daily traffic volume

Sector B: This sector contains information about the maximum theoretical value of a road section. That is the value it would have, if it was new. The sum of all the values in column 6 is the maximum possible road network asset value, if all existing roads were in "very good" condition. Sector B contains the following columns:

- Column 5: Unit value per kilometre of a new road of this type (see step 2)
- Column 6: Value of the road section, if it was new, which is calculated by multiplying the unit value (column 5) with the total length of the road section (column 2)

Sector C: This sector contains the information about the minimum permissible value of the road sections. Research has shown very clearly that it is anti-economical to let paved roads deteriorate to such a bad state, that they require major rehabilitation or reconstruction. This being the case, Sector C shows the value of each section of the road when it is in the worst permissible condition. For paved roads, this is the "regular" condition. For unpaved roads, it is the "regular" condition, if the traffic volume is higher than approximately 30 to 50 vehicles per day. If the traffic is lower than that, the "bad" condition can be used. The sum of the values in Column 9 is the minimum permissible road network asset value. That is the value of the road network, when all the roads have reached the point that they need surface renewal to prevent more serious damage. Sector C contains the following columns:

- Column 7: Defines the minimum permissible condition for each road section. This corresponds to the "regular" condition for all road sections, except unpaved roads with a daily traffic volume below 30-50 vehicles per day, in which case it is "bad".
- Column 8: Unit value (per km) of the road section when it is in the minimum permissible condition.
- Column 9: Minimum permissible value of each road section, calculated by multiplying the unit value (column 8) by the length of the road section (column 2).

Sector D: This sector shows the deficiencies of each road section, according to its present condition. The knowledge about the present condition of each road section is a result from the regular inspections made by the road agency. Sector D includes the following columns:

- Column 10: Present condition of each road section, over the scale from "very good" to "very bad" (if this type of classification is used).
- Column 11: Unit value of the deficiency. That is the unit cost per kilometre of bringing the road to the "very good" category (see step 3).
- Column 12: Value of the deficiency. That is the total cost of bringing the road section from its present condition to the "very good" category, calculated by multiplying the unit value (column 11) by the length of the road (column 2).

Sector E: This sector contains the results of the calculation of different values, both for each road section and also for the total network. First, it shows the asset value of the road network in its present state. Next, it shows the position of the present asset value in relation to the maximum theoretical value and the minimum permissible value. Finally, it shows the percentage of the roads, which have deteriorated to a condition worse than the minimum permissible. Sector E contains the following columns:

- Column 13: Present asset value of the road section, calculated by subtracting the value of the deficiency (column 12) from the new value (column 6). The sum of all the values in this column is the present road network asset value.
- Column 14: Present value of the road section as a percentage of the maximum theoretical value (column 13 related to column 6).
- Column 15: Present value of the road section as a percentage of the minimum permissible value (column 14 related to column 9).
- Column 16: This column (a and b) shows those road sections, which are in worse condition than is economically permissible. If the percentage-value in column 15 is less than 100%, the length of the section (in km) is placed here, separating paved from unpaved road sections. The sum of the values in these two columns show the length of the network, which is in a more worse condition than economically permissible. If this is compared with the total length of the paved and unpaved network, the percentage of roads in this state can be calculated.

Calculation Step 5: Data Revision and Entry into the Spreadsheet

The data should be revised to make sure, that it is complete, in the required format and coherent. In revising the data the following aspects should be taken into account:

The data of the road inventory may have been recorded simply on paper or in a computer database. If it was done on paper, there is no other option than to manually enter the data for each road section into the spreadsheet. On the other hand, if the inventory is in the form of a computer database, the possibility of directly transferring data from the database into the spreadsheet should be used.

One should check whether there is a possibility of easily dividing the road inventory into different parts, separating data by region or by road surface type (paved, gravel or dirt). Instead of preparing a single very large spreadsheet, several spreadsheets could be created. This procedure avoids problems with the capacity of the programs and the computer (see step 4).

It also should be checked to see if the inventory is up to date, to confirm that it reflects the real extent of the network, as well as the real present condition of all road sections in the net work. It is unlikely, that the state of all road sections was determined on one single day. The data on their physical condition, however, should not be more than six months old, at the most.

It also has to be checked, that the information on traffic volumes is up to date, especially if there is reason to believe that there have been significant changes in the recent past. This is especially important for roads with little traffic, where the most economical alternative may be to let the road deteriorate to a "bad" condition (see step 4).

Entering the data should be done by personnel with some basic knowledge of roads. Ideally it should be done by the same engineer, technician or economist in charge of calculating the road stock. It should be remembered, that a calculation is only as good as the data used and faulty data input may make the whole exercise futile.

Calculation Step 6: Interpretation of the Results

The results shown in the different columns have to be carefully studied in order to be thoroughly understood. For example, an increase in the maximum theoretical value of the road network (column 6) between one period and another shows, that road sections have been added to the network or that some road sections were substantially improved and do now reflect a better design standard. The length of the network cannot show this in itself. The lengths of a network can also contract, but this is not very frequent.

The present value of the road network asset (column 13) is only a number, usually astronomical, which means almost nothing for the ordinary citizen. On the other hand, if it is compared with the maximum theoretical value and with the minimum permissible value, it becomes more meaningful. This comparison is expressed in the percentages in columns 14 and 15.

The "mid-point benchmark test" is also very important. It means that at any point in time the value of the road network should, ideally, be around the mid-point between the maximum possible value and the minimum permissible value. This concept is explained below.

The Mid-point Benchmark Test

When the road network of a country is in bad condition, the deficient management of the road asset by the road agency becomes obvious. In such a situation, the road network asset value calculation shows a result which is below the minimum permissible value. It must then be asked what the ideal value of the road network, should be ?

It would be a mistake to argue that the road network value should be the same as the maximum theoretical value; in other words, that all road sections should at all times be in very good condition. Besides the fact that this is impossible in practice, it would mean a tremendous waste of funds, because conservation works would be done much sooner than necessary.

The correct answer is the following: if the road agency always works in the optimum manner, the value of the road network will always converge on the "mid-point benchmark" between the maximum theoretical value and the minimum permissible value. In most countries, road agencies which would now aspire to bring the value of the road network to that mid-point benchmark, would have to start from a point considerably down the scale.

Calculation Step 7: Publication of the Results

This step is the most important of all. One of the purposes for calculating the road asset value is to make an impact on pressure groups and on the general public. This can only be done if the results and their interpretation are widely publicized by the media. One or several press conferences should be organized and efforts made to have them broadcast on radio and television. Also, it would be a good idea to hold seminars, conferences and discussions on the subject. As well as the written report on the results, graphic material should be prepared to support the text.

10.3 Comments on the Calculation Method

10.3.1 Lifespan of a Calculation Method

The general concept of road asset value will be valid for a long time. The method for calculating it, perhaps not. The simple method proposed here was invented having in mind the level of information, resources, and means presently available in Latin America and the Caribbean. We know that these are limited and will continue to be limited for some time longer. Once the countries have progressed further, a more sophisticated methodology may be developed. Moreover, the calculation of the road asset value will contribute to the solution of a problem which will only exist, in its present form, for a limited period of time. We call this period "the third age".

Ever since motorized road transport has existed there have been obstacles to its evolution. Although several problems have been simultaneously present at any time, during different periods a different particular problem has always stood out as the fundamental obstacle:

The first age: In the first age, from the invention of the first true motor vehicles at the end of the 19th century to the Second World War, the main limiting factor was vehicle technology. Vehicles were relatively expensive, not very reliable and their capacity was limited. As vehicle technology was not well developed, much of the available public and private funds were spent on other means of transport which were at the time much more advanced, such as railroad and marine transport, ports and river navigation.

The second age: In the second age, which began at the end of the Second World War, the main factor limiting the development of road transport was the lack of roads. With the substantial improvements in vehicle technology during and after the war, which made it possible to make better quality vehicles with a much larger capacity at lower costs, car ownership became general. This led to enormous pressures to extend road networks. This phenomenon occurred in all countries and led to a real road construction fever. A high proportion of public funds were allocated to the building of extensive networks of paved and unpaved roads. The availability of foreign funds, in the form of bilateral and multilateral loans, speeded up the creation of these networks. In most of the countries of Latin America and the Caribbean, this second age came to an end in the 1980s, when the demand for new roads declined.

The third age: The third age began in the 1990s, when the main factor limiting highway transport became, and will continue to be for some time, the absence of adequate conservation of the road networks which were built in the second age. The third age is just beginning and few countries are effectively and consciously redirecting their financial and human resources toward the conservation of already existing roads. In most countries, the construction of new roads has been drastically reduced, but no real importance has been given to conservation except in rhetoric. Everybody understands that the second age is over, but few people have yet noticed the arrival of the third.

The fourth age: The fourth age will begin at the end of the third age. It will probably be characterized by a shortage of traditional vehicle fuels and a sharp increase of pollution problems. This will make it necessary to make big investments in developing alternative sources of energy. The problems of the fourth age can already be predicted and it can almost be predicted when it will begin. It is estimated that the third age will not last more than approximately 30 to 35 years, which will make it shorter than the second age which lasted 40 years, and much shorter than the first which lasted approximately 50 years. Consequently, the calculation of the road network asset value can be a very important tool for the next 30 or so years. For the first half of this period the method proposed here, in spite of its simplicity, will be sufficient for many countries because of the limited availability of information and resources already mentioned. In the second half of this period, when the countries of Latin America and the Caribbean have progressed in road management, the calculation method could perhaps be made more sophisticated, because the available information will probably be better.

10.3.2 Obsolete Roads in the Calculation

It has happened more than once that an old road, which has been very well conserved, becomes obsolete. It could be that the place where it leads to has lost importance and nobody wants to go there any more or, since it is narrow and winding and can only be travelled at slow speeds a new wider and straighter road has been built. It could also be because it cannot be used by the new trucks, which are bigger and heavier, or because it cannot carry the enormous increase in traffic. Whatever the reasons, technological and economical development has left a road behind which was probably designed to technical standards which are deficient today. Although this road is part of the road asset, it may not be in the public interest to spend funds on keeping it in good condition. The road falls into disuse, because it is inadequate for today's traffic.

Generally, roads become obsolete when there is an important technological change, or a change in the volume of traffic. In ancient times, the road networks of the Incas and the Aztecs became obsolete with the introduction of the wheel. More recently, many roads built before 1940 became obsolete with the appearance of 18 meter 6-axle trucks with an overall weight of 50 tons. This poses the question of how soon will the present network in Latin America, which was built mainly in the 1950s, 1960s and 1970s, be obsolete?

The design standards used for most of the present roads still apply and probably will for 20 or 30 years more. No radical change seems imminent in the size of trucks. The trend to increase their weight could make it necessary to reinforce the pavement of some important roads, but not to completely abandon large parts of the network. Obsolescence due to the incapacity to absorb the great volume of traffic is very isolated and usually occurs only at access points to very large cities. Generally speaking, it does not seem likely that there will be serious problems of road obsolescence in the next thirty years. In order to keep the calculation transparent, it is preferable not to consider obsolescence, at least in the present circumstances. Perhaps in the future, when the road asset value is more commonly calculated, the method could be made more sophisticated and include this aspect.

10.3.3 Future Benefits in the Calculation

Would it not be better to define the value of a road as the sum of the future benefits it offers to its users? This concept, generally accepted by economists, could be applied to roads; to calculate future benefits, however, a set of data is necessary. In the first place, there is no data about how many vehicles will travel this road in the future, nor of the speed with which the road will deteriorate, nor of the costs of transport or the future usefulness of the road. In consequence, the concept of future benefits, although correct in theory, is of little practical use here and should therefore be rejected in calculating the road asset value.

10.3.4 Bridges in the Calculation

Bridges should be separated from roads, because the methodology for determining their asset value is significantly different. In practice, it is not yet common practice to evaluate the condition of bridges as part of a bridge management system, perhaps because there is no up-to-date information about their condition. Consequently, in the meantime, the concept of calculated depreciation will have to be used for bridges, or they could also be left out of the calculation of the road stock.

The Idea behind the Calculation

A very long book could be written on the theoretical bases and the method of calculating the road asset value. Moreover, conferences, seminars and round tables-could be organized for experts on the subject. Most likely these would produce interesting discussion, but they would be interminable and the points of view would be irreconcilable. Probably also, while all this discussion was going on, the deterioration of the roads would inexorably proceed faster and faster. In other words, it seems to be impossible to create a viable method of calculating the road stock which is satisfactory from every point of view, which takes into account the specific conditions in every country and which takes in all the technical and economical aspects with absolute precision.

In fact, there are many publications about road technology and road maintenance. Seminars are frequently organized in every continent, which are very interesting for engineers; also, work is being done in some countries on capitalizing the national infrastructure stock, and there are already some partial results which are very interesting for accountants.

Nevertheless, the purpose of calculating the road network asset is not to provide more material for the engineers and economists to debate, but above all, to impress upon the people who are not experts in road management and conservation the urgent need to conserve the roads as soon as possible.

The idea behind the calculation is to show whether or not the country is losing its road network and, if it is, to estimate the order of magnitude and speed of the phenomenon.

If a country is aware of the substantial loss of its road assets, changes can be achieved in current policies, toward a better conservation of roads. If this is achieved, the goal has been met.

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