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ROUND TABLE 70

FORESEEABLE COST TRENDS IN DIFFERENT MODES OF FREIGHT TRANSPORT

EUROPEAN CONFERENCE OF MINISTERS OF TRANSPORT

PARIS 1985

ECONOMIC RESEARCH CENTRE

REPORT OF THE SEVENTIETH ROUND TABLE ON TRANSPORT ECONOMICS

Held in Paris on 10th-11th January 1985 on the following topic:

FORESEEABLE COST TRENDS IN DIFFERENT MODES OF FREIGHT TRANSPORT

EUROPEAN CONFERENCE OF MINISTERS OF TRANSPORT

THE EUROPEAN CONFERENCE OF MINISTERS OF TRANSPORT [ECMT]

The European Conference of Ministers of Transport (ECMT), an inter-governmental organisation, established by a Protocol signed in Brussels on 17th October 1953, constitutes a forum for the Ministers of Transport of 19 European countries[1]. The work of the Council of Ministers is prepared by a Committee of Deputies.

The purposes of the Conference are :

a) to take whatever measures may be necessary to achieve, at general or regional level, the most efficient use and rational development of European inland transport of international importance;

b) to co-ordinate and promote the activities of international organisations concerned with European inland transport, taking into account the work of supranational authorities in this field.

Major problems which are being studied by the ECMT include: transport policy; the financial situation and organisation of railways and road transport; problems concerning inland waterway transport and combined transport; development of European trunk lines of communication; problems concerning urban transport; the prevention of road accidents and co-ordination, at European level, of road traffic rules and road signs and signals; traffic trends and long-term traffic forecasts.

Moreover, the ECMT organises Round Tables and Symposia. Their conclusions are considered by the competent organs of the Conference, under the authority of the Committee of Deputies, so that the latter may formulate proposals for policy decisions to be submitted to the Ministers.

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Publié en français sous le titre :

ÉVOLUTION PRÉVISIBLE DES COÛTS
DES DIFFÉRENTS MODES DE TRANSPORT
DE MARCHANDISES

ECMT publications are distributed by the OECD Publications Office,
2, rue André-Pascal, 75775 PARIS CEDEX 16, France.

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FORESEEABLE COST TRENDS IN DIFFERENT MODES OF FREIGHT TRANSPORT

GENERAL ASPECTS

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SUMMARY

1. INTRODUCTION: EVALUATING TRANSPORT COSTS, AND PROBLEMS IN DETERMINING COST TRENDS

1.1. A relevant question

Levels of, and trends in freight transport costs have to be taken into account in terms of both the efficiency of production and the activity of the companies carrying out and organising such transport.

The role played by transport in production-distribution chains can be assessed in terms of the proportion of the price of final products it accounts for, a proportion that is not easy to ascertain: in France, some detailed and comprehensive studies have been carried out, especially by the Service d'Analyse Economique et du Plan (SAEP), Ministère de l'Urbanisme, du Logement et des Transports (Service for Economic Analysis and the Plan, Ministry of Urban Planning, Housing and Transport), and by the CNR (Comité National Routier -- National Road Commission). It is particularly difficult to estimate the internal costs incurred by agricultural, industrial and commercial enterprises (transport and handling inside fields, factories, warehouses, etc., organising the sub-contracting of the transport of raw materials purchased and produce being sold) and the costs incurred by the consumer travelling to make his purchases in markets and shops. Although the proportion of the price of goods constituted by such transport costs varies greatly, depending on the nature of the product and on the geographic production-distribution chain, it is, no doubt, seldom negligible.

The price of transport has a dual impact on the activity of carriers and those who organise transport:

-- It affects the activity of the firms associated with the different transport modes insofar as the prices of transport by different modes influence both overall demand and, even more, modal split;

-- It affects balance sheets of enterprises insofar as the price of transport corresponds only approximately to the cost of providing transport.

The usefulness of ascertaining trends in transport prices is therefore quite clear. Despite the fact that the price and cost of transport are not necessarily equivalent as we have said, any attempt to ascertain price trends must start with the question: what trends can be foreseen for freight transport costs?

Moreover, a knowledge of costs is of interest in its own right for two reasons which are bound up with the fact that there may well be a discrepancy between price and cost:

-- In the medium or long term, the discrepancy might change substantially, the degree of change differing from one mode to another, particularly if the pattern of passing on certain costs ("fixed" and "indirect" costs) to users were in itself to be changed;

-- If some costs are not passed on to users, it is important to know what the cost is to the community.

1.2. An apparently simple reply

The economist has a conventional reply to this question, namely that in order to determine trends in the cost of transport inputs, both the volume and unit costs of the inputs must first be ascertained. The initial question can then be replaced by two simpler ones, i.e. what do we know about the trend in productivity and the trend in the unit cost of inputs?

1.3. Many conceptual and practical problems

The question concerns trends in costs, so it might be thought that a reply could be offered even if the precise level of the costs is not known. However, as indicated earlier, there is good reason to make a critical analysis of cost structures.

The kind of factors to be taken into account in transport costs, even if some of them are not passed on to users, is well known, although considerable difficulties arise in practice as regards both defining concepts and methods and making quantitative estimates. This background report therefore seeks solely to classify these factors and draw attention to problems relating to methodology. In other words, its main purpose is to formulate questions, although some -- no doubt debatable -- responses may be proposed, both questions and proposed responses providing the basis for the Round Table discussions.

One of the major conceptual difficulties is how to define labour productivity in owner-operator units in road or waterway transport, since it is indeed a problem to determine the volume of labour on the basis of travelling and waiting time which is, moreover, not known with any accuracy. In other words, how can one ascertain the volume of labour on the one hand and unit costs on the other, so as to be able to measure labour productivity and the way it develops? This theory-based distinction is fortunately not fundamental to the general issue raised, namely trends in costs. There remains, however, the problem of making quantitative estimates.

By and large the fact that enterprises restrict the distribution of their operating data is not the only reason why it is difficult to make quantitative estimates, since cost structures are not well known either. In France, for example, a critical analysis has only just been undertaken with a view to getting a clearer picture of the potential demand for combined rail-road transport, the study being focussed on the comparative costs of the three following transport modes: door-to-door transport by road, wagonload transport by rail, and combined rail-road transport. Not much is known about past trends in transport productivity, especially as regards road transport. It is at present much more a matter of what experts think rather than what scientific method has demonstrated. In short, the value of the data available for France varies depending on the transport mode and they must be interpreted with caution. It might be worthwhile during the Round Table to take the orders of magnitude given in this report and, wherever possible, compare the situation in France with that in other countries as described by the other Rapporteurs.

1.4. Content of the report

A reply to the question raised calls for a clear idea of the trend in productivity which in turn first requires knowledge of trends in the volume of transport output, so some thought necessarily has to be given to the structure of demand in order to try to define a transport "unit of output" (Cf. Chapter 3). In any production process, the quality of the product can vary from one producer to another and can change over time. The transport of goods does not simply entail their movement from A to B, since the quality of service can also be very important to the customer, a point that has to be stressed.

Chapter 2 compares transport modes and includes a description of similarities and differences as regards not only physical and technical features but also institutional and organisational factors which have an important role to play, in conjunction with the above-mentioned quality of service. This chapter could have been placed after that on demand, but since this report was to try to give an intermodal view, it was decided to start with a description of the different modes, showing how they compete and how they complement one another.

Cost structures -- the cost of using transport infrastructures, vehicles' running costs, and indirect costs -- are analysed in Chapter 4. As regards the running cost of vehicles, empty return runs or journey with part load only can have an important effect.

Innovation, for example, may have both technical and organisational characteristics. What contribution can it be expected to make towards stepping up productivity? What are the foreseeable trends in unit costs, especially as regards the remuneration of labour? Such questions are examined in Chapter 5.

Chapter 6 gives the general conclusions and endeavours to set out recommendations that will help to make the freight transport system more efficient.

2. TRANSPORT MODES: TECHNICAL, ORGANISATIONAL AND INSTITUTIONAL ASPECTS

Transport modes can be defined in terms of their physical characteristics: infrastructure and vehicles. However:

-- They often complement each other within a multimodal chain, and handling operations at transshipment points can have a major influence on the overall transport cost and forwarding time;

-- The standard of the transport services offered covers both cost and quality;

-- The foregoing points show that the organisational and institutional aspects of transport supply and the role of the transport organiser are extremely important.

2.1. The physical specifications of transport modes: types of infrastructure and carrying units

Inland transport, the main subject of this Round Table, is characterised by a fixed infrastructure, generally in network form, which is used by the carrying units.

In terms of the physical characteristics of the infrastructure, there are three modes of transport for both freight and passengers, namely, roads, railways and waterways (also called navigable routes or inland navigation, as distinct from sea routes).

The permissible payloads of the freight carrying units are fairly standard on each of the three types of infrastructure:

-- Approximately 25 t for road vehicles, with some variation possible due to differences in national regulations on weights (maximum permitted running weight, axle load, etc.);

-- Between a few hundred and a few thousand tonnes for inland navigation craft, which can be individual boats or boats in convoy, depending on the capacity of the waterway, and in particular the depth of the channel and size of the locks;

-- Between one and several thousand tonnes for trains.

One characteristic of rail transport that deserves special mention is that by coupling wagons, carrying units of anything from an individual wagon to a complete train can be constituted, limited only by overall length or the total weight to be hauled. In fact, it can be said that there are two railway techniques resulting in very different economic conditions (for a given distance) as regards both the unit transport cost per wagon or per tonne, and the forwarding time: i) a complete train and ii) an individual wagon (or grouping of wagons), the cost and forwarding times of which are greatly augmented by terminal routing (to the first marshalling yard and away from the last one) and the time spent in the yards. Naturally, intermediate solutions do exist, such as light trains ("rapilèges" -- "fast-and-light"), sets of wagons formed into trains at the point of departure and separated on reaching the general area of destination, etc.

The changeover from non-bogie wagons to bogie wagons should also be mentioned since it has certain advantages: roughly doubling the payload -- an increase from about 25 t to some 55 t -- thus reducing the transport cost per tonne by about 33 per cent, and a higher maximum running speed.

When the consignor and the consignee are both connected to the railway network, or have a wharf on the waterway, the transport cost per tonne (for a given journey) decreases sharply with the increasing size of the payload of the different transport modes. These modes can thus be seen to be largely complementary in the sense that they occupy specific sections of the market: waterways and complete train-loads are particularly well suited for large-size consignments whereas road haulage and individual wagons will be used for small-size consignments.

Within these two broad categories, however, competition between waterways and complete train-loads and between road haulage and individual wagons can be fierce.

In the straightforward scenario we have chosen (consignor and consignee connected directly with the network), it must be borne in mind that transport operations require the loading and unloading of carrying units, so the handling costs involved essentially mean that:

-- Waterways are better suited for bulk transport, although there are exceptions (vehicles, containers, etc.);

-- Technical means are adopted to reduce costs, e.g. specialised carrying units (in addition to such units being better adapted to standards as regards weights and dimensions, especially for rail and road); improved handling equipment; and attention to packaging (which also has a role as regards making fuller use of the payload capacity and of the space available inside a carrying unit).

2.2. Multimodal transport chains

In many cases, the consignor and the consignee are not directly on the rail or waterway network. The transport chain is then multimodal: a "principal" transport (by railway or waterway) has to be completed by an "approach" (or "terminal") transport at one end at least of the chain, and this is normally carried out by road, though it can be by rail completing transport by inland waterway. Accordingly, the transport modes in a multimodal chain are seen as complementary.

For the chain as a whole, the total cost (or price) is the sum of the costs (or prices) of each successive transport mode, handling at each end and handling for transfers between modes, i.e. change of carrying unit (so-called transfer points). The costs (or prices) which are additional to that of the principal transport vary widely and depend:

-- In the case of terminal transport, on the distance involved;

-- In the case of handling, on the type of freight and packaging, and on handling equipment and operating conditions.

Accordingly, so far as total transport cost is concerned, the degree of competition between transport modes (or more precisely between transport chains defined in accordance with the principal mode used) varies greatly.

2.3. Intermodal and combined transport

By using "intermodal" transport, transfer costs between modes can be reduced by:

-- Transferring the carrying units (and, possibly, the tractive units) from one mode to another, conventional examples being transfer from rail to sea leg (ferries), transfer from road to sea leg (roll-on/roll-off), and the loading of road vehicles onto railway wagons ("piggy-back" with road trailers, the "highway on wheels"); or

-- Using container units (without wheels), so-called "ISO" sea containers, and swop bodies and other containers designed for overland transport.

When the carrying units or containers (in the wide sense of the term) use different transport modes, this is usually called "combined" transport, a term that can have a narrower meaning if only land transport modes are included, thereby excluding ferries and roll-on/roll-off systems (see the definition proposed by Mr. Frybourg for the ECMT's Round Table 64).

Attention should also be drawn to the other advantages of intermodal transport, especially as regards containers (in the wide sense of the term), namely:

-- Goods in transit are protected against damage, bad weather and pilferage;

-- Better storage conditions and, more generally, better integration into a logistics system, including the monitoring of progress along the chain;

-- In the case of ISO containers, better maritime transport conditions (including less time spent by ships in ports); container transport has in fact developed largely on the strength of these advantages.

On the other hand, the costs involved in container transport must also be borne in mind: the cost of equipment, and extra transport costs entailed by the tare weight and empty return runs.

2.4. Technical norms: weights and dimensions

Many commodities, depending on their type and packaging, have a relatively low density as expressed, for example, in t/m^3 (see paragraph 3.1.). The amount that can be loaded into a carrying unit may therefore be limited by the usable space in the unit which explains the importance of the usable space that a unit has, and of the ratio usable space/payload. In particular:

-- The usable space of railway wagons can be limited by the structure gauge of the line, especially in the case of combined transport using road semi-trailers;

-- Bogie-wagons have a payload of roughly twice that of non-bogie-wagons but are longer by only some 50 per cent, which gives a less favourable usable space/payload ratio;

-- The usable space/payload ratio is generally higher for road vehicles than for railway wagons.

Another aspect of technical norms is the unit load/carrying unit ratio:

-- It is well known that the standard pallets do not fit easily inside ISO containers, but is there in fact much demand for transport using pallets in such containers?

-- The length of swop bodies and other inland containers varies but is often a multiple of a standard unit. However, the length of road and rail vehicles is not always used to the full.

2.5. Quality of service, and organisational and institutional aspects

Whoever is responsible for shipping on behalf of the consignor or the consignee will often be very particular as to the quality of service offered. The concept of quality of service is relevant to the different aspects of the transport operation in its various stages: total forwarding time and reliable delivery dates, information as to the whereabouts of the goods, and ability to adapt to unforeseen developments in transport conditions. It also includes factors relevant to the safety of goods in transit such as protection against damage and pilferage.

Railway companies seek to improve their quality of service by offering different "quality/price" options: the choice offered by the SNCF between "ordinary" and "rapid" service allows customers to give priority either to forwarding speed or to cost. In this way, physical transport modes can be further divided into organisational sub-modes.

Roads and waterways are at an advantage here since the carrier has the goods physically in his charge and this gives increased flexibility with regard to collection and delivery times. The railways also seek to offer similar flexibility with regard to the collection and delivery of goods, while at the same time they try to keep running costs to a minimum by delegating the organisation of local terminal forwarding to multi-purpose stations.

As regards roads and inland waterways, legal and institutional criteria may be used as a basis for defining the sub-modes consisting of own account transport (or "private" transport) and transport for hire or reward (also called "public" transport). It should be remembered that laws and regulations differ from country to country and intermediate situations are possible, particularly for various types of road vehicle hire: long-term hire or single-journey hire, hire with or without a driver, etc.

From an economic standpoint, the distinction between own account and hire or reward is far from simple:

-- Transport is part of the production-distribution process, and industrial undertakings may subcontract any given part of their activities: the use of public transport is only one example of subcontracting which an undertaking may choose for various reasons connected more or less directly with running and management costs;

-- Own account transport can give shippers more control over transport operations. However, this solution is profitable only if transport is required at regular intervals and in circumstances in which empty return runs can be avoided, the best example being deliveries between factories of undertakings with branches in many different premises;

-- The existence of "hire or reward" road hauliers which are subsidiaries of industrial undertakings means that it is possible to have own account quality of service while limiting the number of empty or part-load return runs.

Lastly, it should be borne in mind that combined rail-road transport operations may involve a good many transactors:

-- The customer in this type of transport may be the shipper or a road haulier;

-- The use of different transport modes in succession needs to be co-ordinated: there may be a different road haulage firm involved at each end of the chain, or several national rail networks may be used;

-- The container may be owned by any one of the transactors.

Hence, there are many possible legal and institutional structures which might be regarded as constituting transport sub-modes (see the ECMT's Round Table 64).

2.6. The importance of the role of transport organisers

The aim in the foregoing sections has essentially been to define transport modes or multimodal chains, and to describe the quality of service. Operating conditions, particularly empty runs, have been referred to only in passing.

It is quite obvious, however, that the degree to which vehicle capacity is used plays an important part in determining costs (Cf. paragraph 4.3.). More generally, in seeking to make the transport system more efficient, the question arises as to the right balance to be struck between quality of service and cost (see paragraph 4.5.). Suffice it to say for the moment that efficient transport is not simply a question of forwarding goods by means of a high quality service but also of "organising" transport operations in such a way in space and time that both vehicles and goods move as efficiently as possible.

It is of course up to the transport undertaking to see to this organisation, but an important role is also played by other agencies connected with the transport operation. Some of these, known as "intermediary" (between shipper and carrier) or "auxiliary" transport agencies provide services such as handling, insurance, and customs clearance. In many cases, however, the shipper will call on a transport "organiser" to supervise the transport or even to take over the wider task of organising the logistics of the transport operation.

The management of freight transport is therefore shared by a complex mixture of economic agents, the more so as some undertakings carry out many different tasks. The nature and importance of the activities vary:

-- From one country to another depending on historical developments: the initiatives taken by the agencies concerned, the way in which laws and regulations have developed, etc.;

-- Within a given country and for a given type of multimodal chain, the variation has been considerable from one transport operation to another depending on the policy adopted by the economic agent (shipper or transport organiser) in charge.

2.7. Related categories of output

For the sake of completeness, it should be pointed out in this description of transport services offered that there are related categories of output, a fact that does nothing to facilitate the analysis of transport costs (see Chapter 4):

-- At the level of transport output in the strict sense; in particular, railway companies carry both passengers and freight and are engaged in both conventional transport by rail and also combined transport operations;

-- At the level of transport organisation services and ancillary transport services, in view of the many different kinds of activity carried out by undertakings involved in the transport system, as mentioned above.

3. THE DEMAND FOR TRANSPORT: DIVERSITY AND REQUIREMENTS AS REGARDS THE QUALITY OF SERVICE

Although the previous chapter dealt mainly with transport supply, it made a number of references to the adaptation of supply to demand, so this chapter will be brief and cover:

-- The diversity of demand: structure by type of freight and geographical structure;

-- The importance of the quality of the services offered, the transport operation being placed in its logical context;

-- The problem of defining transport output units, a definition that is called for if any meaningful approach is to be adopted towards the concept of productivity.

3.1. Type of freight and size of consignments

First, freight can be assigned to different categories on the basis of physical characteristics, packaging, and the quantity dispatched (called a batch or consignment). The physical characteristics of the freight, such as their type and size, measured in tonnes for example:

-- Determine the payload capacity required of the carrying unit and, in the case of low density consignments, the usable space that is needed;

-- Can mean that specialised carrying units are called for, particularly in the case of freight which has to be transported at a controlled temperature, and in the case of liquids or liquid gas, which can be carried in bulk in tankers but often require tankers which are reserved exclusively for specific substances;

-- Can call for special precautions, e.g. fragile or dangerous substances.

3.2. Geographical structure

The cost of transporting a consignment of given physical characteristics varies widely depending on the physical whereabouts of the consignor and consignee.

In the first place, it is obvious that carrying units' running costs increase in line with the distance to be covered.

Secondly, for a given distance, the variation in running cost differs according to the transport mode:

-- These costs are relatively stable for road vehicles, due to the uniformity of the network used. There are, however, variations that result from the differing characteristics of the various sections of the route chosen (variations which do not necessarily even out over the whole journey), such as the physical characteristics of the road and traffic density which affect journey time, fuel consumption, any tolls, etc.;

-- For inland waterways, there are variations linked with the characteristics of the infrastructure (difference between the distance as the crow flies and that actually covered due to the meanderings of the waterway, number and characteristics of locks affecting journey times, and, more particularly, the carrying capacity of the waterway which determines the payload of the craft used) and the need, if any, for any terminal hauls;

-- For railways, apart from the effect of any terminal hauls, the cost of forwarding wagons depends on the characteristics of the infrastructure for the route in question and, more particularly, on the volume of demand for this route (economy of scale in the forwarding of wagons, sets of wagons or trains, and in marshalling operations).

Finally, a cost factor that applies to all transport modes is the number of empty return runs made by carrying units and containers. The number of such runs depends:

-- On a statistical difference over the long term in the demand for outward and return runs on the route concerned;

-- Even when the statistical imbalance is slight, on "seasonal" or chance variations from one day to the next or in the week;

-- On the degree to which the carrying unit is of a specialised type for, while specialisation to whatever degree makes for more efficient transport and handling, it does of course have the disadvantage of increasing the number of empty runs.

3.3. Logistics policy

The choice of transport chain, at least in the case of the actual moving of goods within production-distribution chains that are stable and regular in time, is made in the broader framework of a logistics policy. To be precise, the term "transport" logistics should be used although the subject can be broadened to include "industrial" logistics upstream and "after-sales" logistics downstream in the chain.

A logistics policy for transport between given locations for consignor and consignee first involves a decision as to what the trade-off is to be between the size of consignments (and hence their periodicity) and the volume of stocks. By and large:

-- The choice of large consignments can reduce transport costs by enabling the shipper to use a railway wagon instead of a lorry, a bogie wagon instead of a non-bogie wagon, or a complete train-load instead of a set of wagons;

-- On the other hand, storage capacity will need to be increased (which means higher costs), and the cost of having stock tied up -- linked both to the unit value of the commodity and the frequency of consignments -- will be higher.

It must be stressed that the volume to be transported over a long period (for example, a year) is of considerable importance: a change from 25 t a day to 50 t every other day increases the average time for tied-up stock by only one day, but where the volume to be transported is 25 t a month the cost of holding stock will be 30 times higher.

Of course, other factors connected with the quality of service influence the choice of a logistics policy: reliability of delivery times, flexibility in adapting to changes in production or consumption, ability to monitor the progress of the transport operation, etc.

More generally, if the logistics are well organised, the geographical structure of production-distribution chains may have to be reappraised, especially as regards the number and siting of storage facilities at various stages in the chain. The established trend away from many local depots to a smaller number of regional ones seeks to achieve an optimum in which transport costs play an important part: greater distances between storage depots and delivery points and so higher costs, but lower transport costs between factory and depot because consignments are larger.

Grouping consignments -- for example, by using the traditional method of sending a number of small consignments in the same vehicle, or by setting up intermodal transshipment centres -- also enables transport organisers to achieve economies of scale insofar as larger consignments or quantities are handled at focal points in the network. However, such organisers offer services which are broader than the physical transport itself and amount to a range of logistical services for hire or reward.

In short, the cost of the physical transport operation (including handling) is but part of the overall cost of the organisation and management of the transport of freight from one place to another, a part that -- even when preponderant -- may differ in its development from the other cost components and so by no means reflect the overall trend in costs.

3.4. Requirements as regards quality of service

The different aspects of quality of service have already been mentioned several times (see paragraphs 2.5., 2.6. and 3.3.). They have a key role in certain economic respects as is quite understandable, particularly where time is concerned:

-- The time for which goods of a high unit value are tied up during transport or storage involves a by no means negligible cost;

-- Reliable delivery dates are important in the case of supplies or products in production-distribution chains;

-- Urgent deliveries: perishable goods, consignments to replace exhausted stocks, production hold-ups.

It is therefore difficult to understand the findings of some studies which suggest that shippers apparently attach more importance to gaining a day or half a day than would seem to be warranted by the effect that a programmed delay of this order has on the cost of the goods being tied up. It is, however, true that the shorter the forwarding time, the easier it is to monitor a transport operation.

3.5. Unit of transport output

The simplest physical measure of the amount of goods to be transported is their weight (or more precisely, mass), expressed in kgs, 100 kgs or 1 000 kgs, a weight or tonnage that is usually clearly established as it is used in fixing the transport price. However, the measurement can differ appreciably according to what is understood by weight: the gross weight (including packaging and possibly the vehicle itself) or the net weight, the real weight of the goods, i.e. that on which the tariff is based. In some cases (e.g. removals), the physical volume is used as the measurement while in others (e.g. the transport of vehicles or animals), the measurement is the actual number carried.

Totalling the tonnages carried is not a very satisfactory method of measuring transport output since it takes no account of distance -- an essential factor in determining the cost of transport -- and can result in double counting where multimodal transport chains are concerned. The tonne/kilometre can therefore be considered a more satisfactory measurement, although the distance covered in going from point A to point B differs according to the transport mode and may be the actual distance or that on which the tariff is based.

More generally, the t/km measurement does not take sufficient account of variations in transport costs due to differences in demand arising from the physical make-up of the consignment (the type of foods and the consignment size) and the geographical structure of the demand. Even as an indicator of trends over time, the t/km measurement is inadequate since physical and geographical structures change.

If a more appropriate definition of volume of transport -- in the sense of volume of output -- is to be ascertained, a normal or "physical" approach might be to establish categories of consignments that are sufficiently uniform from the standpoint of transport costs, and then weight these by means of a scale of the relevant transport costs. Since there is virtually no limit to consignment weights and shipping distances, it is natural to try to establish a breakdown (first problem) into categories which would have to be defined on the basis of the types of goods (second problem) and a starting point/destination classification (third problem). The system of tariff structures for road transport in France provides some idea of how these three problems can be dealt with, although these mandatory rates apply to long-distance transport only and do not cover all types of freight.

In spite of the apparent complexity of the scales, the tariff structure itself is quite straightforward:

-- Goods are classified in eight categories on the basis of their physical characteristics with category No. 4 as reference (i.e. index = 1); rates range from 1.32 for category 1 to 0.86 for category 8;

-- For each category, the rate is proportional to (d + 160 km), where d is the chargeable distance, this being approximately the distance by road in kilometres. However, appreciable changes vis-à-vis this affine function have been made in the case of categories 7 and 8;

-- The function for the rate is also close to an affine of the weight in tonnes (x) of the consignment, the rate being proportional to (5 tonnes + 0.75 x);

-- By means of a classification of routes which takes particular account of the likelihood of obtaining return loads, rates can be varied by anything from about -5 per cent to +10 per cent.

The size of the x-axes at the origin (-160 km and -5 t) suggests that the method of using weight and distance to get t/kms would not be relevant. But do these x-axes at the origin correctly reflect cost structures, even in the case of transport by road? More particularly, is it not necessary for the x-axis at the origin of -160 km (which should take account of the immobility of the vehicle during loading and unloading) to vary according to the type of goods and packaging?

Rates for the various categories of goods differ considerably. Although the density of the freight is of course taken into account in the classification, is there not also some differentiation based on value?

To sum up:

-- It is clearly not easy to adopt a "physical" approach of this kind and take the fullest possible account of all the factors mentioned, because there is inadequate data on the cost structure, including the starting point/destination classification;

-- However, consideration should be given to the idea of an "approximate" method whereby t/km figures for a number of categories of goods would be weighted (these categories and the weighting coefficients being applicable to all inland transport modes); such an approach might serve to correct the effects of changes in the structure by categories of goods and by distance. In practice, it would be necessary to establish categories of raw materials, semi-finished products and manufactures.

Another approach, based more on transport economics, would be to calculate trends in transport revenue at constant prices. This would have the advantage of taking account of changes in structure (physical and geographical structures of consignments, and structures by transport mode), and even of trends in quality of service insofar as these are accurately reflected in trends in transport prices. It is by no means certain, however, that we can resolve the difficulties involved in applying this method:

-- Precise data on revenue is available only in the case of the railways;

-- Can sufficiently representative price indices be calculated for each mode of transport?

-- Price structures do not accurately reflect cost structures.

In the last analysis, it is primarily important to be able to make a quantitative estimate of the extent to which changes in the structure of demand influence transport costs, which will call for:

-- An accurate analysis of the structure of costs (see Chapter 4);

-- A very thorough analysis of trends in the structure of demand, care being taken to assess the extent to which findings may be influenced both by inaccuracies in the statistical series available and assumptions relevant to the selection of practical methods (categories of goods, relative cost indicators, etc.). In this respect, there are no doubt lessons to be drawn from the studies or research already carried out by certain countries.

4. THE STRUCTURE OF TRANSPORT COSTS

This chapter examines the components of transport costs, classifying them under the usual headings which correspond fairly naturally to their origin: direct costs connected with infrastructures, direct costs connected with the movement of vehicles, and indirect (or external) costs taking account of other aspects such as the effects of traffic congestion, accident costs, pollution, etc., all these direct and indirect costs being also known as social costs. Our main concern is to point out the similarities and differences between transport modes, showing the comparative importance of the different components and the way they vary as a function of traffic volume.

These components cannot be analysed in isolation from one another, however. In particular, infrastructure investment may be intended to maintain the quality of service with an increasing volume of traffic or to improve the quality of service. For this reason we intend to review a number of general economic concepts, then, after describing the different cost components, return to the problem of quality of service.

4.1. General economic considerations

By and large it is well known that transport is subject to the law of increasing returns, i.e. the cost per unit of transport output falls as the traffic volume (number of units of output) rises, this being mainly due to costs connected with infrastructures. The result is that:

- The theory of optimum allocation of resources leads to charging at marginal social cost in order to ensure maximum economic surplus (profit + consumer surplus);
- Marginal social cost is less than average cost, so that there is no guarantee of budgetary equilibrium;
- Budgetary equilibrium may nevertheless be an objective set by the government in order to make users pay the total cost of the transport system;
- Depending on the charging system adopted, there may be a substantial gap between the cost of transport and the price charged.

The situation as regards general principles is as follows:

- In 1971 the European Economic Community recommended, as a long-term objective, charging for infrastructure use in such a way as to achieve budgetary equilibrium for each transport mode and each type of use, the latter corresponding to the distinction between passenger and goods transport;
- In France, the situation in goods transport is close to marginal social cost pricing. This is discussed in more detail below.

If, as mentioned above, the aim of budgetary equilibrium for each type of use (i.e. in the present case goods transport) is justifiable, it must be emphasised that its application for each transport mode could lead to distortions in the allocation of resources or, from the standpoint more generally considered, in the conditions of intermodal competition. This is the case where the charge to be added to marginal social cost differs greatly between modes.

A number of other general economic aspects are also worth recalling:

-- For a given transport mode the unit of transport output to be considered is not necessarily strictly the same for the different cost components -- if a common unit may be used as a first approximation, however, the different cost components, both average and marginal, are cumulative;

-- The cost trend as a function of traffic volume as discussed here is a global concept covering the whole of the transport network over a period of a year -- it must not be forgotten that the situation may be very different at any particular point in space and time;

-- The estimation of external costs raises serious problems, in particular in the case of pollution.

4.2. Infrastructure use

Considering first of all the transport infrastructure in a given year and ignoring any modifications in the following year, the infrastructure costs for this period are:

-- The annual depreciation charge;

-- The costs arising from infrastructure use -- maintenance, operating and management costs.

The problem is to estimate how infrastructure use costs vary with the volume of goods transported, taking account of the existence of associated output and in particular, in the case of rail and road transport the two uses (passenger and goods) mentioned above. In the case of waterways, passenger transport and associated output such as water production, electricity generation, flood protection, irrigation and recreational uses will be disregarded.

Analyses of costs as a function of traffic volume carried out periodically in France for the General Council of the Ponts et Chaussées (Department of Public Works) try to estimate fixed costs (corresponding to the base axis and possibly including depreciation charges) and variable costs to arrive at an approximate average marginal cost. From the standpoint of marginal cost pricing only the variable costs are taken into account.

The structure of infrastructure costs depends to a large extent on the historical development of the transport network concerned. A very fully developed system represents a rich heritage (relatively low depreciation costs) but may lead to high fixed operating costs.

The railways provide an instructive example. The calculations are rather complex and the results are somewhat sensitive to the assumptions used, among which:

- -- Strict separation between infrastructure and other costs -- definition of infrastructure cost components;
- -- Choice of the unit of transport output -- gross or "virtual" tonne-kilometres worked (the latter being used by the UIC classification of tracks and being intended to take account of speed as well as the effect of axle weights on track maintenance);
- -- Accuracy in estimating marginal costs, this being based on comparing the cost per kilometre of track according to the 12 UIC categories;
- -- The apportioning of fixed costs between passenger and goods transport -- estimation of avoidable costs and apportioning of non-avoidable costs, this being based on operating receipts, gross tonne-kilometres worked or marginal costs.

The results available concern all railway activity (passenger and goods traffic) exept for suburban and mail services. The most recent figures are for 1975, i.e. before the introduction of the southeastern TGV (high speed train). They nevertheless clearly show the low proportion of variable costs -- about 20 per cent of total infrastructure costs and about 23 per cent of operating costs.

It is relatively easy to analyse the costs of using rail infrastructures as a function of track length, as the network is fairly homogenous as regards both capacity and operating costs.

The problem is more complex in the case of waterways, where the situation differs according to capacity and the number of locks. The variable component of infrastructure use costs appears to be low -- in the order of only 10 per cent -- for the French waterways system.

The road system (made up of motorways, national highways, secondary roads, etc.) is also heterogenous as regards quality of service (average speed) and operating costs as a function of traffic volume. Furthermore there is the problem of the fair apportioning of infrastructure use costs between cars and commercial vehicles and, in the case of the latter, taking account of total weight.

Seasonal variations in traffic volume may lead to the conclusion that infrastructure capacity is inadequate, at least over certain links, and consideration being given to the possibility of introducing charges to bring supply and demand into balance. Practical implementation of such a scheme could be difficult and costly, however:

- -- First, the capacity limit (or saturation) is rarely clear-cut -- there is usually more of a reduction in the quality of service due to congestion;
- -- Second, the seasonal variations in the volume of passenger and goods transport are fortunately to a large extent complementary in thecase of the two transport modes concerned, road and rail. Goods traffic

tends to fall off during the summer months and at weekends, and goods trains and to some extent trucks tend to run mainly at night.

How is the problem of new investment to be approached as regards the relationship with traffic volume?

If it were a matter simply of maintaining the quality of service with an increasing volume of traffic the problem would be relatively simple from the conceptual standpoint -- an attempt could be made to establish the development cost, marginal by definition. In practice the problem would of course be complicated by the lack of homogeneity in space and time.

Due to a slowdown in the rate of increase in goods traffic over the past ten years or so this problem of maintaining the quality of service has become less serious than in the past, but it is not without import for the years to come to the extent that:

-- A significant increase in road haulage is to be expected;

-- Increasing passenger traffic, both rail and road, has an effect on the quality of service of goods transport.

In any event, infrastructure investment will be increasingly called upon to improve the quality of service as regards:

-- First, external costs -- congestion, safety, pollution;

-- Second, other aspects, in particular those connected with the size and volume of consignments (e.g. improvement of railway loading gauges) and the organisation of multimodal transport chains (e.g. for combined transport -- intermodal transshipment centres, "highway on wheels").

This will be discussed further in section 4.5.

4.3. Movement of vehicles

In addition to infrastructure costs, direct transport costs include the costs incurred in actually carrying out transport operations. These may be broken down as follows:

-- Costs associated with the movement of vehicles -- the present analysis will be limited to these;

-- Other costs incurred by transport undertakings -- marketing, management, etc.;

-- Possibly -- this being a matter of definition -- the costs of loading and unloading at each end of the transport chain.

The relative importance of the cost of vehicle movement varies considerably according to mode.

In the case of waterways and roads, transport services are differentiated activities, so that the transport cost can be considered to be proportional to the traffic volume (linear function), but this does not mean that the average cost per unit of output does not change over time.

In the case of railways, however, all transport services are managed by a national undertaking in the majority of countries and as a result of the economies of scale mentioned above (in both marshalling yards or intermodal transshipment centres and the routing of wagons) activity is subject to the law of increasing returns, or in other words decreasing average cost (per unit of transport output). What is more, marginal cost is probably also decreasing as a rule. For these reasons there may be great differences between links, not only in average costs, but also in marginal or variable costs, according to the volume of traffic.

As was emphasised in Chapters 2 and 3 in discussing all modes, cost levels at any given time and cost trends over time are influenced by other factors, such as:

-- Payload and usable space of the vehicle or intermediate container;

-- Proportion of empty hauls or part loads, due to imbalances between the volume of traffic in the two directions and the greater or lesser specialisation of the vehicles used.

4.4. External costs

These include costs of quite different types:

-- The costs of congestion, borne mainly by infrastructure users;

-- The cost of accidents, which may concern non-users;

-- The costs of pollution, essentially noise and air pollution, borne mainly by infrastructure frontagers.

The importance of these different costs varies greatly according to transport mode:

-- Congestion concerns mainly road transport, but may also concern waterways where these are narrow and there are many locks. No real problem on the railways thanks to continued investment efforts (increased number of tracks, new lines for high speed passenger trains);

-- Accidents are virtually limited to the roads;

-- Noise and air pollution are perceived by the population mainly for road transport even though the noise generated by other modes may be far from negligible. It should be noted that the disamenities associated with the existence of infrastructures are also sharply perceived when new road or rail infrastructures are built -- division of farms, impairment of the countryside.

From the standpoint of disutility to the community a whole (or in cost/benefit analysis terms, social costs) these costs are very difficult to estimate:

-- This is the case for accidents, when it is attempted -- quite rightly -- to go further than simply including the compensation paid by insurance companies (see ECMT Round Table 63);

-- There is no method -- either existing or even planned -- for calculating the social cost of pollution. If a consensus could be reached on acceptable levels of pollution (in other words a quality of service objective) resolution of the problem would be simplified. It would be possible to estimate the cost of the investment measures required on vehicles (to reduce noise and exhaust emissions) and infrastructures (noise reduction through deviations, excavations, screens, etc.) to achieve this objective. It is possible, however, that acceptable levels of pollution will tend to fall over time;

-- Congestion raises the problem of the social cost of lost time. While this problem is not very easy to resolve for private cars, it is relatively simple to estimate the economic impact of lost time for goods vehicles. It still remains, however, to clarify the interaction between the two types of use, passenger and goods transport.

It seems reasonable to consider that the social cost of accidents and pollution are proportional to the volume of goods transport, though the relative weighting of the different categories of vehicle according to size needs to be examined. It is well known that the average and marginal costs of congestion are increasing.

After this review of the different components of social cost as a function of the volume of goods transport, we now return to the question of pricing in France.

In the case of the railways, where the indirect costs are relatively insignificant and average direct costs are decreasing, marginal cost pricing is by no means capable of ensuring budgetary equilibrium. The approach adopted by the SNCF, in agreement with the government, is intended to reduce the deficit as much as possible without distorting the conditions of competition, in particular vis-à-vis road haulage. The price is therefore at least equal to marginal cost and is as high as possible while remaining advantageous with respect to road haulage.

In the case of waterways, pricing is approximately at marginal social cost, the charges for infrastructure use and the taxes on fuel more or less covering marginal cost.

The situation is more complex in the case of the roads:

-- First, it should be recalled that the indirect costs are difficult to estimate;

-- The gradual establishment of a motorway system has increased the total capacity of the road system to meet increasing demand at the same time as improving the quality of service (average speed, safety, comfort) as compared with national highways. In view of the generally high quality of the latter, it was decided to fix toll charges on motorways at a level more or less corresponding to the difference in quality of service between the two types of trunk road. This has made it possible both to finance infrastructure investment and maintain a proper balance of traffic between motorways and highways;

-- In the case of goods transport the aim is marginal social cost pricing. This seems to have been just about achieved on the overall level, taking account of fiscal measures (fuel tax, vignette, axle tax), but the situation is not the same on all parts of the network (differences in the degree of congestion, lower marginal indirect costs on motorways) or for all sizes of vehicle, and pollution costs are disregarded since it is not known how to calculate them.

4.5. Return to the quality of service

The economic approach via production costs is more complex in the case of transport than manufactures, due to the spatial character of transport output and the quality of service component which covers aspects connected with both external costs and technical innovation (size of vehicles, speed limits, as well as the congestion aspect).

If it were known how to estimate the external costs accurately enough, it would be possible to internalise them in a cost function and hence determine the optimum supply for a given volume of traffic.

As this objective remains over-ambitious at present, it is better to aim at two more limited but nevertheless useful goals:

-- First, the economic and social impact of the quality of service factors connected with technical innovation as mentioned above is simpler. Whether it is envisaged to increase vehicle size (bigger trucks, expanded railway loading gauge) or, for example, to increase train speeds, the investment cost (infrastructures, rolling stock) can be compared with the savings on operating costs (and, in the second case, logistic costs). It is also necessary to take account of possible modal switches;

-- Second, working on the basis of a given quality of service, to the extent that an optimum supply for different volumes of traffic can be clearly determined, it is possible to calculate a marginal development cost geared to the expected medium and long-term growth in traffic.

It is not easy to estimate development costs, however, as many factors have to be taken into account -- differences in space and time, traffic forecasts, modal switches, more or less even distribution of investment over time and estimated depreciation charges (financial or economic).

This is nevertheless the only clear approach making it possible to:

-- Evaluate the economic and social benefits of investment, if necessary taking account of land use considerations;

-- Estimate fixed and variable costs;

-- Determine an optimal pricing system for the transport system as a whole (to ensure optimum modal split), where necessary taking account of the need to balance the budget, covering fixed costs in their entirety or part only, depending whether regional policy considerations lead to regional authorities being responsible for part of the financing.

5. FORESEEABLE TRENDS IN PRODUCTIVITY AND COSTS

Future trends in transport costs will depend very much on the productivity potential of technological and organisational innovation. An understanding of past trends in productivity and costs would nevertheless be most instructive, but unfortunately the data available are very incomplete.

5.1. Past trends in productivity

The surplus accounting method developed by the CERC (Centre d'Etude des Revenus et des Coûts) makes it possible to evaluate trends in the overall productivity of factors of production and to show the proportion of productivity gains due to each. The method is applied regularly to the SNCF. The traffic volume is obtained for eight categories of passenger traffic and ten categories of freight, the passenger-kilometres or tonne-kilometres for each category being weighted by the unit receipts for the reference year.

For the period 1970-78 the average annual overall productivity increase was 2.8 per cent. Despite the difficulties in interpretation due to there being related categories of output, the rate of productivity increase seems to be of the same order of magnitude for both passengers and goods. As has been mentioned more than once, structural factors (geographical pattern of traffic, imbalance between the volume of traffic in each direction, time pattern) create considerable differences within this overall picture. What is more, the method takes no account of improvements in the quality of service within the different categories of goods traffic. Lastly, it should be noted that due to a certain inertia in the adjustment of the labour force, changes from one year to another follow changes in traffic volume very closely.

In the case of road haulage there are much less data on which to base an analysis of productivity trends. The studies carried out by the IRT (Institut de Recherche des Transports) and the SAEP (Service d'Analyse Economique et du Plan) for a working party of the Commissariat du Plan, based mainly on the findings of a road haulage sample survey (covering the activities of vehicles of over 3 tonnes payload over the period of a week) showed for the period 1966-79 for the whole of the industry (professional hauliers and own-account operators):

-- A substantial increase in the average payload -- from 8.2 to 11.6 tonnes, i.e. 41 per cent in 13 years;

-- An increased in annual kilometrage per vehicle (up 16 per cent in 13 years), connected with changes in the structure of the vehicle stock;

-- Relative stability in the coefficient of utilisation, defined by the ratio of tonne-kilometres to payload per kilometre and thus taking account of both the proportion of laden trips and capacity utilisation.

5.2. Past trends in costs

For the SNCF the surplus accounting method by its very nature enables the volume and unit cost effects of the factors to be dissociated.

In the case of road haulage, the CNR (Comité National Routier) and the Direction des Transports Terrestres regularly calculate the operating costs of standard vehicles for a given annual kilometrage. This makes it possible to:

-- Follow trends in the breakdown of costs among the different components:

-- Distinguish trends in operating costs.

It would be very interesting to compare these data and those described in Section 5.1 with the data available on prices, as regards both structure and trends. Some data on prices do in fact exist, but unfortunately only for the most recent period:

-- A monitoring system for domestic and international road haulage rates based on a constant sample of traffics (defined by geographical relationship and type of goods -- "OPTIM" system) has been introduced by the government in liaison with the industry;

-- The 21st report of the Commission des Comptes des Transports de la Nation (covering transport in France in 1982-83) gives average unit prices for 1983 (per tonne-kilometre) taking account of the geographical nature of the transport operation (long or medium-haul zone, domestic or international transport), payload category of the vehicle and broad category of commodity. This information is given for the hire or reward sector on the basis of the amount invoiced by the carrier (excluding tax) as determined by the road haulage survey;

-- The same report also gives an estimate for the years 1977-81 (based on the annual survey of carriers and transport auxiliaries with at least 6 employees) of the cost structure (as revealed by the operating accounts) by branch (in the case of road haulage, long or medium-haul zone), using a novel econometric method to distinguish between the different activities of a single firm.

5.3. Productivity potential of technological and organisational innovation

In a situation where the traffic volume is stationary or even falling it is not easy -- economically or socially -- for transport undertakings to increase their productivity. In the medium and longer terms considerable progress can be expected, however, due to:

-- Technological innovation in vehicles, packaging and handling;

-- And perhaps to an even greater extent, organisational innovation based on technological innovation (development of information technologies). Reliance can be placed on the spirit of enterprise in a complex and interwoven group of activities which nonetheless remain capable of adjusting flexibly to a transport demand that is partly regular but mainly changing over space and time. It is worth restating the most important objectives -- better organisation of production-distribution chains and a better match between the movement of vehicles and that of goods.

Two particularly well-known aspects should be recalled:

-- In the case of the railways and combined road/rail transport much remains to be done in the field of international transport management (harmonisation of national freight rates, full control over forwarding);

-- The working conditions and remuneration of owner-operators are often considered to be abnormal. It is up to the trades concerned themselves to try to reconcile freedom of enterprise and freedom to operate with fair reward, often in the context of a struggle for survival. In the medium and longer term an increase in unit costs is to be expected, but here again the productivity potential must not be forgotten.

6. GENERAL CONCLUSIONS -- HOW TO IMPROVE THE EFFICIENCY OF GOODS TRANSPORT

By way of a brief conclusion to this report, attention is drawn to two points.

6.1. Transport prices reflecting the cost structure

In the first place a better knowledge of cost structures and trends is required. This report has pointed out many shortcomings in this respect. But there are also data (available statistics and data existing in the form of sources of information) whose potential is as yet not sufficiently exploited -- a major task of critical analysis and synthesis to be undertaken?

The second line of attack, following on from the synthesis of data, should no doubt be directed at clarifying pricing systems with a view to improving the "conditions of competition" between transport modes. The need for clarification concerns not so much the concepts as practical evaluation of the "cost and production functions".

6.2. Encouraging innovation

It is probably not unrealistic to expect a lot from innovation, but it will be necessary to take proper steps to encourage this innovation.

It is not just a matter of promoting research and development. It is also necessary for governments to promulgate clear regulations in both the technical and social fields -- working conditions, access to transport trades and markets.

We consider it important to stress that the decisions to be taken by transport undertakings involve a substantial commitment for the future in view of the relatively long lives of infrastructures and equipment. Taking the example of the size and weight of vehicles, their considerable impact on the whole of the logistic chain needs to be borne in mind -- packing and protection standards and methods, handling technologies, storage area equipment.

FORESEEABLE OPERATING COSTS IN ROAD FREIGHT TRANSPORT

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SUMMARY

INTRODUCTION

If research is to produce useful results, good quality data on the topic must be available.

Two sources of data can be used in France for the study of road haulage costs:

-- a survey carried out by the Direction des Transports Terrestres (DTT) in the Ministry of Transport. The method involved taking a sample of road haulage firms and recording the annual operating loads for lorries with a permissible maximum weight of 38 tonnes. The purpose of the survey was to calculate the operating cost per kilometre. The sample taken in 1983 comprised 208 firms but the size and composition of the sample has varied over time;

-- The Comité National Routier (CNR) set up by various road transport bodies, publishes indices for the main components of the operating costs of long-distance public transport vehicles.

This report will examine operating cost trends for road haulage firms. The cost will be expressed in terms of the output unit, which in itself is not easy to define (tonne carried; t/km, or kilometers). Existing studies use kilometers, in which case kilometers for laden vehicles have to be distinguished from total kilometers. The number of kilometers can also be related to road transport regulations and available infrastructure.

A calculation based on the kilometer also disregards the qualitative aspects of transport and, more broadly, the diversity of the services provided. A kilometer-based operating cost is thus only relevant on the assumption that the services provided are of the same kind.

What is the advantage of calculating the operating cost, which is a book cost, rather than the marginal cost which can be used for the allocation of resources in a theoretical market?

The cost per kilometer reflects the average use made of the factors involved in the movement of a vehicle. The coverage of these costs is a matter of a particular firm's business policy (volume carried and prices) and depends on the firm's situation : in the short term the firm's production capacity is fixed but not necessarily adapted to requirements. If the firm is to stay in business, however, the total services provided must cover its costs.

The operating cost is determined by the unit price and quantity of each input. While input prices are set by the market, their use depends on the firm's level of activity and organisation. If the level of activity remains constant, variations in the use of inputs reflect the firm's ability to make productivity gains, a decisive factor in terms of trends in future costs. The aim in this report will be to ascertain recent productivity gains and determine the potential for the future, hence the breakdown into the following two sections:

1. Operating cost trends (1979-1983);

2. Foreseeable trends.

The operating cost referred to throughout the report is a representative one for the long-distance vehicles of firms whose main activity is road haulage.

1. OPERATING COST STRUCTURE AND TRENDS (1979-1983)

Disregarding the firm's overheads, the main components of the operating cost of a road haulage vehicle are: fuel, driver and vehicle.

Note will be taken of changes in the price of each factor, the proportion of total operating costs accounted for by each, and any gains in productivity recorded.

The following data is taken mainly from the Ministry of Transport (DTT) survey. The operating cost referred to is the cost per kilometer of 38 tonne long-distance vehicles.

1.1. Fuel

Pump prices were as follows at 30th September of each year (base 1978 = 100):

1979	1980	1981	1982	1983
123.5	150.0	188.3	215.4	226.6

The DTT survey shows a different trend for firms' fuel prices. In addition to discounts for bulk tanker deliveries there have been tax changes since 1982 (progressive deductibility of VAT on fuel), so the index for firms' fuel prices was at 208 in 1983.

In comparison, the operating cost for 1983 was 178. Fuel accounted for the following percentage of operating cost:

PERCENTAGE OF OPERATING COST ACCOUNTED FOR BY FUEL

1979	1980	1981	1982	1983
22.4	24.0	25.2	25.3	24.3

apart from 1983 when stabilizing factors intervened: partial deductibility of VAT, lower fuel consumption. As regards the latter, the following average consumption was recorded (for a 38 tonne articulated vehicle):

AVERAGE CONSUMPTION FOR 38 TONNE UNIT

	1978	1979	1980	1981	1982	1983
1/100	44.8	44	44	42.6	42.2	40.8

The average consumption of a vehicle therefore seems to have fallen by approximately 9 per cent over a five-year period as a result of:

-- progressive replacement of vehicles and the improved energy efficiency of the recent models of traction units;

-- drivers having learned -- or even been taught -- to drive economically.

These productivity gains on fuel consumption reduced the overall operating cost by about 2 per cent.

1.2. Drivers

In 1978, driver's wages, employers' contributions and bonuses accounted for 22 per cent of a vehicle's operating cost.

According to the DTT survey, wages and bonuses were indexed at 160 in 1983 (base 1978 = 100). Employers' contributions as a share of wages were some 14 per cent higher. Accordingly, between 1978 and 1983, wages, bonuses and employers' contributions rose to index 178, the same as that for operating costs. In fact the percentage of operating costs accounted for by drivers increased only slightly:

PERCENTAGE OF OPERATING COST ACCOUNTED FOR BY DRIVERS

1978	1979	1980	1981	1982	1983
21.9	22	21.4	21.1	22.3	22.4

Analysis of operating cost should also take into account changes in the length of worktime. Available information (1) indicates that:

-- the working week was shortened between 1980 and 1983. In 1980, in firms with 10 to 49 employees, 74 per cent of employees worked more than 44 hours a week. In 1983, the proportion had fallen to 35 per cent;

-- compliance with EEC regulations on driving time has improved.

PERCENTAGE OF BREACHES OF REGULATIONS PER PERIOD REVIEWED (1)

Breach Year	Driving time shift	daily	weekly	fortnightly	Daily rest
1976	13.3	19.8	16.7	16.4	26.3
1983	6.4	6.2	2.6	3.0	15.0

Before drawing conclusions from these figures, however, the volume of activity of the firm should be borne in mind. A shorter working time may be the result of a lower level of activity, while the firm's organisation and drivers' roster remain unchanged. The DTT survey gives the following data:

Vehicle/kms	driver/kms	driver/vehicle
1979 107 000	102 000	1.049
1980 100 000	98 000	1.020
1981 101 400	93 700	1.08
1982 103 500	93 200	1.11
1983 102 300	95 300	1.07

Comparing 1980 and 1983, vehicle/kms increased while each driver covered a shorter distance. The driving time therefore seems in fact to have diminished while the number of drivers per vehicle has increased.

Drivers' pay rose in line with the overall cost index, so it would be reasonable to expect that labour costs accounted for a higher proportion of operating cost. Since it did not, it may be inferred that productivity gains offset the shorter work time. Such gains may be evaluated from the following sources:

-- wages and employers' contributions index;

-- CNR index for driving personnel which allows for the impact of social regulations (changes in the number of drivers required under existing social regulations for continuous operation of a vehicle).

A "high" estimate of productivity gains is obtained from the difference between the CNR index and firms' actual wage costs:

COMPARISON OF DRIVING PERSONNEL COST INDICES

	1979	1983
CNR index	100	176
Nominal salary, bonuses and employers' contributions	100	163
Operating cost	100	163

Productivity gains on driving personnel would therefore appear to have been 7.5 per cent in volume over a four-year period. The estimate assumes, however, that:

-- the CNR index roughly reflects the impact of labour and driving regulations;

-- firms complied with the new regulations;

-- It should also be said that the increase in the productivity of the labour input may be real if it is the consequence of better organisation (turnround planning) or only apparent if it results from more selective business. Some of the firms in the sample may, owing to the social legislation and related controls, have contracted out haulage which they would have had difficulty in handling within the regulations. Such selection obviously yields productivity gains. This hypothesis is borne out by several studies. It implies that the productivity gains in the sector as a whole were less than indicated by analysis of firms which changed the pattern of their business rather than their internal organisation (5).

1.3. Vehicle maintenance and replacement

Maintenance and replacement are obviously connected: longer service life means less provision for replacement is required but there is a greater risk of higher maintenance costs.

The replacement and maintenance of vehicles will be examined in turn:

a) Replacement

If it is to have practical significance, the operating cost of a vehicle must include a provision for the eventual replacement of the vehicle, a concept that differs from that of written-off depreciation.

The annual provision made in the DTT survey was :

$$\text{Replacement cost} \times 0.04 + \frac{\text{replacement cost (1) - residual value (2)}}{\text{service life}}$$

1. At time of estimate
2. At end of service life

This method gives a provision per kilometer which reflects market conditions.

The new price of a traction unit with trailer rose to index 162 from 1979 to 1983 on the basis of list prices. The rise is near enough in line with that in the overall operating cost, so the replacement provision should have increased in line with the operating cost. In fact, the average service life for a traction unit increased over the period in question from 5.2 years in 1979 to 6.2 years in 1983. The annual replacement provision thus fell by approximately 15 per cent.

The SAFIDELT (2) analysis confirms that the policy over the period was to replace vehicles less frequently. Written-off, depreciation for vehicles fell from 10.2 per cent of operating costs in 1979 to 8.9 per cent in 1983.

However, slower vehicle turnover leads to productivity gains only if the latter are not offset by higher maintenance costs. Here, too, while maintenance costs increased at about the same pace as the overall cost, the proportion of maintenance costs in the operating cost of a vehicle diminished (Source : DTT):

MAINTENANCE, REPAIRS AND LUBRICANTS

	1979	1980	1981	1982	1983
Percentage of operating costs	9.4	9.1	9.9	9.7	8.2

Maintenance costs fell in spite of the longer service life. This may be explained by several factors: better quality vehicles, drivers trained to drive more economically and the annual kilometrage levelled off or even dropped.

While there were certainly productivity gains on vehicle maintenance, it is more difficult to gauge the effect of replacing vehicles less frequently. In a theoretical calculation of operating cost, the replacement provision is obviously smaller if the service life of vehicles increases, disregarding variations in the residual value. If a firm's actual practice diverges from the theoretical picture, in particular by making insufficient provisions for replacing vehicles, the fact that replacement is postponed may be attributable to the firm's worsening financial situation, which means that it will derive no benefit from the productivity gains.

* * *

Analysis of the 1979-1983 period shows productivity gains were achieved by road haulage firms in the use of their main inputs: fuel, labour and vehicles.

It is impossible to measure these gains exactly, since to do so:

-- the sample of firms would have to be kept constant and representative; with regard to the latter requirement, firms would have to be segmented by activity;

-- other unanalysed factors would have to be stable.

As these requirements are not met, the estimates only represent orders of magnitude.

1.4. Road haulage prices

Owing to the behaviour of those involved and the particularities of the road haulage market, there is a time-lag before prices are geared to costs. Although no road haulage price index is available to substantiate this claim, the price-cost gap can be assessed by examining trends in firms' profit margins.

On the basis of SAFIDELT data (2), the following changes in added value, self-financing and operating results may be noted:

100=1977	1978	1979	1980	1981	1982	1983
Turnover	113	136	161	192	200	226
Added value	113	133	155	174	191	219
Self-financing	114	132	149	155	157	190
Operating result as percentage of turnover	2.2	1.8	1.5	1.7	0.9	1.1

The data shows that the profit margins of the sample firms (haulage + rental) narrowed. The small improvement in self-financing over the 1978-1982 period is shown clearly. The slight upturn in business in 1983 enabled self-financing to be improved that year.

It may be concluded from these data that prices lagged behind costs. In France, long-distance transport is subject to a compulsory bracket-rate system of pricing. Haulage firms can thus pass on cost increases to prices in the short term and still comply with official rates. The inadequate price levels are in fact attributable more to the way in which the sector is organised and haulage firms behave.

In a theoretical market price, determination is based on the relationship between supply and demand. Supply represents for each firm a portion of the marginal cost curve. Other than in the case of the marginal firm which is being driven out of the market, prices cover costs.

Any durable inadequacy of price levels can only be explained by excess capacity, bad management and by the postponement or non-effective elimination of marginal firms.

As regards overall capacity, road haulage traffic (for hire or reward over distances of more than 150 kms) can be compared with capacity in use (vehicles with a payload over 6.6t):

TRAFFIC AND CAPACITY TRENDS

	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
Traffic (millions of t-Kms)	44.7	41.5	44.2	44.6	47.0	49.6	48.3	45.3	43.9	42.1
Capacity (thousands of t.)	2117	2134	2151	2258	2253	2300	2222	2332	2217	2295

Since 1979, traffic has fallen off considerably (-15.6 per cent), whereas overall capacity has remained at the same level.

The use of capacity can also be determined from vehicles' load factors. The DTT survey gives the following figures:

LOAD FACTORS FOR VEHICLES

	1978	1979	1980	1981	1982	1983
Kms laden/unladen	0.86	0.87	0.85	0.85	0.83	0.85
t-kms capacity/t-kms carried	0.777	0.79	0.77	0.77	0.76	0.77

The factors reflect variations in economic activity: 1982 was, in contrast with 1979, a year in which there was a downturn. No conclusions can be drawn from the figures, other than that the economic situation was a major contributory factor to the variations.

It is impossible to determine what the optimum load factors would have been. "Apparent" excess capacity is inevitable in road haulage since:

-- inter-regional flows tend not to balance out owing to the specialisation of economic regions. Part loads and unladen return journeys are thus unavoidable;

-- Road haulage is subject to large seasonal variations so reserve capacity has to be kept for peak periods.

Effective excess capacity tends to push down prices, a process that spreads all the more easily in that a number of firms have only a rough idea of their costs. Many haulage firms have hitherto taken profitability to mean maximising the use of their vehicles, and thus their turnover. In a period of recession, it has often still been their aim to fill vehicles, no matter what price cuts they grant, instead of adapting their fleets to the level of business so as to ensure their profitability. The main consequence of the sector's particular characteristics has been a high firm closure/creation ratio. The closures are related to the inadequate returns on some kinds of business, particularly sub-contracted unskilled haulage for which a large number of owner-operators compete. In contrast, a large number of latter type of firm are created. The capacity of newly created firms offsets the capacity lost through closures.

The price-cost distinction is important: the sector's structure determines in part the gap which may exist between costs and haulage rates. If for example, at a later stage there is a greater number of well-managed firms in the sector, this might be attributable to the fact that better use is being made of capacity and that the problem of inadequate self-financing has been remedied. Conversely, the continued presence of owner operators doing sub-contracted work, and not always complying with regulations, helps to push prices down. These operators work through middlemen who use their haulage capacity. Some of the costs are therefore passed on to the community, in particular those arising from accidents caused by the excessive working hours which are frequent among owner operators.

Changes in the sector are inevitable. They will have an impact on the differences between firms' costs, market rates and the cost to the community. Although it is not possible to construct a model incorporating these features, they should nevertheless be borne in mind.

2. FORESEEABLE TRENDS IN THE OPERATING COST PER KILOMETER OF A 38-TONNE LONG-DISTANCE VEHICLE

It is proposed to estimate the variations in the operating cost per kilometer of a 38t. vehicle from now until 1989. The forecasting method will be as follows:

-- the forecast values as well as projected values will be expressed as variations in volume and price from 1984 levels. It will be assumed that the economy as a whole will undergo no inflation between 1984 and 1989. The variables which have been omitted are obviously based on the same assumption;

-- the inputs to be projected are:

. fuel

. driving personnel

. haulage vehicles.

Assumptions will be made about the price of each input and the variations in productivity with regard to the use made of it.

-- The purpose of the forecast is to estimate the variation in operating cost per kilometer, a cost that is comparable in content to the cost described in Section 1 above and provides the same kind of information;

-- projections will be made for load factors, unladen runs, etc. The impact of a possible rebuilding of self-financing capacity will also be evaluated. An attempt will be made to ascertain trends in the price per kilometer of road haulage.

-- Road haulage firms differ greatly in size and type of business:

. parcels, groupage, batch consignments, tanker transport;

. scheduled and unscheduled services;

. national and international haulage, etc.

The structure of operating cost reflects the firm's main kind of business. A business profile similar to that used in the DTT survey will be drawn: general long-distance road haulage. The operating cost for an annual number of kilometers taken to be 100 000 broke down as follows for 1984:

-- Fuel: 24 per cent;

-- Wages and employers' contributions: 22.5 per cent;

-- Replacement of vehicles (traction unit and trailer): 19 per cent

The estimate will be based on this structure of operating cost.

-- In order to allow conclusions to be drawn from the estimated trend in operating cost, it will be assumed that the standard firm(s) is tuned in to energy saving, management constraints, etc.

-- The impact of possible changes in regulations concerning weight, dimensions, will be disregarded. The evaluation will make a linear extrapolation on the assumption that maximum use is made of vehicles in terms of payload and available space.

2.1. Fuel

a) Price trends

Any assumption about future trends in fuel prices has to take account of a number of factors since the price paid by the consumer is determined by:

-- economic factors such as extraction and shipping costs, exchange rates, refining and distribution costs;

-- economic policies such as paying for infrastructure costs by a tax on fuel consumption;

-- political decisions whereby the revenue from a tax on fuel consumption is used to cover government expenditure;

-- political pressures exerted by users and their pressure groups.

It is not easy to cover all of these factors in projections. Nevertheless, the following assumptions will be made:

-- it is probable that excess capacity in the oil-producing countries and slower economic growth (June 1985) in the OECD countries will lead to stabilisation of the nominal oil price in dollars around 1990;

-- the experts all agree that the dollar is over-valued in relation to the productivity of competitors' economies. This makes it more likely that the nominal price of crude in national currencies will remain constant, amounting to a relative drop in its price;

-- the trend towards lower crude prices will not feed through to pump prices, so the energy conservation policies adopted will not be jeopardised. It also means that around 1990 fuel prices will remain constant in real value terms. Another factor which may hold them constant may be that the external costs (disamenities, pollution) generated by road traffic will be increasingly passed on in the form of taxation. Such a policy would respond to present-day concerns.

b) <u>Energy savings and related-costs</u>

The following factors contribute to lower fuel consumption:

-- Better energy efficiency of vehicles;

-- Selecting vehicles and equipment (deflectors, etc.) which are suited to the type of haulage;

-- Vehicle maintenance;

-- Drivers' training.

The additional cost of such measures has to be weighed against the fuel savings they make possible :

-- It is not possible to calculate that proportion of the rise in purchase price of a vehicle which is due to technical improvements. It may be noted, however, that traction unit prices were at index 162 in September 1983 against the price index at 157 (base 100: September 1979). The same divergence will be projected in the forecast, with a fuel saving of between five and eight per cent. Such a saving means that in five years time, vehicles will consume on average less fuel than the highest performance vehicles today: the saving would result from the combined effect of replacing vehicles and technical progress;

-- The impact of a better definition of vehicle and equipment specifications and maintenance will be discounted. It should merely be noted that the choice of appropriate vehicles may mean choosing less powerful and therefore less expensive vehicles;

-- If training is to be efficient, it should form part of a more general strategy :

-- Induction training for drivers;

-- Installation of recording devices (data logging, computer analysis);

-- Continuing training for drivers (on-the-job instructors, refresher courses).

If these conditions are met, savings of up to 15 per cent can be achieved; this figure will be adopted for the estimate. It is, however, on the optimistic side since there are diminishing returns from the measures taken. It would also seem that few firms have so far adopted an efficient policy.

Against the saving, the cost of training drivers will be estimated at the cost of a five-day course a year (2 per cent of annual work time) plus results-related bonuses (1 to 4 per cent of wages).

2.2. Driving personnel

Driving personnel's working conditions are governed by two texts:

-- EEC regulation of 25th March 1969 on driving and rest time; interpreted and applied in France with a certain amount of latitude;

-- Decree of January 1983 laying down working hours for road haulage firms.

The following percentage of breaches of the regulations on driving hours were recorded in 1983 :

BREACHES OF REGULATIONS ON DRIVING HOURS

	Daily	Weekly	Fortnightly
As percentage of periods monitored by checking tachometer records of driving hours	6.2	2.6	3

An ONSER (Organisation Nationale de Sécurité Routière) survey carried out in the second quarter of 1983 showed that lorry drivers were driving some 53 hours per week on average. The figure varied widely, however, according to the type of haulage (standard deviation of 10 hours),

It is difficult to make any predictions about future trends and, more particularly, to quantify their consequences. Any calculation made in this connection is uncertain since:

-- Compliance with the EEC regulation can have a varying impact (two drivers, relay working, even combined transport). Extra manpower may only be used partially, thus pushing up costs sharply. In other cases, the organisation of regular routes may give higher productivity;

-- The effects of shorter working hours are bound up with the system of paying overtime and likewise depend on the productivity gains that can be achieved.

Notwithstanding the methodological difficulties, the following assumptions will be made for the 1984-1989 period:

-- drivers' real wages will remain constant regardless of changes in the number of working hours;

-- In 1989, the average weekly work time will not exceed fifty hours. Drivers who worked a longer week in 1983 will be cut back to a fifty-hour week. The shortfall will be made up by extra drivers:

-- There will be no reduction for drivers who work less than fifty hours per week.

The assumption is, therefore, that extra drivers will work the hours over fifty hours.

The extra drivers needed can be calculated from the findings of the ONSER survey for working hours in the second quarter of 1983:

DRIVERS' WORKING HOURS

Hours per week	44-48	48-52	52-56	56-60	+60
Percentage of drivers	14	14.3	16.1	9.1	26.8

Taking the average value of each group and a working week of 62 hours for drivers who do more than 60 hours, the total number of hours which have to be made up for 100 employees is:

[16% x (54-50) + 9% x (58-50) + 27% x (62-50)] x 100 = 466], i.e. on the basis of a 50-hour working week, nine and ten additional drivers are needed.

Using the same sources and method of calculation, variations in the cost of driving personnel can be estimated for different working hours: about 12 per cent for a 48 hour week; 16 per cent for a 46 hour week; 25 per cent for a 42 hour week.

The additional cost to be spread evenly over the 1983-1989 period would therefore be approximately 10 per cent for a 50 hour week. Such an estimate should, however, be treated with caution. It disregards productivity gains, or possible losses in the extra resources (drivers or vehicles). A rigorous estimate would have to start off from concrete examples and additional cost arising from shorter working hours would have to be quantified in each case. There would probably be a wide variation depending on the type of route and related constraints (deadlines, customs clearance etc.). In contrast, the proposed estimate is macroeconomic and comparable with other projections in the field. The scenario adopted by the eight Plan (1981-1985) allowed for a

21 per cent increase in labour costs, well above the figure obtained by this estimate. The assumptions were different; the report was based on an average working week of 60 (and not roughly 54) hours which would be reduced to 48 hours, with 3 per cent productivity gains.

2.3. Replacement of vehicles

The calculation will be based simply on the impact of re-adopting a replacement policy similar to that used in 1979:

Vehicle	Average service life		provision 1979/1983
	1979	1983	
Traction unit	5.2	6.2	+ 15.6%
Trailer	8	9.2	+ 14.6%

The impact on maintenance costs (which have fallen in the past in spite of the longer service life of vehicles) and the residual value of vehicles are disregarded.

* * *

The following table summarises the effects of the above assumptions on operating cost. It is clear from the orders of magnitude shown that the foreseeable gains may be partly cancelled out by the application of social legislation and serve partly to rebuild the provisions for replacement of vehicles. The cost of long-distance road haulage would therefore remain constant.

2.4. Rebuilding self-financing capacity

In the first part of the report, it was pointed out that the financial situation of firms was deteriorating, as evidenced by their declining self-financing capacity. It would seem that this cannot go on indefinitely. It results in the ageing of haulage vehicles, which may be, wrongly in the author's opinion, interpreted as higher productivity in the use of vehicles.

On the assumption that vehicles will be renewed by 1989 and that their average age will have reverted to that existing in 1979, operating costs will increase by approximately 3 per cent. This will be made possible by replenished self-financing capacity. Such a possibility seems likely because:

-- Haulage firms are increasingly management-conscious and aware of their collective responsibility for the decline in their prices;

TRENDS IN FACTORS AND OPERATING COSTS (1984/1989)

Effects / Variable	Volume		Factor Cost			Operating Cost	
	Carburant	Personnel	Fuel	Personnel	Vehicles	Coeff.	Δ Cost
Energy savings							
-- Training	-15		-15			0,24	-3.5
		+3 +6		+3 +6		0,225	+0,8 +1,5
-- Vehicle technology	-5 -8		-5 -8			0,24	-2 -1
					+4	0,15	+0,5
Working hours		+9 +16		+9 +16		0,225	+2 +3.5
Replacement of /vehicles/rebuilding self-financing					+15	0,19	+3

-- Increasing use is made of computers, in particular management software which can be run on microcomputers or remote accessed. In either case, the cost is small in comparison with the information a firm obtains about its operation. The additional information which firms will obtain about their real cost prices will probably eventually modify their behaviour, exerting pressure on them to reconstitute their self-financing capacity.

The consequences of such a possibility can be estimated from the SAFIDELT survey data: in 1979, self-financing represented 10 per cent of the turnover of firms mainly engaged in long-distance haulage. In 1983, it was only 7 per cent. Thus self-financing capacity equivalent to 3 per cent of turnover needs to be made up. It is striking to see the similarity between this figure and the increase in operating costs which would result in bringing down the average age of vehicles to the 1979 level. It tends to prove that firms offset their inadequate rates by prolonging the service life of their vehicles.

* * *

In addition to the above estimates, which mainly follow on from the effect of general trends on inputs, it is worth trying to evaluate the potential productivity gains which may be derived from better markets organisation. Information technology can obviously play a major role in such organisations. Two examples will be given: a computerised haulage "exchange" matching supply and demand and reductions in times other than driving laws.

2.5. Matching supply and demand

Shippers' and haulage firms' offers could be matched by means of a data communications network and centralisation/decentralisation of information.

A shipper or haulier could thus feed details of his offer into the system (destination, day, freight, weight, etc.) and receive the proposition closest to it.

There would thus be fewer part loads and unladen return runs and overall capacities would be used more rationally.

Such a system is operational in France for removals. Members of the scheme have cut their unladen runs by some 30 per cent in two years (4).

If the same system was used for road haulage, with 30 per cent fewer unladen return runs, a load factor of 0.90 per cent would be achieved compared to 0.85 per cent at the present time. In other words, for the same overall use of inputs, 90 per cent of the kilometers covered would be gainful instead of 85 per cent as at present. For the same turnover, the price per kilometer could be reduced by 5.5 per cent. The drawbacks of such a system should nevertheless be mentioned: excess haulage capacity -- a factor in pushing down prices -- would be increased. Such market organisation would be accompanied by firms going out of business or reductions in their size. The sector as a whole is ill-prepared for such changes which have hitherto led to an increase in the number of firms supplying traction services only on a sub-contract basis(5).

2.6. Reduction of times other than driving hours

In conjunction with the above-mentioned system, information technology would make it possible to reduce loading and unloading times. A haulage firm could access the customer's loading.unloading schedule and select/reserve his slot in it. An interactive system would make it possible to reconcile partly each party's requirements. There would be a large time saving since the ONSER survey showed that driving laws accounted on average for only 60 per cent of total work time:

Absence from home	Driving hours/work time %	
	Average	deviation
Four times a week	65.3	10.9
One to three times a week	61.2	11.4
Total	59.3	14.1

Non-driving time includes time going through customs, loading and unloading, and other activities. The survey does not give the breakdown of them. In respect of customs clearance, however, computerisation could help to solve some of the difficulties. Company organisation (roster planning, allocation of personnel and vehicles, monitoring vehicles on the road, etc.) could also be improved by it; dedicated software is increasingly available).

Computers would certainly increase the amount of information available at any moment, and by processing it, give greater flexibility. Not all information is useful, however, and the efficiency of such systems depends on the quality of the information/ranking/interpretation sequence adopted. For this reason, the introduction of computer systems has not always achieved its aims. Nevertheless, the economic losses resulting from a lack of organisation will undoubtedly be progressively reduced.

Such losses may be evaluated from the ONSER survey:

-- average weekly driving time is about 32 hours (% driving time x work time);

-- For the same work time, a 25 per cent reduction in waiting time would add 16 per cent on average to driving time, i.e. raise it to 37 hours (within regulations).

For the same volume of output, vehicle and personnel requirements would be correspondingly reduced (on a simple straight-line estimate).

Labour and vehicles alone account for approximately 42 per cent of operating costs with a driving work time ratio which would attain some 70 per cent.

While the accuracy of the calculation is open to question, it nevertheless illustrates the savings which are possible by narrowing down the uncertainties, which is what information is about.

2.7. Operating cost and future services

This report has been primarily concerned with probable variations in firms' operating costs. Any attempt to determine future haulage prices, however, comes up against two unknowns: what will be the characteristics of future services and what organisation will firms adopt to provide them? These questions can be answered to some extent:

-- The quality of haulage will take precedence -- together with the organisation of more economical working procedures -- over price alone;

-- This emphasis on the qualitative aspects (regularity, speed, availability), particularly for high added value goods, will increase the number of journeys with part loads, as such requirements frequently entail small loads. Load factors will thus decrease.

Firms will introduce scheduled routes to meet this kind of demand. Better turn-round organisation allows productivity gains by reducing uncertainties (waiting time, contingencies etc.) and improved driver and vehicle allocation planning. As stated earlier, computers will make this type of operation even more efficient. Accordingly, future services will probably combine lower operating costs per kilometer with, given the instability of load factors, a higher cost per unit carried.

The higher cost per unit carried does not represent an irrational allocation of resources: what matters is that there should be an adequate return on the additional cost. Strictly speaking, the price should then be no more than adequate to cover the economic benefits that the industrial and commercial undertakings gain from better quality transport.

Demand responsive haulage, which cannot be programmed, will obviously continue to exist. Its price will vary according to the operating cost, the transparency of the market (cf.2.5.) and the degree of competition between firms.

In short, it may be assumed that services will develop more or less along the following two lines.

-- Increased emphasis on the qualitative aspects, with the price adjusted accordingly. Haulage and logistics are intimately related.

-- Haulage will become increasingly standardized. The large number of owner operators will maintain excess capacity for non-specialised haulage. Prices will tend not to cover full costs.

CONCLUSION

Between 1978 and 1983, productivity gains partly offset the additional costs to hauliers which had stemmed from higher fuel prices and the need for greater compliance with regulations on driving and work time. Firms' costs nevertheless rose on average at a faster pace than inflation. Road haulage rates were not adequately geared to the rising costs and firms began to show less profit.

The projections in this report are limited in scope, but it should be noted that:

-- as regards economising on fuel, there is a large potential but other factors are in the balance (expenditure on technology, personnel training);

-- work and driving time will inevitably be gradually standardized, cancelling out microeconomic productivity gains.

As compared with improvements to the management methods used by firms, there is much more to be gained by organising the sector and markets, for example by:

-- reducing the number of part loads by providing better information about freight available.

-- reducing waiting time.

Information technology paves the way for such developments, and the accompanying productivity gains would make it possible to:

-- Rebuild the self-financing capacity of haulage firms;

-- Standardize driving and rest time, two essential goals that might accordingly be approached without increasing the cost of services.

Road haulage owes its expansion to the diversity and quality of services offered. The future will emphasise the importance of qualitative factors over price alone. Even greater diversification in road haulage capacity is therefore to be expected as hauliers adapt to the requirements of industrial and commercial undertakings.

Foreseeable gains in the productivity of operations will not necessarily filter through to reduce the cost per unit carried, since qualitative requirements will tend to force down load factors. Information technology may mitigate this effect, however, by making the market more transparent.

Lastly, the organisation of the sector, i.e. the way in which functions and payments for services are distributed among firms, will also influence the divergent patterns of development as regards road haulage costs, prices and cost to the community.

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THE RAILWAYS

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SUMMARY

1. FOREWORD

In the year 2000 will rail freight transport be more expensive or cheaper than today?

1.1. Costs

Costs may be considered to be either:

a) Full book costs;

b) Marginal costs.

1.2. Full book cost

The accountant works out the full cost of all of the different rail transport operations -- which therefore include the various freight shipments -- and calculates how the railway's total costs are to be allocated or broken down among them (1). The figures must balance exactly, since by definition the sum of the full book costs of the different operations is equal to total costs. In order to allocate or break down the indirect and/or common costs, the accountant uses national and often arbitrary scales which means that the book costs calculated in this way are likewise national or arbitrary. Whatever its advantages from other standpoints, the full book cost cannot be used in the decision-making process.

1.3. Marginal cost

Only the marginal cost can be used in the economic decision-making and selection process (choice of investment projects, tariff policy, etc.) (2).

The marginal cost is the slope of the curve or derivative of total cost with respect to the quantity produced.

A distinction must be made between:

a) the short-run marginal cost (a few hours, a few days, a few months, etc...) which applies only for a given production capacity immediately available;

b) the long-run marginal cost which applies in the long-term (for example, a year, several years, or sometimes several decades, etc...); this marginal cost is the derivative of total cost with respect to production capacity, it being assumed that this capacity is utilised in full.

The horizon selected of around the year 2000 in this particular case corresponds to the long run, so no account will be taken of the short-run marginal cost and the following analysis will solely concern the long-run marginal cost.

1.4. Marginal cost, selling price, "contribution margin", balanced budget

The marginal cost establishes only the lower limit or "floor" of the selling price. The amount by which the selling price exceeds the marginal cost may be called the "contribution margin". If a balanced budget is to be achieved, the sum of all contribution margins must equal or exceed the sum of non-marginal costs (2).

1.5. Calculation of the marginal cost

The marginal cost is the slope of a curve or the derivative of a function, so the constant terms are irrelevant since they vanish upon differentiation.

When specifically calculating the long-run marginal cost, account it taken only of the additional costs entailed by the optimal or integral use of an additional capacity. In order to resolve the problem of discontinuities, the "step" or interval between the new higher capacity and the initial capacity is defined in real, practical and indivisible units of a certain size, such as an additional pair of trains per day.

Since our aim here is solely to ascertain orders of magnitude, it seems reasonable to make a few simplifying assumptions at the risk of what it is hoped is an acceptable degree of inaccuracy.

More particularly, it will first be assumed that all the railway's fixed installations and organisational factors are given and offer enough surplus capacity to accommodate the proposed additional services. Although this is not strictly true, it is not an unduly exaggerated or Machiavellian assumption. In other words, it is assumed that the proposed services will call for no changes in the railway's fixed installations and organisational factors, so there is no point in taking account of their cost. The only costs that will be taken into account are those which vary with the additional sevices planned (investment or costs relevant to depreciation and interest, and operating costs including maintenance).

The following costs in particular are among those which vary with the volume of transport in question:

a) Driving crews of main-line locomotives (wages, bonuses and allowances, social insurance contributions, other direct and indirect costs);

b) Tractive energy (oil for diesel locomotives; electric power delivered to high-voltage terminals of substations);

c) Rolling stock:

c 1) Locomotives:

-- average annual depreciation and interest payments;

-- maintenance (average long-term costs: repairs and scheduled overhauls throughout the locomotive's life);

c 2) Wagons:

-- average annual depreciation and interest payments;

-- maintenance (average long-term costs: repairs and scheduled overhauls throughout the wagon's life);

d) Collection and distribution of wagons by pick-up goods trains, shunting, marshalling of wagons, train formation, etc.

1.6. Outline of the report

We shall begin by calculating or estimating the orders of magnitude for particular types of transport operation in Western continental Europe in 1984.

The cost will be calculated in Swiss francs at the level of prices as at early 1984 (3).

We shall then calculate or estimate the orders of magnitude of costs for similar transport operations which might be carried out in about the year 2000 and, since we do not have the gift of prophecy, we shall have to make assumptions. It does not seem unreasonable to assume that today's advanced technologies will probably be in current use in 15 years' time, but we explicitly reserve the right to be mistaken. For technical reasons, no account will be taken of the future rate of inflation. In other words, we shall imagine a year 2000 with the 1984 price levels. On the assumption that the purchasing power of the monetary unit remains constant, we shall adopt a discounting rate of 3 per cent.

Strictly speaking, a discounted balance sheet should be drawn up for each type of transport operation and for each variant but, in order to obtain orders of magnitude which are less abstract and more straightforward than discounted totals, we have preferred to calculate annual averages.

It must be stressed that the following calculations provide only orders of magnitude -- the absolute levels depend on the values assigned to the data --, so it would be wrong to attribute to them an importance which they do not have. What concerns us here is not the absolute level of costs but the future trend in costs. We are looking for a vector; the co-ordinates of the origin of the vector are of little interest.

We shall compare the hypothetical results for the year 2000 with those for 1984. A number of differences will be noted and we shall try to interpret them.

1.7. The explanatory variables

The long-run marginal cost defined above is in each particular case a function of the many explanatory variables, notably:

-- Starting point of the transport operation;

-- Terminal point;

-- Route to be taken;

-- Characteristics of goods to be carried (type; nature: liquid, solid, gaseous; in bulk or packaged; density; stackability; etc.);

-- Usual size of consignments to be carried;

-- Flow (quantity to be carried per unit of time);

-- Regularity or irregularity of flow over time;

-- Period allowed for transport; method of forwarding;

-- Type of wagon to be used;

-- Load factor (ratio of the amount of goods per wagon to the capacity of the wagon in tonnes);

-- Empty run factor (ratio of empty to laden runs of wagon; alternatively, the ratio of empty to total runs of wagon);

-- Organisation of forwarding (shunting operations, use of pick-up goods trains and through trains between successive shunting operations, station stops and marshalling, train formation, etc.);

-- Type of traction; characteristics of locomotives to be used;

-- Maximum speed, timetable, average running speed and commercial speed;

-- Turn-round time of wagons to be used;

-- Where applicable, simultaneous use of fixed installations (lines, stations) for other transport operations (passenger traffic, for example) and the relevant interaction;

-- And so on.

There is no general average marginal cost or, put another way, a general average marginal cost would make no sense. The only significant and useful marginal cost is that defined in each particular case in terms of all the relevant variables.

It is impossible to imagine all the possible combinations of variables and the different values that they may be assigned.

To avoid submerging ourselves in masses of data, we shall be obliged to confine ourselves here to a selection of marginal costs. We shall try to ensure that the selection is as far as possible representative of the commonest types of rail freight operation (4).

1.8. Selection of costs

The selection consists of the following types of transport operation in 1984 and in 2000:

-- Carriage in individual wagons by ordinary goods service;

-- Carriage in individual wagons by fast or special goods service;

-- Combined transport;

-- Heavy block train with programmed turn-round.

For the year 2000 we have also included a few variants such as the fast light block train with programmed turn-round.

We shall give the calculations in detail so that the reader may, if he wishes, see for himself the effects of changes in the variables and, if necessary, correct our errors.

All the examples are calculated for a haul of 500 km, far longer than the average haul for goods transport operations in Western Europe in general. However, it is also a distance over which the railways should be able to make the most of their advantages in terms of quality of service and cost. It was for this reason that the distance was selected.

We have ascertained that, irrespective of the distance, the estimated variations in cost between 1984 and the year 2000 for the different types of transport operation examined below have the same relative order of magnitude and bear the same signs, so our conclusions are not a function of the distance.

2. COSTS SELECTED FOR 1984

2.1. Carriage in individual wagons by ordinary goods service

To begin with we shall examine a 1984 transport operation using ordinary goods service (or slow freight service) in individual wagons over a distance of 500 km.

The case of specially reserved block train services, i.e. non-scheduled services, is very similar and may be taken under the same heading. The calculations may be set out as follows:

2.1.1. Description

The reference "step" or interval selected for the calculation of a long-run marginal cost corresponds to a pair of goods trains providing a daily through service between two marshalling yards.

The other data are as follows:

-- Carriage by individual complete wagon-loads;

-- Length of haul: 500 km, of which:

. by through train between two marshalling operations: 400 km;

. by pick-up goods train between the private siding or station or departure and the first marshalling operation, and from the second marshalling operation to the terminal siding or station: a total of 100 km;

-- Maximum speed of through train: 80 km/h;

-- Average running speed of through train (account being taken of any intermediate stops): 60 km/h;

-- Bogie wagons;

-- Average weight of empty wagon: 24 t;

-- Average load per wagon: 30 t;

-- Average gross weight per loaded wagon: 24 t + 30 t = 54 t;

-- Average ratio of empty to laden runs of wagons: 50 per cent;

-- Average ratio of empty runs to total runs of wagons: 33 per cent;

-- Average formation of through trains:

	16	loaded wagons
+	8	empty wagons
total	24	wagons

-- Tonnage hauled by a through train (gross tonnage hauled -- GTH):

-- 16 wagons x 54 t/wagon =	864 GTH
8 wagons x 24 t/wagon =	192 GTH
	1 056 GTH

-- 1 pair of through trains per day;

-- 250 days in service per year (for example: the 265 days of the year less 52 Saturdays, 52 Sundays and 11 holidays or days off for other reasons);

-- Freight tonnage carried (total for both directions):

2 trains/day x 16 wagons/train x 30 t/wagon = 960 t/day

and

960 t/day x 250 days/year = 240 000 t/year;

-- tonne-kms per year:

240 000 t/year x 500 km = 120 x 10^6 NTK
(net tonne-kms or tonne-kms of goods).

2.1.2. Cost calculations

a) Driving crews of locomotives of through trains (wages, bonuses and allowances, social insurance contributions, other direct and indirect costs): SF 280 000/year;

b) Tractive energy:

-- Average annual kilometrage of through trains:

two trains/day x 250 days/year x 400 km/train = 200 000 train-kms/year;

-- In addition, kilometrage of light locomotives, etc.: 6 000 locomotive-kms/year;

-- Electric traction of through trains;

-- Annual consumption at high-voltage terminals of substations:

200 000 train-kms/year x 16 kWh/train-km = 3.2 x 10^6 kWh/year

plus

6 000 locomotive-kms/year x 3 kWh/locomotive-km

= 0.018 x 10^6 kWh/year

total 3.218 x 10^6 kWh/year

-- Average cost: SF 0.12/kWh

-- Annual cost:

3.218 x 10^6 kWh/year x SF 0.12/kWh = SF 386 160/year

c) Rolling stock:

c 1) Locomotives:

-- Depreciation and interest payments:

-- minimum: 1 locomotive in service;

-- maximum: 2 locomotives in service;

-- probable average: 1.5 locomotives in service;

-- reserve: 10 per cent;

-- ratios of availability (number of locomotives in working order available to the railway in relation to the total number of locomotives including those out of service for maintenance, repair and overhauls and waiting for maintenance, repair and overhauls): 90 per cent;

-- number of locomotives:

$$1.5 \times \frac{1}{1 - 0.1} \times \frac{1}{0.9} = 1.8 \text{ locomotives;}$$

-- purchase price of an electric locomotive: SF 4.5×10^6/locomotive;

-- total purchase price: SF 4.5×10^6/locomotive x 1.8 locomotives = SF 8.1×10^6;

-- lifespan of locomotive: 30 years;

-- conventional straight-line method of depreciation and interest payments: SF 413 262/year;

-- Maintenance, repairs, overhauls:

-- annual kilometrage: 206 000 locomotive-kms/year;

-- average unit costs of maintenance, repairs and overhauls in the long term:
SF 0.80/locomotive-km;

-- annual costs: SF 0.80/locomotive-km x 206 000-kms/year = SF 164 800/year;

c 2) Wagons:

-- Depreciation and interest payments:

-- loaded wagons per day (250 days/year): 16 loaded wagons/train x 2 trains/day = 32 loaded wagons per day;

-- average turn-round time of a wagon: 5 days (this is the average turn-round time in the 250 days out of the 365 in the year; the corresponding average turn-round time is therefore:

$$\frac{365}{250} \times 5 = 7.3 \text{ days in the year);}$$

-- reserve: 10 per cent;

-- ratio of availability: 90 per cent;

-- number of wagons: 32 loaded wagons/day x 5 days/wagon $\times \frac{1}{1 - 0.1} \times \frac{1}{0.9}$ = 192 wagons

-- unit purchase price: SF 0.11 x 10^6/wagon;

-- total purchase price:
192 wagons x SF 0.11 x 10^6/wagon = SF 21.12 x 10^6;

-- lifespan: 30 years;

-- annual depreciation and interest: SF 1 078 000/year;

-- Maintenance:

-- annual kilometrage:

2 trains/day x 24 wagons/train x 250 days/year x 500 km = 6 x 10^6 wagon-km/year;

-- average unit costs: SF 0.10/wagon-kms;

-- annual costs: SF 0.10/wagon-km x 6 x 10^6 wagon-kms/year = SF 600 000/year.

d) Collection and distribution of wagons at marshalling yards, pick-up trains, shunting operations, marshalling and train formation; a summary analysis gives a provisional average order of magnitude of at least SF 150 per wagon, or for one year: 2 trains/day x 24 wagons/train x 250 days/year x SF 150/wagon = SF 1 800 000 year.

2.1.3. Recapitulation

	SF 10^6/year
a) Driving crews of through trains	0.280
b) Tractive energy	0.386
c) Rolling stock:	
c 1) locomotives:	
-- depreciation and interest	0.413
-- maintenance	0.165
c 2) wagons:	
-- depreciation and interest	1.078
-- maintenance	0.600
d) Collection, distribution, shunting	1.800
Long-run costs:	4.722

Long-run marginal costs with respect to the tonne-km of goods carried:

$$\frac{4.722 \times \text{SF } 10^6 \text{ year}}{120 \quad \times \quad 10^6 \text{ NTK/year}} = \text{SF } 0.039 \text{ NTK}$$

Long-run marginal costs with respect to the tonne of goods carried for a distance of 500 km:

$$\frac{4.722 \times \text{SF } 10^6 \text{ year}}{240\ 000 \text{ net tonnes/year}} = \text{SF } 19.67 \text{ net tonne}$$

2.2. Carriage in individual wagons by fast goods service

2.2.1. Description

The reference "step" or interval selected for the specific calculation of the long-run marginal cost corresponds to a pair of through goods trains providing a daily fast or special goods service between two marshalling yards.

The other data are as follows:

-- Carriage by individual complete wagon-loads;

-- Length of haul: 500 km (of which 400 km between the two marshalling operations);

-- Maximum speed of fast through train: 100 km/h;

-- Average running speed: 75 km/h;

-- Bogie wagons;

-- Average weight of empty wagon: 24 t;

-- Average load per wagon: 25 t;

-- Average gross weight per loaded wagon: 24 t + 25 t = 49 t;

-- Average ratio of empty runs of wagons to total runs: 33 per cent;

-- Average formation of through train:

		10 loaded wagons
	+	5 empty wagons
total		15 wagons

-- Average tonnage hauled by a through train (gross tonnage hauled -- GTH)

10 wagons x 49 t wagon	=	490 GTH
5 wagons x 24 t/wagon	=	120 GTH
		610 GTH

-- 1 pair of through trains per day;

-- 250 days in service per year;

-- Freight tonnage carried (total for both directions):

2 trains/day x 10 wagons/train x 25 t/wagon = 500 t/day

and

500 t/day x 250 days/year = 125 000 t/year;

-- Tonne-kms per year:
125 000 t/year x 500 km = 62.5 x 10^6 NTK

2.2.2. Cost calculations

a) Driving crews of locomotives for through trains: SF 192 000/year;

b) Tractive energy:

-- Annual kilometrage of through trains:
2 trains/day x 250 days/year x 400 km/train
= 200 000 train-kms/year;

-- Light locomotives: 6 000 locomotive-kms/year;

-- Electric traction of through trains;

-- Power consumption:

200 000 train-kms/year x 15 kWh/train-kms = 3 x 10^6 kWh/year

+ 6 000 locomotive-kms x kWh/locomotive-kms

= 0.018 x 10^6 kWh/year
total 3.018 x 10^6 kWh/year;

-- Average cost: SF 0.12/kWh;

-- Annual cost:
3.018 x 10^6 kWh/year x SF 0.12 kWh = SF 362 160/year

c) Rolling stock:

c 1) Locomotives:

-- Depreciation and interest payments:

-- 1.5 locomotives in service;

-- reserve: 10 per cent;

-- availability: 90 per cent;

-- number of locomotives: 1.8;

-- purchase price of an electric locomotive: SF 4.5 x 10^6/locomotive;

-- total purchase price: SF 4.5 x 10^6/locomotive x 1.8 locomotive = SF 8.1 x 10^6;

-- lifespan: 30 years;

-- depreciation and interest payments: SF 413 262/year;

-- Maintenance:

-- annual kilometrage: 206 000 locomotive-kms/year;

-- average unit costs: SF 0.80/locomotive-km;

-- annual costs: SF 0.80/locomotive-km x 206 000 locomotive-kms/year = SF 164 800/year.

c 2) Wagons:

-- Depreciation and interest payments:

-- loaded wagons per day: 10 loaded wagons/train x 2 trains/day = 20 loaded wagons/day;

-- average turn-round time: 5 days (7.3 days in the year);

-- reserve: 10 per cent;

-- availability: 90 per cent;

-- number of wagons: 20 loaded wagons/day x 5 days/wagon x 1.2 = 120 wagons;

-- unit purchase price: SF 0.11 x 10^6/wagon;

-- total purchase price: 120 wagons x SF 0.11 x 10^6/wagon = SF 13.2 x 10^6;

-- lifespan: 30 years;

-- depreciation and interest payments: SF 673 464/year;

-- Maintenance:

-- annual kilometrage: 2 trains/day x 15 wagons/train x 250 days/year x 500 km = 3.75 x 10^6 wagon-kms/year;

-- unit costs: SF 0.10/wagon-km;

-- annual costs: SF 0.10/wagon-km x 3.75 x 10^6 wagon-kms/year = SF 375 000/year;

d) Pick-up train runs, shunting operations, etc.:
2 trains/day x 15 wagons/train x 250 days/year x SF 150/wagon
= SF 1 125 000/year.

2.2.3. Results

	SF 10^6/year
a) Driving crews	0.192
b) Tractive energy	0.362
c) Rolling stock:	
c 1) locomotives:	
-- depreciation and interest payments	0.413
-- maintenance	0.165
c 2) wagons:	
-- depreciation and interest payments	0.673
-- maintenance	0.375
d) Collection, repairs, shunting operations, etc.	1.125
total	3.305

Long-run marginal costs with respect to the net tonne-kilometre of goods carried: SF 0.053 NTK.

Long-run marginal costs with respect to the net tonne of goods carried for a distance of 500 kms: SF 26.44/net tonne.

2.3. Combined transport

The carriage of ISO intercontinental containers or European continental swap bodies ("maxicadres") on flat wagons and of semi-trailers on pocket wagons between terminal stations has characteristics similar to those of fast or special goods transport between marshalling yards. There is however the following difference. The rail operations relevant to the collection and distribution of wagons and the shunting and marshalling of wagons are replaced in combined transport by the transshipment and storage operations in terminals and by the terminal hauls by road (collection and distribution of containers and semi-trailers).

As an initial approximation, pending further information, recent calculations showed that the costs of terminal operations (transshipment, storage) and terminal hauls by road in combined transport would seem to be very broadly of the same order of magnitude on average as those of the various shunting operations and the collection and distribution of wagons going to and from the loading and unloading of sidings in stations and private sidings. For this comparable cost, however, combined transport has the advantage of enabling the railways to offer a door-to-door service in the same way as the road haulier.

2.4. Block train with programmed turn-round

2.4.1. Description

What is involved here is an on-going service programmed over a very long period (number of years or even decades in principle) with intensive use of rolling stock (the supply of coal to a power station is the usual example).

As a general rule, the terminal shunting operations relevant to these block trains take place on the private sidings of the consignors and consignees. With certain exceptions, the clients carry out the operations themselves. In any event, the operations are usually of the simplest kind.

The reference "step" or interval selected for the specific calculation of the long-run marginal cost corresponds to a pair of block trains (loaded train in one direction and empty train in the other) providing a daily service between two private sidings.

The other data are as follows:

-- Length of haul: 500 kms;

-- Maximum speed: 80 km/h;

-- Average running speed:

. loaded: 50 km/h
. empty: 60 km/h;

-- Bogie wagons;

-- Weight of empty wagon: 24 t;

-- Load per wagon: 56 t;

-- Gross weight of loaded wagon: 80 t;

-- Ratio of empty to loaded runs of wagons: 100 per cent;

-- Ratio of empty runs to total runs of wagons: 50 per cent;

-- Formation of train: 20 wagons;

-- Tonnage hauled by a train (gross tonnage hauled -- GTH):

. loaded: 1 600 GTH
. empty: 480 GTH;

-- One pair of trains per day;

-- 250 days in service per year;

-- Freight tonnage carried per year:
20 wagons/day x 56 t/wagon x 250 days/year = 280 000 net tonnes/year;

-- Tonne-kms per year:
280 000 net tonnes/year x 500 kms = 140 x 10^6 NTK.

2.4.2. Cost calculations

a) Driving crews of locomotives: SF 384 000/year;

b) Tractive energy:

-- Daily kilometrage of trains:

500 kms loaded
+ 500 kms empty;

-- Annual kilometrage of trains:
500 kms/day x 250 days/year = 125 000 train-kms loaded/year;

and

500 kms/day x 250 days/year = 125 000 train-kms empty/year;

-- Kilometrage of light locomotives:
25 000 locomotive-kms/year;

-- Electric traction;

-- Annual consumption at high-voltage terminals at substations:

125 000 train-kms loaded/year x 19 kWh/train-km
= 2.375 x 10^6 kWh/year;

125 000 locomotive-kms/year x 13 kWh/locomotive-km
= 1.625 x 10^6 kWh/year;

25.000 locomotives/year x 3 kWh/locomotive-km
= 0.075 x 10^6 kWh/year;

total 4.075 x 10^6 kWh/year

-- Average cost: SF 0.12/kWh;

-- Annual cost:

4.075 x 10^6 kWh/year x SF 0.12/kWh = SF 489 000/year.

c) Rolling stock:

c 1) Locomotives:

-- Depreciation and interest payments:

-- 2 locomotives in service;

-- reserve: 10 per cent;

-- availability: 90 per cent;

-- number of locomotives: 2 x 1.2 = 2.4;

-- purchase price of an electric locomotive:
SF 4.5 x 10^6/locomotive;

-- total purchase price:
SF 4.5 x 10^6/locomotive x 2.4 locomotives = SF 10.8 x 10^6;

-- lifespan: 30 years;

-- depreciation and interest payments:
SF 551 016/year;

-- Maintenance:

-- annual kilometrage: 275 000 locomotive-kms/year;

-- unit costs: SF 0.80/locomotive-km;

-- annual cost: SF 0.80/locomotive-km x 275 000 locomotive-kms/year = SF 220 000/year.

c 2) Wagons:

-- Depreciation and interest payments:

-- loaded wagons per day: 20 wagons/day;

-- turn-round time: 3 days (4.4 days in the year);

-- reserve: 10 per cent;

-- availability: 90 per cent;

-- number of wagons:
20 wagons/day x 3 days/wagon x 1.2 = 72 wagons;

-- unit purchase price: SF 0.11 x 10^6/wagon;

-- total purchase price:
72 wagons x SF 0.11 x 10^6/wagon = SF 7.92 x 10^6;

-- lifespan: 20 years;

-- depreciation and interest payments: SF 532 382/year;

-- Maintenance:

-- annual kilometrage: 2 trains/day x 20 wagons/train x 250 days/year x 500 kms = 5 x 10^6 wagon/kms/year;

-- unit costs: SF 0.10/wagon-km;

-- annual costs:
5 x 10^6/wagon-kms x SF 0.10/wagon-km = SF 500 000/year.

2.4.3. Results

		SF 10^6/year
a) Driving crews		0.384
b) Tractive energy		0.489
c) Rolling stock:		
c 1) locomotives:		
-- depreciation and interest payments		0.551
-- maintenance		0.220
c 2) wagons:		
-- depreciation and interest payments		0.532
-- maintenance		0.500
	total	2.676

Long-run marginal costs with respect to the net tonne-kilometre of goods carried: SF 0.0191 NTK.

Long-run marginal costs with respect to the tonne of goods carried for a distance of 500 kms: SF 9.56/net tonne.

3. SELECTION OF FUTURE COSTS

3.1. Preliminary remarks

In the western world in general and in Western Europe in particular the tertiary sector will in future continue to grow faster than the primary and secondary sectors. The share of overall traffic accounted for by heavy raw materials will continue to diminish and trade in goods will increasingly consist of intermediate and finished products. Average load factors will therefore tend to diminish. Moreover, consignors and consignees of goods will attach increasing importance to stringent stock management and to the reduction of stockholdings. They will also continue to become more and more demanding as regards the frequency, rapidity and preciseness of transport services.

In these circumstances, it has here been assumed in particular that:

-- Through trains providing ordinary goods services will in future travel at a maximum speed of 100 km/h (instead of 80 km/h as at present);

-- Through trains providing fast or special goods services will in future travel at a maximum speed of 120 km/h (instead of 100 km/h as at present).

On the other hand, it would seem reasonable to assume that there will be no radical changes with respect to the collection of wagons to be sent to marshalling yards and the distribution of wagons leaving the yards or as regards the shunting and train formation operations.

3.2. Carriage in individual wagons by ordinary goods service

The result of increasing the maximum speed from 80 km/h to 100 km/h will be, all other factors being equal, lower driving crew costs and higher tractive energy costs, with no change in the long-run marginal cost. But can it be assumed that all other factors will be equal?

Given the uncertainty, we thought it advisable to consider two variants:

- For the calculations in paragraph 3.2.1, the average load per wagon remains the same as in 1984 at 30 tonnes of goods;
- For the calculations in paragraph 3.2.2, it is assumed that the average load per wagon will be 25 tonnes of goods (instead of 30 tonnes).

As in all industrialised countries, the structure of demand is changing in all West European countries. The proportion of raw materials and intermediate products carried in bulk is diminishing, as is the proportion of heavy processed products of relatively high density, while the proportion of intermediate and finished products, both light and cumbersome, is increasing. In these circumstances, it may very well be that the average load per wagon will diminish (not in volume but in tonnage) unless the length, surface area and volume of wagons is increased to meet the requirements.

3.2.1. First variant: average load per wagon unchanged

Description

With reference to paragraph 2.2.1, the only changes relate to the maximum speed (100 km/h instad of 80 km/h) and the average speed (75 km/h instead of 60 km/h).

Results

	SF 10^6/year
a) Driving crews	0.192
b) Tractive energy	0.554
c) Rolling stock:	
c 1) locomotives:	
-- depreciation and interest payments	0.413
-- maintenance	0.165
c 2) wagons:	
-- depreciation and interest payments	1.078
-- maintenance	0.600
d) collection, distribution, shunting	1.800
total	4.802

Long-run marginal costs with respect to the net tonne-kilometre of goods carried: SF 0.040/NTK.

Long-run marginal costs with respect to the tonne of goods carried for a distance of 500 kms: SF 20.00/net tonne.

3.2.2. Second variant: reduction of average load per wagon

Description

With reference to paragraph 2.2.1, the following changes are to be noted:

-- Maximum speed: 100 km/h (instead of 80 km/h);

-- Average speed: 75 km/h (instead of 60 km/h);

-- Average load per wagon: 25 t (instead of 30 t);

-- Average gross weight per loaded wagon: 24 t + 25 t = 49 t;

-- Formation of through train and gross tonnage hauled:

18 loaded wagons x 49 t/wagon	=	882 GTH
+9 empty wagons x 24 t/wagon	=	216 GTH
27 wagons		1 098 GTH

-- Freight tonnage carried:
2 trains/day x 18 loaded wagons/train x 25 t/wagon x 250 days/year = 225 000 net tonnes/year;

-- Tonne-kms per year:
225 000 net tonnes/year x 500 km = 112.5 x 10^6 NTK/year.

Results

	SF 10^6/year
a) Driving crews	0.192
b) Tractive energy	0.578
c) Rolling stock:	
c 1) locomotives:	
-- depreciation and interest payments	0.413
-- maintenance	0.165
c 2) wagons:	
-- depreciation and interest payments	1.212
-- maintenance	0.675
d) collection, distribution, shunting	2.025
total	5.260

Long-run marginal costs with respect to the tonne-kilometre of goods carried: SF 0.047/NTK.

Long-run marginal costs with respect to the tonne of goods carried for a distance of 500 kms: SF 23.38/net tonne.

3.3. Carriage in individual wagons by fast goods service

3.3.1. Description

With reference to paragraph 2.2.1, only the following changes are to be noted:

-- Maximum speed: 120 km/h (instead of 100 km/h);

-- Average speed: 90 km/h (instead of 75 km/h).

3.3.2. Results

	SF 10^6/year
a) Driving crews	0.165
b) Tractive energy	0.422
c) Rolling stock:	
c 1) locomotives:	
-- depreciation and interest payments	0.413
-- maintenance	0.165
c 2) wagons:	
-- depreciation and interest payments	0.673
-- maintenance	0.375
d) collection, distribution, shunting	1.125
total	3.338

Long-run marginal costs with respect to the tonne-kilometre of goods carried: SF 0.053/NTK.

Long-run marginal costs with respect to the tonne of goods carried for a distance of 500 km: SF 26.70/net tonnes.

3.4. Combined transport

For the time being it would seem reasonable to assume that the technology and organisation of combined transport using containers and semi-trailers should not change radically over the next ten to fifteen years, so the costs of combined transport in about the year 2000 are likely to be about the same as today (at constant prices).

3.5. Heavy block train with programmed turn-round

It would seem that the system of carrying heavy freight by block train with programmed turn-round will not have changed to any great extent in 10 to 15 years' time so, at constant prices, in the year 2000 it should cost about the same as today.

In some cases, an increase from 20 t to 22.5 t in the maximum weight per axle for loaded wagons would mean that the same amount of freight can be carried by fewer wagons. All other factors being equal, this will result in savings of about 5 per cent. It is interesting to consider the case in which, primarily as a result of the use of automatic coupling, it should be possible to put into service much heavier block trains than those considered in paragraph 2.4.

3.5.1. Description

With reference to paragraph 2.4.1, only the following changes are to be noted:

-- Formation of a train: 40 wagons;

-- Tonnage hauled:

-- loaded: 40 wagons/train x 80 t/wagon = 3 200 GTH
-- empty: 40 wagons/train x 24 t/wagon = 960 GTH

-- Freight tonnage carried per year:
40 wagons/train x 56 t/wagon x 250 days/year = 560 000 t/year

-- Tonne-kms per year:
560 000 t/year x 500 km = 10^6 NTK;

-- The train is hauled by two locomotives (multiple-unit working).

3.5.2. Results

	SF 10^6/year
a) Driving crews	0.384
b) Tractive energy	0.880
c) Rolling stock:	
c 1) locomotives:	
-- depreciation and interest payments	1.102
-- maintenance	0.440
c 2) wagons:	
-- depreciation and interest payments	1.065
-- maintenance	1.000
total	4.871

Long-run marginal costs with respect to the net tonne-kilometre of goods carried: SF 0.0174/NTK.

Long-run marginal costs with respect to the tonne of goods carried for a distance of 500 kms: SF 8.70/net tonne.

The cost would be reduced by about 5 per cent by increasing the maximum weight per axle of loaded wagons from 20 t to 22.5 t.

3.6. Fast light block train with programmed turn-round

When we think of a block train at present, it is almost always a train as heavy as possible and usually quite slow.

It is worthwhile here to examine the advisability for the future of improving the quality of service and meeting the requirements of certain clients by providing fast light block trains with programmed turn-round over the long term which will not be designed to carry heavy goods but regular consignments of intermediate and finished products which have a low density and high value-added per unit of weight and volume.

3.6.1. Description

The reference "step" or interval selected for the specific calculation of the long-run marginal cost corresponds to a pair of fast light block trains (loaded in one direction and empty in the other) providing a daily through service between two private sidings in accordance with a long-term programme agreed between the railway and its clients.

We shall examine two variants: one with a 10-wagon train (variant A) and the other with a 5-wagon train (variant B).

The characteristics are as follows:

-- Length of haul: 500 km;

-- Maximum speed: 120 km/h;

-- Average speed: 90 km/h;

-- Bogie wagons;

-- Average weight of empty wagon: 24 t;

-- Average load of wagon: 25 t;

-- Gross average weight of loaded wagon: 49 t

	variant A	variant B
-- Formation of train	10 wagons	5 wagons

-- Tonnage hauled by train:

-- loaded	490 GTH	245 GTH
-- empty	240 GTH	120 GTH

-- One pair of trains per day (outgoing loaded, return empty);

-- 250 days in service per year;

	variant A	variant B
-- Tonnage carried per day	250 t/day	125 t/day
-- Tonnage carried per year	62 500 t/year	31 250 t/year
-- Tonne-kms per year	31.25 x 10^6 NTK	15.265 x 10^6 NTK

3.6.2. Cost calculations

a) Driving crews: SF 165 x 10^6/year;

b) Tractive energy:

-- Daily kilometrage of trains:

-- loaded:	500 train-kms/day
-- empty:	500 train-kms/day

-- Annual kilometrage of trains:

-- loaded:	125 500 train-kms/year
-- empty:	125 500 train-kms/year;

-- Kilometrage of light locomotives: 25 000 locomotive-kms/year;

-- Electric traction;

-- Unit consumption at high-voltage terminals of substations:

	variant A	variant B
-- kWh/train-km loaded	15	9
-- KWh/train-km empty	9	6.5
-- kWh/locomotive-km	3	

-- Annual consumption, 10^6 kWh/year:

-- loaded trains	1.875	1.125
-- empty trains	1.125	0.812
-- light locomotives	0.075	0.075
total	3.075	2.012

-- Unit cost: SF 0.12/kWh

	variant A	variant B
-- Annual cost, SF 10^6/year	0.369	0.241

c) Rolling stock:

c 1) Locomotives:

-- Depreciation and interest payments:	variant A	variant B
-- 1.5 locomotives in service;		
-- reserve: 10 per cent;		
-- availability: 90 per cent;		
-- number of locomotives: 1.5 x 1.2 = 1.8;		
-- purchase price of an electric locomotive: SF 4.5 x 10^6/locomotive x 1.8 = SF 8.1 x 10^6;		
-- lifespan: 30 years;		
-- depreciation and interest payments: SF 10^6/year;		0.413

-- Maintenance:

-- annual kilometrage: 275 000 locomotive-kms;

-- unit cost: SF 0.80/locomotive-km;

-- annual cost: SF 10^6/year 0.220

c 2) Wagons:

-- Depreciation and interest payments:	variant A	variant B
-- loaded wagons per day	10	5
-- turn-round time in days	3	3
-- reserve: 20 per cent		
-- availability: 90 per cent		
-- number of wagons	40	20
-- price of a wagon: SF 0.11 x 10^6/wagon;		
-- total price, SF 10^6	4.4	2.2
-- lifespan: 15 years		
-- depreciation and interest payments, SF 10^6/year	0.369	0.184

-- Maintenance:		
-- annual kilometrage of wagons, 10^6 wagon-kms/year	2.5	1.25
-- unit costs: SF 0.10/wagon-km		
-- annual costs, SF 10^6/year	0.250	0.125

3.6.3. Results

	$SF\ 10^6$/year	
	variant A	variant B
a) Driving crews	0.165	0.165
b) Tractive energy	0.369	0.241
c) Rolling stock:		
c 1) locomotives:		
-- depreciation and interest payments	0.413	0.413
-- maintenance	0.220	0.220
c 2) wagons:		
-- depreciation and interest payments	0.369	0.184
-- maintenance	0.250	0.125
total	1.786	1.348
Marginal costs:		
SF/NTK	0.057	0.086
SF/net tonne	28.58	43.14

4. COMPARISON OF RESULTS

The purpose of Section 2 was to calculate orders of magnitude of long-run marginal costs for a selection of freight transport operations by rail in 1984, while Section 3 aimed to do the same for a comparable selection under the conditions likely to prevail in about the year 2000. A comparison of the results of the two sets of calculations is set out in the following table:

	Costs, SF/NTK		
	1984	2000	percentage difference
1. Carriage in individual wagons by ordinary goods service	0.039	0.040 or 0.047	+ 1.7% / +21%
2. Carriage in individual wagons by fast goods service	0.053	0.053	0
3. Combined transport	~0.05	~0.05	~0

	Costs, SF/NTK		
	1984	2000	percentage difference
4. Block trains with programmed turn-round	0.019	0.0191 or	0
		0.018 or	- 5%
		0.0174 or	- 9%
		0.016	- 14%
5. Fast light block trains with programmed turn-round		0.057 to 0.086	

Subject to all of the reservations which are called for when theorising in this way, the following observations may be made:

If the average load per wagon remains the same, the cost of an ordinary goods service in individual wagons will not change appreciably, but the running speed will increase.

A fast or special goods service in individual wagons will cost about the same in future as at present but the running speed will increase.

The cost of carriage in bulk by heavy block trains with programme turn-round might diminish somewhat in the future.

Although the calculations would have to be verified, the railways might be able to offer to fairly large-scale regular customers a number of specific "tailor-made" or "individual" services in the form of fast light block trains at a marginal cost that might make them competitive.

5. INNOVATION, IMPROVED MANAGEMENT AND TECHNICAL PROGRESS

We have so far left aside a whole series of factors which are difficult to quantify but have a far from negligible influence on costs such as, in particular, improvements in management and technical progress up to the end of the century. The following comments may be made in this connection:

5.1. Purchase of certain rolling stock

International tendering and purchases from the most efficient suppliers on the world market might serve to bring down the prices of wagons, at any rate provided continental and world-wide agreements do not frustrate international competition.

5.2. Progress in electronics

The more general use of sophisticated electronic equipment in the construction of electric locomotives will not reduce their price, but an appreciable reduction in maintenance costs is to be expected. Moreover, the fact that the locomotives of the future will all combine the characteristics of tractive force and speed should improve the efficiency of their use and, in the last analysis, mean that fewer are required.

5.3. Availability of rolling stock

The ratios of availability of locomotives and wagons used for the preceding calculations are perhaps not particularly ambitious. A number of West European railways now have rates higher than 90 per cent. Improvements in this connection might entail a reduction in investment or in the cost of depreciation and interest payments.

5.4 Wagon turn-round time

In Western Europe, wagon turn-round times are not as high as in the United States but higher than in the USSR and China, whereas average distances for the carriage of freight are much higher in North America, USSR and China than in Europe. It is true that the western world's decentralised mixed economies do not use the same stringent methods as the USSR and China to speed up loading and unloading operations. It is also a fact that traffic flows on the main railway lines in Europe are but a fraction of those in the USSR and China, which means that the length of time wagons spend in marshalling yards can be cut. Lastly, it is true that the proportion of block trains with programmed turn-round in the USSR and China is much higher than in Western Europe. Nonetheless, it should be possible to reduce turn-round times in Western Europe where customs authorities in particular could help insofar as each frontier crossing now usually entails a delay of at least 24 hours. All improvements in this connection would help to reduce the stock of wagons and so lead to savings in investment or in depreciation and interest payments.

5.5 Energy cost

In the long term the price of oil, and more particularly that of energy in general, will increase at a faster rate than prices as a whole. However, will the rise in energy prices affect rail freight transport more than other modes?

Energy accounts for a relatively small proportion (roughly 10 to 20 per cent) of the long-run marginal cost of rail freight transport in 1984 and the year 2000. It should be noted, moreover, that tractive energy usually accounts for between 5 and 10 per cent of the total costs of West European railways.

In the year 2000 the railways will use electric traction for almost all through freight trains between marshalling yards. Electricity is a secondary energy obtained by converting any primary energy (liquid, solid or gaseous fuels, hydraulic or nuclear resources, etc.). Consequently, while the prices of the various interchangeable primary energies are tending to come into line, the railways do not have the same degree of dependence on oil as their competitors. From this standpoint, railway undertakings have no reason to be as pessimistic as operators of other modes. On the contrary, the situation of the railways might improve in relation to the others.

6. CONCLUSIONS

Demand and customer requirements in the year 2000 will differ from those of today, and the transport operations will not have the same structure.

Given the changes in demand, it is reasonable to assume that the railways will be offering better quality services in the year 2000 at more or less the same cost in real terms.

All the potential technical improvements, moreover, should contribute to lowering costs.

NOTES AND REFERENCES

1. Leaflets 374 and 375 -- UIC Code -- Union Internationale des chemins de fer (UIC), Paris.

2. As regards the material on marginal cost, reference may be made to the following texts in particular: Dessus, G. -- "Les principes généraux de la tarification dans les services publics" -- Document No. VI 5 du Congrès de Bruxelles de l'UNIPEDE, 1949.

   Boiteux, M. -- "La tarification des demandes de pointe: application de la théorie de la vente au coût marginal". -- Revue générale de l'éléctricité, Paris, Vol. LVIII, 1949, No. 8.

   Hutter, R. -- "Qu'est-ce que le coût marginal?" -- Revue générale des chemins de fer, Paris, February 1950, p. 53.

   Baumol et al. -- "The role of cost in the minimum pricing of railroad services:. -- The Journal of Business of the University of Chicago, Vol. XXXV, No. 4, October 1962.

   Poole, E. -- "Costs: a tool for railroad management". -- New York, 1962.

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   Suard, P., Walrave, M. -- "Eléments d'économie des transport". -- Secrétariat d'Etat aux Affaires Etrangères, Paris, 1971, Chapter IV, paragraph 41.

3. For convenience, the following table gives the exchange rates as at 30th April 1984:

Country	Exchange rate for the national currency unit against the Swiss franc (SF)	Exchange rate for the Swiss franc (SF) against the national currency unit
Federal Republic of Germany	82.60/100 DM	1.21 DM/SF
Austria	11.74/100 Sch	8.52 Sch/SF
Belgium and Luxembourg	4.05/100 BF	24.69 BF/SF
Denmark	22.60/100 DKr	4.42 DKr/SF
Spain	1.47/100 Ptas	68 Ptas/SF
Finland	38.90/100 Mk	2.57 Mk/SF
France	26.95/100 FF	3.71 FF/SF
United Kingdom	3.13/1 £	0.32 £/SF

Country	Exchange rate for the national currency unit against the Swiss franc (SF)	Exchange rate for the Swiss franc (SF) against the national currency unit
Greece	2.10/100 Dr	47.62 Dr/SF
Italy	0.134/100 L	746 L/SF
Norway	29.05/100 NKr	3.44 NKr/SF
Netherlands	73.30/100 Gld	136 Gld/SF
Portugal	1.63/100 Esc	61.35 Esc/SF
Sweden	28.05/100 SKr	3.57 SKr/SF
Yugoslavia	1.70/100 Din	58.82 Din/SF
United States	2.25/1 $	0.44 $/SF

4. The average figures for technical characteristics of freight transport are given in "International Railway Statistics" [an annual publication by the Union internationale des chemins de fer (UIC), Paris], and in particular in:

-- Table 1.22, tractive stock, available and out of service, columns 14, 15, 20 and 21 (average reserves and average ratios of availability);

-- Table 1.32, transport stock, wagons, stock available and out of service, columns 33 and 34 (reserves and average ratios of availability);

-- Table 2.13, miscellaneous averages relating to rolling stock kilometres, especially column 28 (ratio of loaded to total wagon-kilometres);

-- Table 2.4, efficiency of rolling stock use, especially column 26 (average coefficient of available wagons used, all traffic).

INLAND NAVIGATION

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SUMMARY

INTRODUCTION

The "product" that is generated by enterprises in inland navigation cannot be measured in a single dimension like tons or ton-kms. Therefore it is impossible to fix the costs per ton or per ton-km in general.

A transport performance is determined by a combination of:

-- The quantity transported;

-- The transport relation;

-- The type of commodity;

-- The type of vessel.

To gain a good insight into the costs of transport of the inland waterways industry it is worthwhile to look at the model developed by the Economic Bureau for Road and Water Transport (EBW).

The EBW cost model comprises a great deal of information concerning different sections of the Western European inland waterways transport market. The model is implemented as an interactive computer program. It is used by the Dutch transport industry and the Ministry of Transport in solving tariff problems and cost/benefit analyses, by the European Community in the market observation system to derive cost indices for international inland waterway transport, and by different private transport organisations mainly in relation to tariff problems.

At this point I wish to express my thanks for the support I received in the preparation of this paper from Drs. G.G.J. Kramer, economist at the EBW.

1. THE INLAND NAVIGATION COST STRUCTURE

In general the methodology of cost calculation is simple. First the length of the different phases of a trip has to be determined. Secondly, the costs per hour of each phase have to be ascertained, so that the costs of each phase are known. Finally, a summation of costs per phase generates the total costs of a trip. Dividing these by the quantity transported results in the costs per ton.

However, a number of sections in inland navigation can be distinguished (e.g. domestic transport, Rhine transport, international North-South transport). Also there are different types of vessels (tankers, dry cargo) and methods of propulsion (pushing, towing, self-propelling). Besides, transport circumstances may differ for types of commodities, transport relations and type of enterprise (private or public-owned shipping companies, one-vessel family-owned firms).

Through research the EBW has gained an insight into a great number of these circumstances and made these accessible in a number of cost models.

The cost models have been developed to determine the cost of all kinds of trips. By substituting the specific values of a given vessel it is possible to obtain a cost calculation "to measure". In this way alternatives concerning future cost developments can be calculated, which gives some indication concerning future cost levels for inland navigation.

The following cost models are operational:

1. Dutch domestic (self-propelled) dry cargo, capacity up to 1 500 tons;
2. Dutch domestic (self-propelled) dry cargo, capacity 1 5000 tons and over;
3. Dutch domestic (self-propelled) transport of sand and gravel;
4. International and domestic push-barge operations;
5. International North-South transport;
6. International Rhine-transport;
7. International transport of sand and gravel;
8. Tank transport.

Costs are divided into four categories:

1. Cost of capital;

2. Other fixed costs;

3. Cost of crew;

4. Cost of sailing.

Other important factors for cost calculations are:

5. Utilisation of the vessel;

6. Duration of trip phases.

1.1. Cost of capital

Cost of capital consists of depreciation and interest.

1.1.1. Depreciation

Depreciation is defined as: $\frac{\text{investment value -- scrap value}}{\text{depreciation period}}$

As a base for the investment value the replacement value has been used. However, investments are not only made in new vessels, but to a great extent through the purchase of an existing vessel. So the market price of vessels would be a good base. Because market prices tend to fluctuate rather strongly with the conjunctural situation, the insured value has been chosen as a more stable approximation.

As we know that investments are made in relatively new vessels, the insured value of vessels with an age of 10 years less than the average vessel has been taken.

In most cost models the rest value was considered to be zero. The depreciation period is different for different types of ships and depends on the age of the ship.

In Table 1 the depreciation percentages for different types of vessels are presented.

Table 1

DEPRECIATION PERCENTAGES FOR DIFFERENT CATEGORIES OF VESSELS BY AGE

Age	Tow boat	Push boat	Motor-vessel	Pushing motor-vessel	Tank motor-vessel	Dumb barge	Push barge
0-5	6	7	5	6	7	5	5
5-10	7	8.5	6	7	8.5	6	6.5
10-15	8	11	6.5	8	10	6.5	8
15-20	9.5	15.5	7.5	9.5	12	7.5	10
20-25	11.5	20	9	11.5	16	9	15
25 a.m.	13	20	10	13	20	10	20

In the Netherlands the authorities grant a subsidy for investments in capital goods, the so-called WIR-premium. If applicable the investment value is reduced with this premium.

1.1.2. Interest

In calculating the cost of interest it is assumed that only a share of the investment is financed with owned capital. The level of the share of owned capital is dependent on the size and the value of the vessel. For the level of the interest rate on owned capital, the rate on non-risk investments was used and for borrowed capital, the average rate on ships' mortgages.

The interest per year is calculated over the average invested capital during the lifetime of the vessels.

1.2. Other fixed costs

1.2.1. 50 per cent of repairs and maintenance costs are treated as fixed costs, only dependent on the size of the vessel. The other half is dependent on the degree of activity of the vessel.

1.2.2. The insurance costs are calculated as a percentage of the insured value.

1.2.3. Port-, quay-, canal- and lock levies are considered as fixed costs per year. An alternative is the situation where these costs are determined on a trip base, which means that detailed information on levies for individual ports and waterways is needed.

1.2.4. Among others, additional fixed costs include costs for administration, communication and insurance for operation. Overhead costs are taken into account for vessels that are operated in a ship-owner's company.

1.3. Crew costs

Crew costs are determined by:

-- The composition of the crew;

-- The conditions of employment;

-- The number of working hours.

The composition of the crew is derived from the minimum number of crew members according to the "Rules concerning the investigation of Rhine vessels" (see Table 2).

Table 2

MINIMUM NUMBER OF CREW MEMBERS

a) Motor-vessels, navigation at day-time

Function	Capacity (in tons)		
	up to 500	500-1 000	1 000-1 600
Captain	X	X	X
Mate			X
Sailor	X	X	X
Deck hand		X	

b) Push barge operations

Capacity of the engine	-500 hp	500-750 hp	750-1 000 hp		Over 1 000 hp	
Number of barges	1/2	1/2	1/2	3/4	1/2	3/4
Day-time navigation 16 hours	3	4	5	6	5	6
Day-time extended 18 hours	4	5	6	7	6	7
Semi-continuous navig. 20 hours	5	6	7	7	7	8
Continuous navigation 24 hours	6	7	7	8	8	8

In practice on domestic trips the calculation has been as follows:

	Day-time navigation	Continuous navigation
2 barge push boat operation		
up to 750 hp	4 men	7 men
more than 750 hp	5 men	7 men + 1 cook
4 barge push boat operation	6 men	8 men + 1 cook

The calculation of the crew cost is based on the wages and other conditions of employment in international Rhine-navigation. The costs for ships exploited in continuous navigation are based on conditions derived from individual transport firms.

1.4. Sailing costs

Sailing costs comprise the costs of propulsion and the variable part of the cost of repairs and maintenance. The costs of propulsion consist of fuel and lubricants. The use of lubricants is fixed as a percentage of the use of fuel.

The consumption of fuel is dependent on the characteristics of the vessel and the waterway. This relation is fixed in formulas in which the size of the vessel utilised, capacity and speed relative to the water determine the fuel consumption. The degree of utilisation of the capacity of the motor is also taken into account.

1.5. Ship utilisation

1.5.1. Effective hours available

The number of available exploitation days per year is determined by reducing the number of working days by days lost due to repair and maintenance or for reasons like disease, vacation etc., of the fixed crew. Multiplying the number of these days by the average number of effective hours per day, generates the number of effective hours available per year.

The available hours per year are needed to transform the fixed costs per year to costs per hour.

So the number of sailing hours per year is needed to transform the variable part of costs of repair and maintenance to costs per sailing hour.

1.5.2. Degree of loading

The degree of loading forms another aspect of the utilisation of a vessel. Because the size of the vessel and the offered quantity of commodities will not always correspond, the degree of loading is often less than 100 per cent.

1.6. Trip time

In determining the costs of a trip, the round trip is divided into phases, which are the following:

-- Unloaded navigation:

from berth while waiting for chartering to loading berth, consisting of:

-- net sailing time
-- delay due to locks and bridges
-- delay due to other circumstances;

-- Loading:

consisting of:

-- waiting before/during loading
-- net loading time
-- waiting before loaded navigation;

-- Loaded navigation:

consisting of:

-- net sailing time
-- delay due to locks and bridges
-- delay due to other circumstances;

-- Unloading:

consisting of:

-- waiting before/during loading
-- net loading time
-- waiting before loaded navigation;

-- Unloaded navigation:

from unloading berth to chartering berth, consisting of:

-- net sailing time
-- delay due to locks and bridges
-- delay due to other circumstances;

-- Waiting for chartering, idle time.

Net sailing time and delay due to locks and bridges are derived from a model of waterways that generates these times for navigation between 618 places in the Netherlands, Germany, Belgium, France and Switzerland for 8 different ship classes including 2 and 4 barge tows.

The other trip phases are determined by empirically examined relations between the duration of these phases and quantities such as capacity, lot size, geographical location and commodity.

For the transport of sand and gravel different trip times are used. In this market section it is assumed that after unloading the vessels return empty in the opposite direction to the original loading berth (shuttle operations). This is contrary to other transports where an empirically determined average unloaded trip is assigned to each loaded trip.

Because of the great diversity in push-barge operations it has not been possible to calculate a reliable average unloaded trip.

2. TRENDS IN COSTS OF INLAND NAVIGATION

The cost elements described are subject to change. For a number of cost-determining categories we will look into developments in the past and foreseeable trends for the future.

To be distinguished are general trends which affect cost levels and specific trends concerning isolated cost elements.

2.1. General trends

2.1.1. Demand for inland navigation

The demand for transport is greatly determined by developments in the structure of the economy of Western Europe. It may be expected that the transport flows will increasingly consist of semi-manufactured and finished products and relatively fewer raw materials. Besides that, a shift of industrial activities to Southern regions in Europe may continue.

On the other hand, the containerisation of all kinds of general cargo creates new transport flows which more and more can and will be handled by inland navigation. It is beyond the context of this paper to go any further into such developments; however, the importance of these trends for the Western European transport industry and especially for the inland navigation sector should not be underestimated. The developments related to the bulk commodities resulted in a decreasing demand and thus an under-employment of fleet capacity. Measures to relieve the consequences for the transport industry will in the short run lead to cost increases.

However, when a structural policy can be developed through which the turn-around time of the vessels can be made more efficient by reducing waiting and idle time, this will result in transport operations at lower costs per ton transported.

2.1.2. Supply in inland navigation

The supply side is constituted by the available infrastructure on the one hand and on the available capacity of the fleet on the other.

Infrastructure

Infrastructure consists of waterways and ports, including artificial works like locks and bridges and quay facilities. The available infrastructure determines which places are accessible for vessels of different dimensions.

In relation to the road infrastructure the inland waterways infrastructure shows a more stable development (Table 3).

In the last decade the total length of navigable inland waterways in Europe has remained constant and only a slight trend towards greater accessibility for existing waterways can be found. For the future some investments have been planned mainly in enlarging existing waterways.

Developments in quay facilities are partly dependent on private initiative. Some shippers have already invested in modern loading and unloading facilities, thus enabling the handling of bigger quantities more

Table 3

LENGTH OF NAVIGABLE WATERWAYS BY ACCESSIBILITY AND COUNTRY

Accessibility for ships with capacity of	Germany		France		Netherlands		Belgium	
	1974	1981	1974	1981	1974	1981	1974	1981
50 -- 250 t	291	222	840	465	1 007	979	15	8
250 -- 650 t	368	364	3 966	3 893	1 277	1 311	894	866
650 -- 1 500 t	2 589	2 829	399	384	889	883	272	295
1 500 t and over	1 258	1 088	1 823	1 861	1 614	1 679	352	340
Total	4 506	4 503	7 028	6 603	4 787	4 849	1 533	1 510

Source: Eurostat.

efficiently, which leads to a decrease in total transport costs. It may be assumed that this development will continue. It must be noticed that this development is strongly linked with the technical development of the size of the vessels in operation. The bigger the hold of the vessel, the more the increasing size of loading and unloading installations can be used profitably. To the transport sector it is essential that waiting times at loading and especially unloading places are avoided or are paid for by the shippers.

Other interesting development are, for example, the location of terminals for the handling of containers. Another concept which demands a new kind of investment in infrastructure is roll-on/roll-off transport. Here trailers, containers on chassis, and all kinds of rolling stock are carried by ro/ro-vessels.

From the port of destination the trailers are moved by road to the final destination. This concept can fruitfully be applied to certain flows of commodities, especially when the speed of transport is not of vital importance.

Looking at the future a very important question concerning the infrastructure is, who pays for the cost of maintenance and improvement? Until now, especially for international waterways, the authorities take these costs on their own account. However, it is not inconceivable that in the future the branch itself will have to contribute. Such a contribution would mean a cost raising factor.

The increase in the size of the average vessel

The development of the fleet in the past years is mainly characterised by an increase in the average size of the vessels. Many smaller vessels were removed from service and when new vessels were added to the fleet, they were mostly vessels of relatively large dimensions and transport capacity. It is doubtless that this trend will continue in future years.

Principally economies of scale can be obtained by exploiting bigger vessels: e.g. 1 000 tons can be transported more cheaply than can two lots of 500 tons. Realisaton of these economies of scale is limited because of two factors: the available infrastructure and logistic implications.

More and more awareness breaks through that the optimalisation of a part of the transport chain easily leads to sub-optimalisation. Bigger transport volumes make bigger stocks necessary and so lead to higher costs of stocks. An increasing logistical awareness may result in a more aggressive competitive relation between the transport modes: rail, road and water.

However, it may be supposed that the tendency to transport bigger quantities of the commodities which are mainly transported by inland navigation will continue in the years to come. The cost per ton transported will, due to this influence, decrease to a certain extent. Of course there will be many differences among shippers and commodities.

2.2. Specific trends related to cost categories stemming from the simple operation of vessels

Looking at the simple exploitation of vessels, cost developments are to be foreseen. These developments can be illustrated by the use of the already introduced EBW-model for the cost calculations.

2.2.1. The costs of the capital invested

Today, the Western European waterways industry is confronted with a market situation in which massive overcapacity of tonnage exists. It is not to be expected that in the near future extensive investments in newly constructed vessels will be made. So the value of the capital invested in the fleet will not increase very much and depreciation will be rather stable as a result.

In the Dutch situation some rumours have been heard about stopping the general investment premium (WIR). The withdrawal of this premium has a practical consequence in that the amounts of money for the same investments are higher, and this will lead to higher depreciation costs.

Interest

Interest payments over the last few years have had an important influence on the increase in the cost level in the waterways industry. It is hard to predict what the interest level will be, particularly since it is a datum in the transport industry, which means that it can hardly be influenced by the industry itself. It is remarkable that the capital ratios have worsened especially for firms having realised some investments.

An increasing part of the capital invested is borrowed. Of course this development has consequences for the cost level of the waterways industry.

2.2.2. Other fixed costs of operation

Maintenance and repair

There is a tendency for expenses for maintenance and repair to be related to the conjunctural development; this relation, however, is not always an exact one. In a decline the receipts will suffer and only a small financial margin for maintenance will be available.

At the same time the rotation of vessels and the productivity of the fleet is decreasing so the necessity to have maintenance and repair work done has also diminished. In a booming situation when the freight rates are increasing there might be a greater financial margin to pay for maintenance and repair work. In this period of the trade cycle, however, maintenance and repair work will be kept to a minimum because of the relatively favourable chances on the transport market.

In recent years competition between ship yards -- and also the wharves specialising in inland navigation material -- has been hard. This competition might also continue in the near future. As a result the price development in this sector will not differ substantially from the more general price development.

Insurance premiums, harbour fees and other fixed costs

It is expected that these cost elements will run in conformity with general price developments.

2.2.3. Crew costs

Composition of the crew

In international inland navigation, especially on the Rhine, prescriptive rules concerning the composition of the crew are operative. These prescriptions stemmed mainly from safety considerations. There is a tendency to diminish the prescribed number of people in the crew. The technological developments also affecting the outfitting of the vessels in operation make it more and more possible (from a safety point of view also) to accept smaller crews. It may be expected that these technological developments will continue in the near future and that they will spread.

Labour conditions

Continuous bad profitability has characterised a big part of the inland waterways industry for more than 10 years. In this depressed situation not much elasticity is left to financially improve the labour conditions.

The short-term prospects for the economic situation of the waterways industry are not very rosy. They will depend on economic development and on the degree to which governments and the transport industry, in a combined effort, will succeed in controlling the fleet capacity so that a certain rcovery of profitability can be realised. Provisionally it may be expected that only a very small margin exists for a real improvement in employment conditions.

Working hours

In general the working hours of the employees are regulated by collective agreements. The independent shipowner, however, is free (apart from safety regulations) and willing to work many hours a day, especially during the phases of the trip where he can set the pace. This results in many hours worked on Saturdays, Sundays, as well as many hours late in the evening and early in the morning due to sailing times.

A somewhat better profitability situation could result in some reduction in these extreme working hours. The number of hours overtime per crew member could be less, thus lowering the wage cost level.

On the other hand this will have as a consequence a decrease in the number of effective hours for the vessel, resulting in a cost increase.

2.2.4. Sailing costs

Sailing costs increase rapidly when the sailing speed increases. This means that it is profitable not to operate at a maximum speed. From analysis of fuel consumption patterns in recent years it has become clear that the inland waterways operators are more fuel conscious, which means that they are mostly running their engines at under full capacity.

Also new and less power consuming engines contribute to a more economical use of fuel, which lowers the average variable costs. As the lifetime of the vessels and of their engines is also relatively long the effects of new types of engines will only be realised with a considerable time-lag. Developments in the level of fuel prices are of course of great importance.

Based on general opinion it may be expected that fuel prices for the near future will stabilize at their present level.

2.2.5. The turn-around time

Loaded trip time

As was mentioned concerning the use of fuel, it is not to be expected that operation speed will increase. To make some fuel savings because of its high cost a small decrease in the average speed may be expected.

Delays

Delays caused by locks and bridges depend on the capacity of the locks, the intensity of the traffic and the service provided. Large-scale investments to increase capacity with a subsequent substantial positive effect on these delays are not to be foreseen. With the aim of reducing personnel costs different measures have already been taken by which the operational times of locks and bridges are limited. The negative effect on the rotation times of the vessels is cost-increasing. The effect on the total costs of the waterways industry, especially in international transport, has been very moderate up to now.

Empty trip time

The costs involved in empty trip times are considerable in certain sections of the market, especially in point-to-point transport where, after the completion of a loaded trip from A to B, an empty trip is made from B to A.

This situation exists mainly in tanker transport, the transport of sand and gravel and the transport of ore from Rotterdam to the German Ruhrgebiet by push-barges. However, empty trips appear in all market sections.

The causes of empty trips are:

-- The demands made concerning regularity and speed of the transport;

-- The imbalance between the incoming and outgoing flows in certain regions.

Recent EBW-research showed that only a minor reduction in empty trips may result from employing modern methods of communication.

In view of the rather stable regional division of the economic activities which generate inland navigation, it may be assumed that the costs of unloaded navigation will not be subject to substantial change.

Loading and unloading

A large part of the total trip time is passed at the loading and unloading berth (see Table 4). For vessels operating in Rhine transport of dry cargo the time spent at the loading and unloading berth varies from 40 to 55 per cent of total trip time, excluding waiting for chartering. In Dutch domestic transport for some classes of vessels percentages as high as 60 are found.

The time needed for loading and unloading is determined by the quay facilities and the dimensions of the vessel. At several berths investments have been made in modern facilities which enable a faster loading and unloading. It may be assumed that as a result of these and future investments at berths which handle big flows of commodities an increase in loading and unloading speed will materialise. This tendency will be strengthened if the dimensions of the vessels develop in a corresponding way, thus becoming more appropriate for large-scale loading and unloading techniques.

Table 4

COMPOSITION OF TRIP-TIMES FOR SEVERAL CAPACITY CLASSES AND MARKET SECTIONS -- 1983 (SELF-PROPELLED -- DRY CARGO VESSELS)

Capacity class Market section Number of observations	up to 400 t North-South 175 hours	400-800 t domestic 251 hours	800-1 200 t Rhine 156 hours
Loaded navigation	68.0	16.8	42.1
Unloaded navigation	15.1	11.0	8.7
Loading	23.5	14.0	17.8
Unloading	22.6	25.3	26.3
Waiting for chartering, idle time	117.6	72.6	11.0
Total trip time	246.8	139.5	105.9

Source: EBW continuous research on operations in inland navigation.

Waiting time before loading and unloading constitutes some 60 to 70 per cent of the total stay at the loading and unloading berth. This can be due to insufficient capacity of loading and unloading facilities, or to inadequate operational planning by the shipper.

Another main reason of a different order can also be mentioned. For every transport the loading and unloading times used are part of the transport conditions. In the freight rate these (mostly standard) times agreed to are included. So in many cases there is no need for an alert and quick handling of the vessels. The transport conditions, which are also indirectly dependent on the market situations, permit lots of time for loading and especially unloading, without any penalty for inefficiencies.

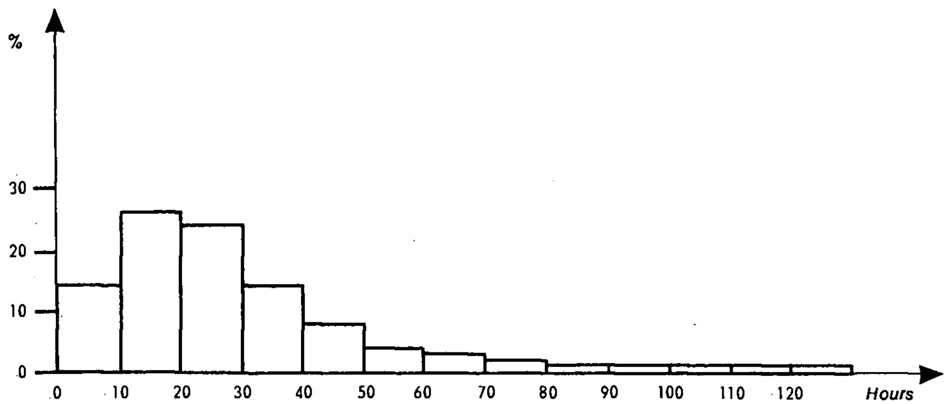
In the phase waiting for loading and unloading alone, considerable savings appear to be possible. This is illustrated by Figure 1, indicating the dispersion in waiting times for some 800 trips. For 40 per cent of the trips the waiting time is less than 20 hours, but for 22 per cent the waiting time is more than 40 hours. If it can prove possible to reduce such extreme waiting hours this will result in a considerable downward influence on the costs.

Calculations show a decrease in average waiting time of 7 per cent if all waiting times over 50 hours were reduced to 50 hours.

Waiting for chartering

In the cost models this is calculated with a normative waiting time for chartering of about one day per trip. In reality the waiting time is considerably longer, even up to three weeks, due to bad conjunctural situations. For the transporter this waiting time is an important factor that brings down productivity and thus leads to a cost increase per ton transported.

Figure 1 **DISPERSION IN TOTAL WAITING TIME BEFORE/DURING LOADING AND UNLOADING**



This implies that the capacity situation is the most determinant factor. Developments and policies concerning the capacity of inland navigation will possible result in a decrease of costs of waiting for chartering.

2.2.6. Freight rates

Up till now the costs of transport were the central item. However, there are only a few markets where the waterway industry can sell its transport services at freight rates that reflect actual cost levels. The market situation has been so depressed that in practice costs and freight rates will differ substantially. The freight rate strongly depends on the conjunctural situation, in such a way that in conjuncturally weak periods the rates will decline.

At the present time, freight rates paid to the transporters are far below the level of the integral economic costs. Looking at the situation for the transport of dry cargo, because of the imbalance between supply and demand of transport capacity, it may be foreseen that strong competition among the transporters will continue in the near future. When a better balance between supply and demand of transport capacity is reached, it may be expected that the now existing difference between fright rates and cost levels will lead to a more than proportional increase in freight rates. This would be a development which is necessary for the transporters to achieve a normal return on investment in human skill and capital.

2.2.7. Evaluation

Many factors have been analysed which all affect the development of inland navigation costs. It is extremely difficult to quantify expectations concerning future cost levels, yet an attempt will be made. For each cost determining factor an assumption concerning the development in five years is made.

The development is expressed as a percentage change with respect to the level at 1-1-1984.

Price changes are defined as real changes, i.e. as differences from the development of general price levels (see Table 6). Cost calculations based on these assumptions are presented in Tables 7 to 10.

It must be emphasized that the figures shown must be interpreted as an illustration of the way in which developments in individual cost elements affect total costs of inland navigation. Other assumptions can be made which are not necessarily less realistic than the assumptions presented here, and in a simple way the consequences for integral costs can be calculated.

Using the same trip as an example, in Table 5, cost indices are presented for the period 1977-1984 with an estimate for 1989.

Table 5

COST INDICES FOR THE TRIP ROTTERDAM-COLOGNE;
DRY CARGO MOTOR-VESSEL OF 1 500 TONS

Year	Index (1980 = 100)
1977	82
1978	85
1979	89
1980	100
1981	109
1982	124
1983	126
1984	125
....	...
1989	124 (1)

1. Estimate based on assumptions, mentioned in Table 6.

To summarise, the following general remarks concerning future developments in the costs of inland navigation can be made:

1. The extent to which the problem of excess-capacity is solved is essential for the transport industry. Only in a balanced situation between demand and supply of transport services can the cost level and trends affect the freight rates under free market conditions;

2. A better balance between demand and supply of transport services will improve transport operations and thus lower costs;

3. A better understanding of the factors influencing transport costs, for both transporters and shippers, will lead to a rise in efficiency and productivity;

4. The introduction of new technological features will continue to lower the costs of inland navigation;

5. For different market sections and types of vessel, different cost trends may be expected, because of the different cost structure of the operations;

6. A great variety in navigation enterprises and vessels which cover -- in competition -- the market of inland navigation will continue to exist;

7. Under moderate foreseeable expectations the cost level in the inland waterways industry might stabilize. The level of freight rates, especially in dry cargo operations, will increase;

9. In a more balanced situation of supply and demand of transport capacity, through a joint effort of transporters and shippers, productivity increases can be realised, mainly by lowering loading and unloading times agreed upon in transport conditions. In this way substantial cost savings in inland waterways operations can be made.

Table 6

ASSUMPTIONS CONCERNING THE CHANGE IN COSTS DETERMINING FACTORS BETWEEN 1-1-1984 AND 1-1-1989

Cost category	Percentual change in real level
Investment value	0
Interest	0
Repair and maintenance	0
Insurance	0
Port and lock levies	0
Other fixed costs	0
Number of crew members	- 5
Costs per man per hour	- 2
Use of fuel	- 5
Costs of fuel per litre	0
Available hours per year	- 5
Net sailing hours	0
Degree of loading	0
Speed	- 5
Delay	0
Length of empty trip	0
Net loading and unloading	- 5
Waiting for loading and unloading	- 7
Waiting for chartering	0

Table 7

CALCULATION OF COSTS

Model	:	Rhine transport-motor-vessel-dry cargo
Loaded trip	:	Rotterdam-Cologne
Capacity of the vessel	:	1 500 tons
Year of construction	:	1963
Tons transported	:	1 260
Capacity of the engine	:	899 hp

	1-1-1984	1-1-1989
Utilisation		
Available hours per year	3 498	3 323
Net sailing hours	1 441	do.
Depreciation		
Investment value	f 1 533.029	do.
Rest value	0	do.
Depreciation period (years)	13	do.
WIR premium (%)	12	do.
Interest		
Part of own capital (%)	57	do.
Interest on own capital (%)	6.17	do.
Interest on borrowed capital (%)	9.66	do.
Provision	6	do.

Table 8

COST SUMMARY

Model	: Rhine transport-motor-vessel-dry cargo
Loaded trip	: Rotterdam-Cologne
Capacity of the vessel	: 1 500 tons
Year of construction	: 1963
Tons transported	: 1 260
Capacity of the engine	: 899 hp

	1-1-1984 f	1-1-1989 f
<u>Fixed material costs per year</u>		
Depreciation	103.254	do.
Interest	51.812	do.
Repair and maintenance	25.015	do.
Insurance	32.196	do.
Port and lock fees	13.522	do.
Other fixed costs	23.550	do.
Total	249.349	do.
<u>Fixed costs per available hour</u>		
Material costs	71.28	75.03
Costs of crew during idle time	40.65	38.57
Costs of crew during other phases	50.40	46.87
Total during idle time	111.93	113.60
Total during other phases	121.68	121.90
<u>Costs per sailing hour</u>		
Repair and maintenance	17.36	do.
Fuel	64.29	61.09
Total	81.66	78.45

Table 9

SUMMARY OF TRIP PHASES

Model : Rhine transport-motor-vessel-dry cargo
Loaded trip : Rotterdam-Cologne
Capacity of the vessel : 1 500 tons
Year of construction : 1963
Tons transported : 1 260
Capacity of the engine : 899 hp

	1-1-1984 Hours	1-1-1989 Hours
Loaded navigation		
Net sailing	30.1	31.6
Delay due to locks and bridges	1.6	do.
Delay due to other circumstances	1.4	do.
Total	33.1	34.6
Unloaded navigation		
Netsailing	5.5	5.8
Delay due to locks and bridges	0.0	do.
Delay due to other circumstances	0.5	do.
Total	6.0	6.3
Loading		
Waiting before/during loading	14.2	13.2
Net loading	5.1	4.8
Waiting for loaded navigation	1.0	do.
Total	20.2	19.0
Unloading		
Waiting before/during loading	28.7	26.7
Net loading	16.2	15.4
Waiting for loaded navigation	1.5	do.
Total	46.4	43.6
Idle time	2.9	do.
Total trip time	108.6	106.4

Table 10

GENERAL SUMMARY

Model	:	Rhine transport-motor-vessel-dry cargo
Loaded trip	:	Rotterdam-Cologne
Capacity of the vessel	:	1 500 tons
Year of construction	:	1963
Tons transported	:	1 260
Capacity of the engine	:	899 hp

Trip phase	Hours	Costs per hour				Costs per phase
		Fixed	Crew	Sailing	Total	
1.1.1984		f	f	f	f	f
Loaded navigation	33.1	71.28	50.40	75.33	197.01	6 521.03
Unloaded navigation	6.0	71.28	50.40	74.85	196.53	1 179.18
Loading	20.2	71.28	50.40		121.68	2 457.94
Unloading	46.4	71.28	50.40		121.68	5 645.95
Idle time	2.9	71.28	40.65		111.93	324.60
Total	108.6					16 128.70

Costs per ton transported: f 12.80
ditto, 6 per cent provision included: f 13.62

Trip phase	Hours	Fixed	Crew	Sailing	Total	Costs per phase
1.1.1989						
Loaded navigation	34.6	75.03	46.87	72.64	194.54	6 731.08
Unloaded navigation	6.3	75.03	46.87	75.18	197.08	1 241.60
Loading	19.0	75.03	46.87		121.90	2 316.10
Unloading	43.6	75.03	46.87		121.90	5 314.84
Idle time	2.9	75.03	38.57		113.60	329.44
Total	106.4					15 933.07

Costs per ton transported: f 12.65
ditto, 6 per cent provision included: f 13.45

SUMMARY OF THE DISCUSSION

INTRODUCTION

The Round Table attempted to assess the potential productivity gains of the transport modes in order to determine the foreseeable trends in goods transport costs. The purpose of the discussion was also to identify the transport policy options which would enable these productivity gains to be achieved. The meeting addressed three aspects:

-- The costs of goods transport

-- Foreseeable trends in the costs of transport modes

-- Recommendations and conclusions.

1. THE COSTS OF GOODS TRANSPORT

A cost is incurred when resources to which a value has been assigned are utilised. Two types of cost can be distinguished in the goods transport sector:

-- Operating costs due to the use of transport inputs. Their trend depends on input price and the ability of the enterprise to achieve productivity gains in the use of these inputs.

-- Costs associated with the use of infrastructure.

The latter consist of:

-- Costs of providing infrastructure (construction, financing, maintenance).

-- Costs of interaction with other users (safety, congestion).

-- Costs in the form of pollution caused by vehicle traffic.

The provision of infrastructure does not result in any difficulties in the calculation of its costs but in their recovery and their imputation to users. Measurement methods have to be worked out for the other types of costs which also involve the question of how they are to be incorporated in the costs of transport enterprises. Thus the difference between the actual cost of a service and the cost met by the user is due:

-- To the identification and evaluation of the costs associated with the use of infrastructure.

-- To the extent to which infrastructure utilisation costs are incorporated in operating costs.

-- To the coverage of the operating costs of enterprises by the prices charged on the markets, for the market configuration (structure, regulatory provisions, etc.) may lead to a lasting difference between price and cost.

The positions of the various transport modes in this respect differ greatly and comply very little with the criteria for efficient allocation of resources:

-- In the case of roads and waterways, business activity and infrastructure operation are distinct. Incorporation of the infrastructure utilisation cost (level, procedures) depends on the policies in force. As regards road infrastructures, major differences are observed between countries, due to the existence of tolls and different levels of fuel tax. The prices of services are determined on markets that are also influenced by many regulatory provisions (licences, compulsory rates, etc.). The objectives behind these provisions are manifold (protection of the railways, brake on market instability) and their success has been very limited. This fact is seldom admitted, however.

-- In the case of the railways, operation and infrastructure come under the same body. The influence exerted by policy objectives on the economic role of the railways is undeniable. One effect of this is the inflexibility of this mode's costs, another being the poor economic justification for certain investments.

These differences are also seen in the cost structure. The railways have very high fixed costs (personnel, equipment and infrastructure). A price equal to the marginal cost of a service does not cover the full costs. In road transport the existence of many firms guarantees diversity of supply. The mobility of transport inputs is high since this sector is marked by the coming and going of enterprises. In addition, the distribution of functions and services among the participants in the sector contributes to the formation of costs. The wide range of services and costs in road transport is also due to own account transport activities which meet needs that in principle are not satisfied by the professional road hauliers.

The cost trends for the different modes will depend on:

-- The potential productivity gains of transport undertakings.

-- Regulatory provisions (inclusion of external factors, market regulation, choice of investment).

-- The pattern of activity, for expansion unlike recession facilitates productivity gains.

-- The requirements of demand.

Changes in the type of traffic are seen as the qualitative demands of shippers are stepped up. Future services will comply with these changes. It is therefore difficult to work out a unit of cost which can be used to compare present and future transport operations. This problem is an extension of the difficulty of defining a usable transport unit (t, t-km, vehicle-km).

2. FORESEEABLE TRENDS IN THE COSTS OF TRANSPORT MODES

2.1. Road haulage

The Round Table used different factors to assess the future trends in this sector's costs:

-- Better utilisation of overall capacity is feasible. A reduction in part loads and in empty return hauls would require greater transparency of information on available freight. Information transmission and processing techniques may provide these improvements, for example through freight information exchange centres. Opposition to the introduction of such systems has sometimes been encountered as they tend to reduce the differences in functions among road hauliers, an operational hierarchy to which the biggest enterprises in the sector attach great importance. However, international comparisons show that information exchange systems meet a need (B, NL). Economic losses due to waiting time (border crossing, unloading) may be reduced by the use of information networks. The introductory report underlines great possibilities in these fields.

-- As the lorry drivers' working conditions are aligned more with those of other employee categories, the costs of firms will rise sharply. Even if the operational requirements of the various modes cannot be equated, changes in direction are already noticeable and should continue. The modal split will be only slightly modified by this trend.

-- The regulatory provisions which are intended to regulate markets result in costs. The setting of compulsory rates prevents shippers from benefiting from some of the most efficient firms' productivity gains, for prices rise with average costs. Hauliers who achieve higher productivity gains cannot pass them on in their prices and thus obtain extra profit. Similarly, holding a licence does not guarantee that the firm is the most competitive operator for the routes for which it holds the necessary permit. On the contrary,fixing quotas on the supply side slows down the competitive process. In view of the imbalance between supply and demand, liberalisation of markets at the present time would bring prices down to under the hauliers' breakeven point. In the longer term, maintenance of regulatory provisions does not help to adjust capacity and disseminate productivity gains. The effects of regulatory measures have to be assessed since it appears that they are not without influence on costs.

-- Less capacity is used in own account transport than in transport for hire or reward. A transfer of activity to the latter would reduce the average cost of transport for the community, providing that qualitative requirements were met in the same way. Here again it is therefore essential that regulations should not interfere with the ability of road hauliers to seize market opportunities.

-- With regard to infrastructure utilisation, it has been stressed that road transport causes more negative external effects than the competing modes. The increasing allowance made for these effects by assigning values to them will also influence trends in road haulage costs. As regards costs for providing infrastructures, there will be a move away from a situation where network development had priority to one where maintenance problems predominate. If traffic growth was to continue, an inadequate increase in capacity would result in higher operating costs due to the slowdown in transport speed. An increase in infrastructure capacity would also result in higher costs due to the combination of network maintenance and development problems.

Although network improvements in the past made it possible to increase road transport productivity, there will probably be increasing costs in the future simply to maintain the network's quality standard.

To sum up, it seems difficult to foresee the trends in costs since productivity gains may be offset by the rise in the price of inputs or the way in which they are used. On the other hand, the scope for improving productivity through rationalised use of capacity and better organisation of transport seems to be very great.

The experts also stressed that trends in road transport prices will have only little effect on the modal split but will influence the costs of transport for the community. It is therefore essential to prevent regulations, which have no effect on the modal split, from adding more to transport costs than is required for the harmonization of competitive conditions.

As regards energy constraints, it was accepted that a levelling-off in the cost of imported energy was the most likely assumption in the medium term. However, a rise was inevitable in the long term unless a substitute form of energy was found.

2.2. Railway transport

In the background report on the foreseeable trends in railway costs it was assumed that fixed installations have additional capacity potential. The cost of a service is analysed as a marginal cost. Future services will be marked by a decrease in heavy freight and a qualitative improvement in supply through shorter transport times. The increase in train speeds will thus result in a rise in traction energy costs. This rise will be offset by the decrease in labour (and equipment) costs, as turn-rounds will be speeded up. The greater demands for reliability will add to the attraction of train with programmed turn-rounds. This formula results in lower capacity utilisation for the load per wagon is lower. Similarly, the formation of short trains makes it necessary to distribute traction costs over a smaller number of wagons. Subject to the assumptions stated, costs should steady or rise slightly, although with higher quality of service. Several remarks were made on these different points:

-- The investments to be made to increase the speed of goods trains are limited. Scope for improvement does exist, but the effect of the increased speed of heavy trains on the cost of track maintenance is to be taken into account.

-- If tracks are used to take high-speed trains and fast goods trains simultaneously, the expenses required for the coexistence of the two types of traffic are to be included in the costs of goods services. The availability of time for track maintenance may also become problematic and result in additional cost;

-- The crossing of frontiers is an obstacle to quality of service; time losses are heavy. The imperatives of rapidity and reliability in international transport will be met if the difficulties of Customs clearance difficulties and weaknesses in co-operation between railway administrations are eliminated.

In addition to the preceding points, the experts mainly stressed the excessive fixed costs (infrastructure, labour) of networks. The expression "cost of a policy option of maintaining excess capacity" has been used to describe the situation. It is to be noted that, for example, the savings from eliminating traffic are low in the short term. Only in time are they equal to savings on the replacement of equipment. Capacity and transport inputs are not adjusted to the changes in activity. A reduction in fixed costs would necessitate closure of sections and fewer jobs. The latter requirement is being met for the time being through retirements. Moreover, operation is extremely rigid as the railways are organised more on the basis of technical than economic options. Thus at what cost can the railways provide future services? Developments in data processing give hope of better input allocation and therefore of cost reductions. The management of priority operations will, for example, make the transport of individual wagons less costly. The development of logistics may result in massive and regular consignments, a type of traffic in which the railway benefits from a scale effect. A reduction in the cost of railway transport is therefore foreseeable in the longer term. It will not be achieved unless the management system complies with economic requirements. Otherwise the difference between price and cost will persist, which will distort the decisions of economic agents and accordingly the allocation of the community's resources.

2.3. Waterway transport

The participants in the Round Table defined the potential productivity gains for this mode:

-- The slowness of loading/unloading operations ties down equipment and personnel, which causes economic losses. Technical progress (containers, ro/ro vessels, etc) and port equipment will enable some of these losses to be eliminated;

-- The increase in the size of vessels, the use of push towing and the adjustment of waterway dimensions which differ considerably from country to country will contribute to a decrease in the cost per tonne carried;

-- A reduction in the size of crews is also made possible by the technical advances of recent vessels. In the case of owner-operators, the work is mostly done by the family unit, and it is thus difficult to see any likelihood of a change in operating conditions which involving a large amount of work.

The discussions at the Round Table mainly concerned market organisation, the difficulties of adjusting prices to costs and the maintenance of excess capacity. It is obvious that surplus capacity is necessary to cover seasonal changes in activity. Similarly, regional imbalances in the type and quality of freight make empty return voyages inevitable. However, it is observed that prices do not keep up with the increase in costs, which reflects heavy excess capacity. The economic penalty of this should logically be the elimination of marginal operators and thus a decrease in surplus capacity. In fact the assumption concerning input mobility ignores the attachment of owner-operators to their jobs and the difficulties of finding alternative employment. In the case of these operators, the lack of any alternative and the acceptance of low earnings will lead to the maintenance of their activity without their vessels being replaced or modernised. On the other hand, this sector also includes large enterprises. The coexistence of operators differing in potential also results in sub-contracting. No uniform trend can therefore be detected in the costs and prices for enterprises as a whole.

The participants included the administrative organisation of markets among the explanatory factors for a decline in the competitive position of waterways. The maintenance of practices such as rosters, chartering offices and compulsory rates run counter to the logistical requirements of shippers. The lack of flexibility inherent in any regulated market has been accompanied by inadequate adjustment of services to needs, a process that has contributed to excess capacity. The modernisation of this mode greatly depends on whether the market imbalances can be eliminated.

3. RECOMMENDATIONS AND CONCLUSIONS

On the basis of the foregoing, the Round Table meeting drew the following conclusions:

-- Research on identifying and evaluating external factors should be pursued. The same applies to all categories of costs (fixed, variable, marginal);

-- The capacities of the modes are underutilised and co-operative formulae would contribute to a solution. In the case of rail, better co-operation between railway administrations would limit equipment needs and improve quality of service. Co-operation among road hauliers would increase the transparency of information; the allocation of resources would be more efficient. However, the fact cannot be ignored that improved capacity utilisation would add to the problem of overcapacity in transport. The general outcome of such a situation is the disappearance or reduction in size of the least efficient enterprises.

-- Policy decisions and the measures accompanying them have many effects that sometimes even conflict with the initial objectives. A better assessment of options from the outset is a must. In particular it is not logical that policy decisions should interfere with the achievment and repercussions of productivity gains, whatever the transport mode. In this respect greater flexibility on the part of transport modes is required to adapt to shippers' logistic needs. The opposition between the maintenance of restrictive regulatory provisions (capacity, price) and the requirement for flexibility is obvious. There has to be a change.

-- Improved training of operators in cost analysis is an approach in transport policy that should be given special emphasis. The economic significance of their costs should be brought home to enterprises in order to avoid market instability. Economic effeciency would exceed that obtained by setting supply quotas and compulsory rates, which are measures that have many insidious effects.

-- The enterprises and activities associated with the transport modes have to be informed in advance of changes in regulations. In addition, observation of a transition period facilitates adjustments.

-- Taxes in transport should concern the utilisation and not the possession of a vehicle, for the increase in fixed costs is an incentive to increasing the volume of services to cover these costs.

The transport modes can meet the shippers' requirements in different ways, and the price of transport is only one criterion in the selective process. There is no point in trying to influence the modal split by restrictions on market operation. Individual decisions are made at the least cost to the community, subject to competitive conditions being harmonized. On this basis intervention by the authorities should be limited to creating conditions in which each mode can achieve productivity gains. Each mode has an important potential: road haulage through an increased market transparency and a decrease in unproductive planning (part loads, waiting times); railways through rigorous management critera; inland waterways through the modernisation of its ships, port facilities and infrastructure.

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