EUROPEAN CONFERENCE OF MINISTERS OF TRANSPORT

Guided Transport in 2040

ECMT

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 22 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.

The matters generally studied by ECMT - and on which the Ministers take decisions - include: the general lines of transport policy; investment in the sector; infrastructural needs; specific aspects of the development of rail, road and inland waterways transport; combined transport issues; urban travel; road safety and traffic rules, signs and signals; access to transport for people with mobility problems. Other subjects now being examined in depth are: the future applications of new technologies, protection of the environment, and the integration of the East European countries in the European transport market. Statistical analyses of trends in traffic and investment are published each year, thus throwing light on the prevailing economic situation.

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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SUMMARY

The purpose of this report is to provide information for policy decisions that will influence the future role of guided transport, that is to say all forms of transport involving vehicles guided by a track instead of being steered by a driver. Such transport includes the conventional steel wheel on steel rail railway as well as new technologies now in process of development or as yet to be discovered.

The year 2040 may seem to be in an extremely distant future but, given the very long life-time of both infrastructure and vehicles, the maximum degree of freedom of choice can only be attained by means of early planning. Decisions concerning the future cannot be postponed for too long, since whatever the situation is to be in the middle of the next century, there is need for a considerable period of preparation. Moreover, any investment during the coming decade which is not consistent with the requirements of the future may very well be wasted.

Developments in society are tending to be more in favour of road than rail transport. Transport demand is becoming more diverse in terms of both time and space and is therefore catered for better by car and lorry than by train. However, people and goods will be travelling over longer distances and in this respect the railways are in quite a strong position. One important aspect here is the process of internationalisation on both European-wide and world-wide bases. European-wide railways can acquire a strong position provided that the existing pattern of organisation in national undertakings is adapted to ensure that international transport services can each be marketed by a single economic unit.

If guided transport is to play its role, people will need to feel that they want to use it because it is the best available mode for certain types of transport and not use it only because roads and airports are congested or because alternative modes are not available, too expensive, or socially unacceptable. This factor has to be borne in mind when shaping policies designed to promote the use of rail transport.

Much can be done *in* the ***field of technical developments*** over a period of 50 years, but it must be realised that preparations have to begin now if a system is to be in place by 2040. Public attention is directed in the first place towards the mode of transport and the movement of vehicles, but there are good reasons for arguing that operating systems and user information are more important since they can make the use of infrastructure more efficient so that users' needs are better catered for. It is worthwhile considering the possibility of a European research programme comparable to those now existing for road transport (DRIVE).

Existing environmentalfactors are strongly in favour of making considerable use of rail transport. It is recognised that any increase in road and air transport cannot keep pace with the growth in demand. The introduction of environmental standards for all modes, together with some form of environmental charge, will steer demand towards those modes with the lowest environmental costs.

If guided transport is to be able to do what may be asked of it in future, it is important to work out strategies for increasing its capacity quickly and €or making users aware of the possibilities of rail. Even in cases where existing railway lines are not at present needed, it is important €or the undertakings to keep their rights of way at any rate.

The cost structure for guided transport may be said to have a high level of fixed (or capacity) costs and substantial economies of scale. The extremely long useful life of most equipment makes investment in rail transport a commitment to the long-term future. Experience has shown that a substantial proportion of the investment in infrastructure has been financed by or on behalf of public authorities, and it is unlikely that all the "missing links" in the European rail network can be completed without their participation.

A number of scenarios have been drawn up to show the form that guided transport systems may take some 50 years from now. They also show the geographical scope of these systems.

Guided transport may be confined to those types of operation for which it is particularly suited, namely long-distance transport of passengers and/or freight on corridors carrying heavy traffic, urban and suburban passenger transport in large conurbations, and the crossing (or rather tunnelling through) geographical barriers such as the Alps and the Channel: THE **CONCENTRATED** RAILWAY. This pattern of development is not unlike the one found in North America and would probably develop in Europe if market mechanisms were allowed free play.

In the scenario of THE OMNIPRESENT RAILWAY, guided transport would be found on all or many corridors. While the structure of this network would be similar to that of the existing rail networks in Europe, the scenario would not come about by simply maintaining the ***status*** quo and renewing existing facilities. Networks and operating methods have to be continuously adapted to meet future requirements, and a European authority of some kind should be established in addition to the national bodies in order to ensure that the adjustments are carried out in time.

Another factor to be taken into account is that of the organisation of the railways. While it is not to be precluded that trains will continue to be operated as they are now, **THE TRADITIONAL** RAILWAY, changes in the existing system need to be explored, as is indeed already happening.

One aspect of change is automation. The aim of THE AUTOMATED RAILWAY is not to run trains by means of automatic controls instead of a driver -- as is indeed the case at present with several urban rail systems -- but to organise guided transport in a totally different way by making use of automation. For example, the idea of the train might be discarded and individual vehicles would move through a system, each with its own point of departure and destination. Another option under consideration would separate the bodies (carriages or wagons carrying passengers or goods) from their undercarriages, the undercarriages continuing to operate in the form of trains. The bodies would then be transferred to other trains at junctions. But these are simply examples of systems that might be introduced in a 50-year period.

Another factor that will play a part in changing the organisation of the railways is the establishment of Europe as a single economic and social space, a development that would provide grounds for creating a guided transport system entirely adapted to European needs: THE NEW EUROPEAN RAILWAY. This scenario is not based solely on the improvement of the mechanisms for co-operation among national railway undertakings, the introduction of new vehicles or better operating methods, but on a really new guided transport system, catering for demand on a European scale and making no distinction between national and international traffic. New technologies might be used but there would also be the possibility of integrating into a new European system the high-speed lines that are now being built in a number of countries.

There is no obligation to choose just one of the scenarios (or one in each group), Some countries will think it necessary to provide guided transport on many major links, while others will tend towards the establishment of a sparser network or simply a few corridors carrying heavy traffic. A new European network could be combined with conventional operations on existing networks. The automated railway could be established more easily in a concentrated network but it would be of the greatest utility in a network with many interconnecting lines.

In any event, the choices to be made to meet future requirements have to be made soon, particularly where the European network is concerned. In the current endeavours to integrate national high-speed lines into a European network, it must first be asked whether the decision is the right one. This depends not only on the choice of the most appropriate technical means but also, and perhaps more importantly, on the introduction of means of establishing the economic and commercial responsibilities on a Europe-wide basis.

Lastly, the report sets out a number of possible approaches to transport policy:

1) Governments should help to create a climate conducive to the use of rail transport;

2) Since it is by no means certain that road transport will be able to cater for the expected increase in demand, possibilities for the development of guided transport systems, such as rights of way, should be kept open;

3) It would be advisable to explore the scope for developing international rail services by allowing any national undertaking to build international rail lines and any operator wishing to run international services, to use the lines of several national undertakings on payment of an appropriate charge;

4) Further co-operative research should be carried out with respect to railway operating systems and means of improving user information.

As regards the financial implications of constructing and operating guided transport systems, it must be borne in mind that, as long as the market mechanism is allowed to operate in the road transport sector for the use of vehicles but not infrastructure, that mechanism cannot be expected to produce satisfactory results for rail transport.

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It should be noted that *this report was initially prepared* ***for*** *the European Conference of Ministers* ***of*** *Transport by Mr. Aad RÜHL (Netherlands). It is based largely on written submissions to the 1989 PTRC Summer Annual Meeting and the discussions held there (see Annex). It has been examined in detail by the ECMT Ad Hoc Group on Railways and, while unanimous agreement could not be reached on some of the content, the Group decided that the report should be submitted to the Council of Ministers to provide some lines of approach to the discussion which took place on 21st November* ***1991.***

Chapter 1

STATEMENT OF THE PROBLEM

In its Resolution on Railways, adopted on 29th November 1988, the Council of Ministers of Transport instructed the Committee of Deputies "... to initiate ... a forward-looking study of the longer term which, on the basis of different scenarios for trends in society, focuses particular attention on the scope offered by new technologies". In Later discussions "the longer term" was defined as "around 2040". This report is in response to that instruction from the Ministers [see "Rail Network Co-operation in the Age of Information Technology and High-speed", page 117, ECMT, Paris, 1989. ISBN 92-821-1129-6, FF 150 (also published in French)].

One might question whether it is sensible to try to look so far into the future. There are so many uncertainties involved that some people may consider it pure speculation to do so. However, given the very long timespan over which railway equipment is used, such an attempt is reasonable. If we look ahead to a period some 50 years hence, all the people, vehicles and other equipment now employed or being introduced will no longer be in active service. Only the rights of way, major buildings and heavy structures such as bridges and tunnels may still be in use. The long timespan is therefore a means of achieving a maximum degree of freedom.

There is, however, a strong argument for taking decisions now. For instance, if it were felt that railways should be cut back, the decision to do so would have to be taken promptly so as to avoid making investment that would shortly prove to be wasted. In this case, the reason for a fall in requirements for components of the system would not necessarily have to be a lack of demand. It might for example be the identification of a need for a different and more advanced technology. Moreover, in view of the time needed to expand a rail system, a decision would also have to be taken quickly to ensure that whatever system was wanted could be ready when needed. In thinking about guided transport in 2040, it is necessary to concentrate on factors that can be identified now. For example, it is clear that the volume of transport operations is increasing at a pace that is virtually impossible to curb, although the proportion of bulk goods in the freight sector is falling and, where passengers are concerned, present-day communications technologies could to some extent obviate the need for people to travel at all. It is also known, however, that civil aviation in Europe is outgrowing the available airspace, the road network is approaching saturation point and the number of people who object to expansion in heavy road freight is rising.

It is of course quite clear that transport of any kind whatsoever is an essential and integral part of an economy based on the division of labour. It is therefore up to the policymakers to bring their influence to bear with respect to developments in the transport sector and to make sure that traffic is still moving in 2040. They have to frame transport policies that exploit each mode's inherent advantages to the maximum and combine them in a single common transport system. If they do not, everything will grind to a halt. It also has to be borne in mind that environmental constraints will restrict the extension of some modes of transport.

If a report is to be relevant to all ECMT Member countries it cannot provide details on specific situations but simply sketch out a situation that might exist in the future. As different scenarios already exist as a basis for development, there can be no question of a single description of the future of rail transport. Different scenarios will emerge as socio-economic conditions and policies may differ from one country or area to the next, so one of the scenarios to be developed may apply in particular countries and another elsewhere.

A scenario is, by definition, an image of the future that may in fact be realised, although there is no indication of its probability. In this respect it differs significantly from a forecast which is a likely situation in the light of assumed values of a number of independent variables and of the relations between those values and the phenomena to be predicted. It is pure speculation to attempt -- some half a century in advance -- to determine numerical values for any variable and make assumptions on quantitative relations between independent and dependent variables.

The question to be addressed can therefore be said to be: what options are available for rail transport in the long-term future in the light of a number of assumptions concerning developments in society, and what decisions have to be taken now or in the near future in order to keep those options open? This two-part question is essential in view of the context in which this report exists since it is not designed (simply) to inform or perhaps even entertain the reader but has in its final form been submitted to a European Conference of Ministers who are responsible for the development of transport and need to consider the extent to which, by taking decisions now, they will influence the future, perhaps by eliminating options that might have to be considered later.

Chapter 2

SCOPE OF THIS REPORT

The Council of the ECMT consists of the Ministers of Transport of 22 countries and the situation in each country may differ according to the region. There can be no question of giving an overall picture of the future development of rail transport which will reflect the situation in all cases. There will necessarily be departures from any regular pattern which will be dictated by specific situations or by the consequences of policies adopted.

The aim of this report is to indicate the options available for the development of the rail transport system as a whole and to consider whether it will continue to function much as it does at present, whether new technologies can be expected to have a major impact on the operation of guided transport, whether it may be confined to heavy inter-city flows, etc. While it might be generally concluded that trains cannot be expected to serve rural areas in the future, that is not to say that they will not continue to do so in some countries or regions.

In ECMT discussions concerning the railways, attention is usually focused on national railway systems. In many countries, however, the railways also serve urban areas and particular regions, so consideration will here also be given to those rail services, irrespective of whether they are part of the national system, But specific consideration will not be given to urban and inter-urban tramways -- now often referred to as "light rapid transit" -- although some of what is said will also apply to these forms of guided transport.

The report covers all transport systems which use vehicles guided by a track, including conventional steel-wheel on steel-rail tracks, rubber-tyred wheels on or against any appropriate surface, and vehicles having no wheels at all but supported by air cushions or magnetic fields.

Some consideration will also be given to hybrid vehicles, i.e. guided by a track for part of the journey only, as well as to vehicles guided by electronic equipment built into a track.

It is for the foregoing reasons that the title of the report refers to "guided transport" but the term "railway" will also be used in the widest sense, at any rate where no restrictive qualification is called for.

Chapter 3

DEVELOPMENTS IN SOCIETY

a) *Population structure*

It is impossible to predict what the population structure will be in half a century's time. If one takes a point some twenty years into the future, it can be assumed *that* most of the adults who will be living at that time are already in existence now, but any situation to be found some 50 years from now will depend not only on the lifestyles of people in households at that time but also to a large extent on future birth rates. That is one of the reasons why any quantitative estimate of future traffic is meaningless. Aside from many other uncertainties, the size of the market cannot be known. Accordingly, the following paragraphs set out only a few fairly general indications based on trends that are discernible at present.

The size of the average household is diminishing in most ECMT Member countries owing to a number of contributory factors: fewer children per family, children leaving the family home at an earlier age, more adults living alone or in a one-parent household, and old people continuing to live in what had been the family home. With household incomes higher and better housing conditions in general, there tends to be a lower population density in built up areas. At the same time, more people are living either in cities or at any rate in urban areas, so the absolute figures for rural populations are correspondingly lower. While the populations of inner cities are in fact diminishing owing to lower population densities -- a trend that has now come to a halt in the case of some cities -- the sizes of urban areas are still growing, and smaller cities lying in a fairly large ring around a big city are tending to develop as places to live for people working in the big central city. Such a living environment is more attractive than most suburbs and, while the location is further from the central city, the journey is relatively quick because motorways and intercity trains can be used and provide quicker access than suburban roads and railways.

Another factor relevant to the future demand for passenger transport by rail is the way in which activity patterns tend to become more diverse. As more members of the same household take up occupations and commuting distances increase, people will tend to settle between two job locations rather than nearer to one of them. Patterns of work may become more diverse as people work at different locations rather than in one fixed place. The scope for telecommunications is at present used far less than would now be technically feasible, but people can in future be expected to spend part of their working time at home or at smaller work centres interlinked by telecommunications. All these factors contribute towards making work journeys more diverse and less concentrated in peaks, thus working against guided transport which is most efficient for mass transit. On the other hand, journeys over longer distances may make rail transport more attractive.

People do not, of course, travel only to work. They travel on business, for social and cultural reasons, sports events and as tourists. Retired people will of course travel for private reasons only. While, for the reasons mentioned earlier, the proportion of retired people in the total population cannot be indicated, it may be assumed that many people who have become used to travelling frequently during their active lives will continue to do so, at any rate as long as they remain in good health.

Taking all journey purposes together, it can be said that people will tend to travel more, but it would be quite conceivable to have a long-term projection from a present trend that gave rise to a situation where people were spending 24 hours a day (or even more) in a transport vehicle. Care has to be taken to avoid exaggeration: trees may grow tall but they will never reach heaven.

Where rail transport's market share is concerned, it must be borne in mind that some factors work for and some against the mode. For travelling between a small city and a large city centre, the railways traditionally hold a strong position and can be expected to continue to do so. High-speed passenger lines will strengthen rail's position for long distance journeys but high-speed trains do not usually stop in small or medium-sized towns. Much depends on the pattern of land use. If centres of activity continue to develop on the perimeter of large cities, access will usually be better by road and from airports than by rail. The train can be expected to remain well placed for access to city centres.

b) Production structures

The main factor influencing demand for rail transport is the diminishing importance of heavy industries, since the railways have traditionally catered for their needs by carrying their materials and products, especially where water transport was unavailable.

Another factor is the decentralisation and Europeanisation of production which has meant that intermediate products are sometimes carried over long distances before use in a further stage of production.

A final factor is the "just in time" concept for the organisation of production whereby, instead of having buffer stocks to fill in when supplies arrive irregularly, supplies are scheduled to arrive as and when needed in the process, so any hold-ups or damage in transit will involve the risk of bringing production to a halt.

The "just-in-time" requirements can be met by conventional rail bulk carriage by block train. A power station can be fed with coal by means of a shuttle-train system, and iron ore in an appropriate blend can be carried by train load from a port to a blast furnace. However, a consignment which has to arrive at a precise time cannot conveniently be sent by individual wagon.

A number of changes are however being made to help eliminate this drawback of rail transport, the first being to monitor individual wagon movements continuously so as to keep informed more precisely of arrival times and take action if the forwarding should be inappropriate. Another possibility is to book space in scheduled trains, just as passengers can book accommodation on long distance trains, so that amval at a more or less specific time can be guaranteed. Earlier trials with such a system have shown favourable user reaction.

One factor that works against the carriage of goods by rail is the transfer of production units away from industrial centres and the complex structure of production, with many movements of intermediate products between individual production units, a process that reduces the volume of goods on individual routes. Railways may be able to overcome this drawback to some extent by combining a number of flows on one route and/or by extensive automation of their operations (see below).

c) The propensity to travel

Aside from the distances between locations of different activities (people living farther away from their work, larger schools with larger catchment areas) there is a further factor that may be called the propensity to travel. It involves being prepared to consider going to far away locations without being obliged to do so, like shopping in a distant city rather than in the nearest one of equivalent quality, going to an exhibition or theatrical performance far from home, etc. The concept can even be used with respect to goods. While goods cannot of course take any decisions themselves, their producers and consumers can respectively decide to market them in a larger area or use products from far afield. What is involved here is not the fact that some goods necessarily have to come from other areas where they are produced, for example wine and oranges are not produced in the Nordic countries, but a process of increasing the diversification by selling in Northern Europe wine which comes not only from France or Italy but also from California and Australia.

This propensity is certainly increasing now and, influenced by the discontinuance of frontier controls between EC countries, it can be expected to continue to increase and provide a separate stimulus for long-distance transport. The role played by frontiers between languages can however be expected to continue to exist.

While the growth of business traffic may be curbed by time constraints and the development of telecommunications, tourism is unaffected by these factors. In the long run, it can be expected that more frequent and longer journeys will be taken for purposes of tourism.

d) Internationalisation

At the present time, EC Member States are moving towards a common European space, while the countries of Central and Eastern Europe are developing relations with the Western world. If there are no negative developments over the next 50 years, it can be assumed that international flows of both people and goods in Europe will be much greater than they are now.

At the same time, contacts are also increasing between Europe and other parts of the world, thus promoting the development of long-distance transport by air and sea, Where goods are concerned, containers or other combined transport equipment are bound to play an important role and, where one end of the European leg of the journey is in a large seaport, railways have an advantage from the standpoints of road capacity and environmental pollution and also in terms of speed and cost.

In the case of passenger transport, good links are needed between intercontinental and European services, and many airports will be either the point of departure or destination of a European rail journey if train services are organised to cater for this demand.

Chapter 4

BEHAVIOURAL FACTORS

a) The three A's

All transport depends on personal decisions. In passenger transport, it is usually the person travelling who decided to do so and who selects the mode and route, although it may sometimes be the employer, a family member or other person or organisation. In the case of goods, it may be the shipper, consignee or a third party. The mode of transport will only be selected when three conditions have been fulfilled for the decision-taker concerning the availability, acceptability and awareness, or the three A's examined in turn below.

Availability

A mode of transport can only be chosen when it is available as an option, not on a general basis but for the trip in question. If the possibility of taking a train to go to a theatre is considered, not only must there be a train service between the point of departure and the place where the theatre is located but it must also be possible to return after the performance. For a journey to a winter sports resort, it will not suffice that there are trains to the destination (or at any rate to a place nearby) but bookable accommodation must also be available on the trains. Similarly, in the case of goods transport, a link with the rail system is not enough, since the right type of wagon must also be available. Any number of examples could of course be given in this connection.

Acceptability

The existence of an option does not suffice for it to be taken into consideration. Vehicles might be considered too uncomfortable, access times too long, frequencies inadequate or services too irregular for a mode to be taken into account. It may also be the case that use of a particular mode is simply not considered to be the proper thing to do or, alternatively, that it is a good option but not for "our kind of people". For goods transport, important factors in deciding whether a mode is acceptable or not are the possibility of a guaranteed arrival time and the risk of loss or damage. The possibility of direct contact with a customer also plays a role.

Awareness

A mode must not only be available and acceptable for a particular trip or consignment, but the decision-taker must also be aware of these facts. Awareness is partly a question of information but the fact is that an option that is not really wanted is often suppressed in the mind so that its existence does not come into awareness.

b) The image of guided transport

As explained in the preceding paragraph, the role a mode of transport is going to play depends first on the way in which people look at it. When a mode is considered to be old-fashioned, impractical, not socially accepted, etc., people will use it only if they have no other option, and even then they may sometimes prefer not to travel. In goods transport, if users think there is a lot of pilfering, losses or late arrival in the case of a particular mode, there will be a strong tendency to avoid using it for the carriage of valuable items.

During the 19th century the railways became the main mode of inland transport and continued in that role during the first decades of this century. Road transport has of course always been important for shorter distances and inland and coastal shipping are also important where they exist, but over longer distances people have always thought it natural to take the train or forward goods by rail.

As the private car, coach, lorry and airplane came into more general use as common modes of transport, the train gradually ceased to be the "natural mode". It is easy to see why this happened. As incomes rose, car ownership became an option for an increasing proportion of the population, offering the possibility of a completely open departure time, accompanied or not by members of the family, together with articles which might be appropriately packaged or otherwise, so as to travel -- almost while staying in one's own environment -- to any destination. Similarly, for the dispatch of goods, a lorry owned by the shipper or hired from an operator can be used to carry goods to any destination while remaining under the immediate supervision of the driver.

If rail transport is used, before actually starting a journey people have to go to a station, check timetables and buy tickets. In the course of their journey they may have to change trains, find the right platform and carry luggage from one platfom to another, etc. At the destination, the passenger finds himself at a station in an unknown environment with no knowledge of where to go. In the whole process, the passenger is largely left to his own devices and railway staff are often unprepared -- and indeed unable -- to provide any information. The situation is even worse where goods are concerned, since only when the shipper and consignee are located near a railway track can the transport be direct, otherwise transhipment is necessary. Even when goods travel directly, however, they are unaccompanied and only the non-arrival of the consignment will indicate that there has been a delay.

Such an outline of the intricacies of rail transport may seem very pessimistic and give rise to the question of why, if all this is true, passengers and goods travel by rail at all. The point is, however, that when people use rail transport regularly they get to know how the system works, while services can even be geared to their needs. This is more readily the case for goods transport, since individual shippers using rail regularly are known and special arrangements can be made for them, even to the extent of running through trains for a particular shipper. For passengers, the law of large numbers means that if many people have the same or at least similar travel requirements, services will be designed to meet them. That is particularly the case where commuting to large cities is concerned, but may also apply to holiday travel if many people are spending their holidays in particular regions. By and large, those who have learned to travel by rail are at an advantage even in unknown situations because they know how the system works and how to get information.

The replacement of rail transport by other modes is a process that becomes something of a vicious circle: if fewer people use trains, the captive market for rail transport diminishes and there is a growing impression that the railways exist only for special types of transport, such as land cruises through the United States, commuting in the vicinity of large cities, the carriage of iron ore from an inland mining area to a seaport, etc. As the patronage diminishes, services are reduced so the process continues, a process that is already well advanced in the United States.

If policymakers consider it worth keeping the train as one of the modes that can cater for transport demand in the long-term -- and, as will be seen below, there are many arguments to take this position -- rail transport must be geared to the ways in which people and enterprises wish to organise their activities instead of expecting potential users to adjust to the methods employed as the most convenient way of running a railway. It is also very important to teach people how the system works, and young people should be given priority in this respect. In the first place, many older people have lived through a period in which car ownership was not so widespread; secondly, while we shall of course all be dead in the very long term, younger people have the highest probability of surviving in the relatively long term. If this policy is to be effective, a reasonable standard of service must be offered to these young people so that travel by train is not remembered by them as an activity that they had to put up with when they were at school -- along with a lot of other disagreeable experiences -- but will never repeat once they have a little more money to spend.

A major innovation can do a great deal to promote any product, and rail transport is no exception. The introduction of the Trans Europe Express (TEE) in the fifties represented a significant advance on the international trains existing at that time, which were often still steam hauled, less comfortable and much slower. Indeed it was never considered in poor taste to travel by TEE, as might have been the case for an ordinary train. Today's high-speed trains are in a similar position in that they are regarded as an option by those who would otherwise travel by air or private car. Such is the extent to which this new rail service is differentiated from the conventional one that, when a person arriving at a meeting in Paris was asked whether he had come by train, he is said to have replied: "No, I came by TGV".

A different situation exists when a mode is selected for goods transport since the decision-takers are not travelling themselves. One way of coping with the lack of information about available options is to assign a greater role to the intermediary, an enterprise that does not carry the goods itself but concludes contracts with carriers who can cater for the shipper's needs most efficiently. Unless the individual shipper is very large or has very special needs, the intermediary will have better information on the options available and may also be able to negotiate with carriers to create services that would not otherwise exist.

To sum up, however high the standard of a rail service, if people do not take it into account as an option, the endeavours made to offer such a high standard will be wasted. What essentially has to be done is to make people realise that railways not only exist but exist for them.

c) *Conditions of transport*

When discussing the choice of transport, we sometimes overlook the conditions under which the services are performed or, at any rate, the feelings of users about these conditions. Railway undertakings are necessarily large and have developed over time in such a way that users are "dealt with" rather than "provided with a service" and a minimum of information is supplied.

If you start a journey without having bought a ticket in advance you have to buy one at the ticket window where, in this first contact with railway staff, you find you have people queuing behind you and anxious to catch their train who would not be at all pleased to hear you ask for information about timetables, platforms, necessary changes, etc. All this information can of course be obtained from the printed timetable, station indicators, and announcements on platforms or in trains, but not everyone knows where to find it or is prepared to wait for the announcements.

Furthermore, the information supplied concerns a theoretical situation in which all trains are running on time, use their normal platforms and have the usual formation. Those who have travelled by train know that the theory is not always found in practice: trains run late, connections are not always made, through coaches may be missing. If you are waiting on the platform at about 5.25 p.m. it is very disturbing to hear the announcement that the 5.22 train from B to A has been delayed for an unknown period. Similarly, it is not very convenient when a long international train enters the station and a great many passengers loaded down with luggage have to board in 2 or 3 minutes and find that the coaches are in the wrong order. While many rail undertakings try to provide better information, there is still the feeling on entering a station that one is involved in a large system that, hopefully, one may leave at the right place at about the right time but cannot influence or even understand in the meantime. That situation is not always appreciated by people who have acquired the habit of, quite literally, taking the wheel in their own hands.

A similar pattern exists for goods transport, although one important difference is of course that they usually travel unaccompanied, a further factor of uncertainty. Once a consignment is in transit, the process is difficult to interrupt and one can only hope that the goods will arrive on schedule. The greater the distance and number of frontiers to be crossed, the greater the uncertainty.

These factors are not usually taken into account in behavioural models but they can influence the coefficients assigned to particular aspects of the journey (waiting time or number of interchanges) or a "modal constant". This is not an entirely objective description of the facts however. Regular users of the system will be considerably less affected by the lack of information and uncertainty, but one may never become a regular user if one does not know the system.

d) Towards really accessible rail transport

It is essential to follow two strategies in parallel: first, the provision of better information in all cases, which is even of benefit to regular users who are of course those who do most to ensure the railways raison d'être; secondly, everyone has to be taught how to travel by train, a learning process than can start at primary school (a ten-year old is not too young to make a journey alone) and continue through adult education and also informally via the media (people in television plays might travel by train or meet at stations while waiting for a train). It is important to provide such training for immigrant groups in a country because in many cases they do not have cars and have limited knowledge of the national language.

Similar arrangements should be made for goods transport but here priority should be given to greater reliability of delivery times and the provision of more information for consignees. Considerable commercial success has been achieved in a number of cases where a guaranteed delivery time has been given. Information technology should be developed and used for this purpose.

e) The role of governments

While it is up to the railway undertakings themselves to make their services more attractive, government support can also be of importance. Indeed, the fact that public authorities at all levels make provision not only for roads, telecommunications, electricity, etc. but also appropriate rail services can help to ensure that this mode of transport is recognised as being among the amenities needed by a modern society instead of being just a legacy from the past.

Government policies should not only take account of the provision of facilities but ensure that land use patterns are such that guided transport can in fact fulfil its potential role.

Chapter 5

TECHNICAL DEVELOPMENTS

In considering technical developments in connection with guided transport, attention is first focused on traction systems and speed, vehicle design and means of guidance, and automation. There are however other aspects which may seem less glamorous but are as -- or perhaps even more -- important as high-speed or magnetic levitation, such as operating systems, user information, energy efficiency, environmental protection, and harmonization of technical standards. These factors are examined in this chapter from the standpoint of demand rather than supply, that is to say by describing developments that are desirable if rail transport is to fulfil its proper role in the long-term future, rather than by describing developments that may be technically feasible.

One preliminary remark is called for: technical progress in the sphere of rail transport is a step-by-step process and any attempt to incorporate several stages of innovation in a single step risks failure, the classic example being the British Advanced Passenger Train (APT) for which development started about the same time as the High Speed Diesel Train (HSDT). The *APT* seemed to be far too advanced and the project was shelved several years ago. As Intercity 125 (miles per hour), the HSDT is now the backbone of the non-electrified Intercity services of British Rail. Indeed, the high-speed trains now running in France and Germany, and the tilting trains operating in Italy and Sweden are far less advanced than the *APT*. It is moreover quite natural that not all new solutions should be implemented. The same applies where developments in industry are concerned in that many new products or methods never leave the laboratory stage. It is however difficult to experiment with new trains inside a laboratory.

a) Operating systems

Railways have always placed the emphasis on operational safety and, as compared with other modes, the degree of safety provided by modem signalling systems -- including train control -- is high enough to be nearly perfect. Automatic train operation is now an option but is used only on certain urban railways (metros) which have a uniform train service (all trains with the same type of vehicle and the same schedule of stopping stations) and a fully protected right of way. In the case of regular railways the driver is thought to be able to cope better than an automated system with the existing circumstances, including emergencies.

However, operating systems have functions other than solely ensuring safety. A system should make efficient use of the infrastructure available and do everything possible to ensure that trains run on time. Extra time and energy is used when a train stops, so it is extremely important to keep trains running whenever possible. If there are bottlenecks in the system (junctions or crossings) and it is found that not all trains are able to pass at the time they are expected, the flow of traffic can be improved by slowing down or speeding up some trains to ensure that they all approach a clear signal. A train *that* has stopped immediately before a crossing will spend far more time on the crossing in building up speed than a train that has been held up at some distance from the crossing and then

approaches a clear signal at speed. Some railway undertakings have already done a substantial amount of work in this connection and, with the right degree of effort, these systems can certainly become operational during the period under consideration here. The effect will be to increase both line capacity and service quality. Energy will also be saved.

b) User information

Most railway undertakings publish timetables and issue rules governing deadlines for the arrival of goods. Aside from the fact that this material is not always easy to read, the infomation provided is only on the theory and not on the practice. Trains are sometimes delayed or re-routed and goods may arrive earlier or later than the official deadline. Information technologies can be used to compile relevant information and forecast arrival times. However, it is not enough for this information to be available simply to operators or to be stored in a central computer. Users should be given all relevant information for planning their activities. In this connection, due consideration should be given to problems of perception.

Speed is not the most important factor where goods are concerned but guaranteed arrival time. The consignee should therefore always be notified of any change in this time. It may be appropriate to have a penalty for late arrival in the case of urgent consignments. Similar arrangements should be made if the railway is unable to pick up a consignment on time.

Passsenger information needs are more sophisticated since passengers normally go through the system themselves and may therefore take wrong trains, wait on the wrong platform, fail to get off at their destination, etc. Depending on the type of journey, more or less information will be required, but railway operators must always bear in mind that it is the passenger himself who makes his own decision as to whether or not to get on the train at the time of departure.

Although train staff cannot be present at all the doors, they should welcome passengers after departure by walking through the train so that any persons in doubt can ask for information. The train staff will first have to be given the necessary information in order to be able to do this properly, so any departure from normal practice must be communicated to the staff on trains as soon as possible to enable them to give really useful advice. It is not very helpful to tell someone on a train running late: "I hope your connecting train will wait but I am not sure". On the other hand, it may be very useful to be told: "The train is far too late to meet your connection but if you get off at the next station and take another route you will lose only one hour instead of two".

While much of this type of the information could very well be provided now, it can certainly be assumed that an adequate information system can be introduced well within a time-span of 50 years. This will require some effort, however, and all concerned will have to show considerable discipline to ensure that the system continues to work well. Railway managers will have to realise, however, that most of their clients are more concerned about this type of information than about technical information.

c) Traction and energy

Without becoming too technical, consideration may be given to certain aspects of traction equipment.

The main means of traction can be expected to be electric although the power system cannot be specified. A change from one system to another is in fact extremely costly and disruptive, while bi- or polycurrent vehicles tend to become cheaper. Several railway undertakings are introducing electric locomotives that can haul both heavy passenger trains at speeds up to 200 km/h and heavy goods trains (more locomotives may of course be needed for very heavy goods trains and on mountain routes). Multiple unit sets are normal practice and may continue to be so for high-speed lines, including high-speed goods transport.

Leaving aside technical detail, it will suffice to say that modem traction vehicles are likely to be more reliable, cheaper to maintain and more energy efficient than those built in the past. Moreover, at least two railway undertakings have already developed driving methods that limit the use of energy as far as possible by turning to maximum advantage a moving train's kinetic energy. From the standpoint of energy use, therefore, the benefits of the steel-wheel on steel-rail system can be expected to be even greater.

The situation for autonomous traction vehicles is less promising. The diesel motor, the most common source of energy for rail vehicles, has a number of environmental drawbacks also found in lorries: exhaust fumes and noise. The future prospects are by no means clear. New forms of energy storage might make battery-powered electric vehicles more competitive, while cheaper electrification using tramway technology might shift the balance between autonomous and full electric traction.

A few words on linear induction motors: the normal method of moving a rail traction vehicle is by turning the wheels and relying on adhesion between wheel and rail. For mountain railways, a rack and pinion system is used because adhesion does not allow the necessary motive power to be taken up, There is another method available, however, whereby the vehicle is moved directly and the wheels follow. The linear electric induction motor works in this way. It moves the vehicle along the track by magnetic forces between vehicle and track. It is noteworthy, however, that this type of motor has been recommended only for wheel-less trains such as those using the air cushion or magnetic levitation systems. This technology will not therefore be dealt with as such.

d) Vehicle guidance

Steel wheel on steel rail is the conventional guidance system for railways. Trials have been carried out with inflated rubber wheels on steel rails but these are no longer used. Similar wheels of a larger dimension are used on a flat surface, mainly concrete, by a number of urban railway systems, all of French design.

Most of the interest in new guidance systems is focused on vehicles without wheels. Air cushion trains were developed some decades ago, the most advanced version being the French Aérotrain which could be used for both suburban and long-distance traffic. Attention is at present centred on magnetic levitation trains, namely the Transrapid which uses attracting magnets and is being developed in Germany, and a maglev bain which uses repelling magnets and is being developed in Japan. Both systems are at present operational on test tracks only and no decisions have as yet been taken with respect to their full-scale introduction.

The main drawback of these systems is that they are not compatible with the existing rail networks. Their scope for application in the long term will therefore be determined not only by the question as to whether they are technically successful and economically viable but also by the future situation of traditional rail networks. If there is a need for a special network of high-speed services superimposed on traditional railways, a new technology can be considered. If the existing rail

networks are to contract owing to lack of traffic or, perhaps, confine themselves to local and/or goods trains, new technologies may be introduced in future for intercity passenger services. However, if long-distance services on the existing rail network can reach many destinations, there is very little scope for new technologies.

Developments in future will therefore depend on the general role to be played by rail transport and also on the geographical structure of the particular country. If the demand for transport can be met by linking up a small number of cities, it will be more cost-effective to build a new system than it would be in contexts where long-distance transport consists only of relatively small flows between many cities and towns.

Perhaps the most radical change in the pattern of long-distance traffic is to put it underground, as was done a century ago for urban transport in large cities where the streets cannot carry all the traffic and the construction of viaducts is not always feasible and has negative effects on the environment. It is perhaps natural for a country like Switzerland, that already needs many tunnels to travel from one valley to another, to consider such a solution under the heading of "Swiss Metro", but other countries are also examining the possibility. No experiments have as yet been carried out but much may be done within the next 50 years.

The system makes use of tunnels in which there is a vacuum so that air pressure and piston effects do not interfere with train movements. Magnetic levitation could be used so that very high speeds of some 500 km/h can be achieved. It may however be asked at the outset whether passengers wish to be carried under Switzerland through a continuous tunnel rather than see the country for at least a considerable part of the journey, although this view would have no bearing on goods transport or night trains.

e) Automated transport

Although it is not common practice to organise the automatic running of traditional trains, including magnetic levitation vehicles, it is well within the technical possibilities existing. In fact, users may not even notice that the system is automated, and automation has little influence on the operation of the system.

The automated transport to be examined here consists of the option of allowing vehicles, or transport equipment loaded on vehicles, to fiid their way automatically through the system from their point of origin (or access to the system) to their destination (egress from the system). In such a system, vehicles may run in trains or individually.

The way in which such a system operates is much more like carriage by passenger car or lorry in that a small group of people or quantity of goods is carried by one vehicle from the point of origin to the destination. The first question that might be asked then is whether it would be technically and economically feasible for automated transport to be used for part of the journey of a road vehicle. It is in fact technically possible to operate road vehicles by guiding them on a track for part of the journey, as has already been demonstrated by a number of trials and even the full-scale operation of guided buses. A motorway with guided vehicles has far higher capacity and levels of safety than an ordinary motorway. However, there are a number of reasons why such a solution does not seem likely to be adopted even in the very long term.

A large proportion of the environmental problems inherent in road transport are caused by the internal combustion engine. While an automated motorway system can make these engines more efficient, there is still their basic way of operation and the rolling resistance of rubber-tyred vehicles on a road. One important aspect of passenger transport is that part of the appeal of the passenger car is the fact that the driver at least has the wheel in his own hands. It is open to question whether people would like to travel enclosed in the limited space of a car if they were unable to influence its movement in any way. Lastly, guided transport generally requires a very high standard of maintenance both for safety reasons and also to ensure that operations are not disrupted. It is doubtful whether such a standard could be maintained for a large number of vehicles owned by literally millions of people, each with his own idea about the best way to keep the vehicle running, and perhaps not particularly prepared to spend money to prevent a breakdown which is very unlikely in any event.

Automatic running could however be considered for small passenger vehicles about the same size as a taxi or minibus and for goods vehicles. If this is to be a worthwhile option, it is essential to have an individual right of way with no possibility of interference, a factor that in itself severely limits the scope of such systems. It should also be borne in mind that driverless vehicles may reduce personal safety and do not allow for any contact with consignees for goods deliveries. The energy efficiency of small vehicles is, moreover, necessarily low and they are bound to be costly per unit of capacity.

Another option that has been proposed is to adopt the idea of container transport whereby bodies are equipped to take various types of passenger or goods traffic which would be carried on flat wagons running in trains and be transferred from one train to another instead of shunting the wagons between trains. This rolling stock would mean that traditional railway lines could continue to be used with the energy efficiency of steel-wheel on steel-rail while eliminating the need for shunting or changing trains. Moreover, efficient use could be made of the equipment since the carrying vehicle can be used for any type of transport according to demand.

There is no way of knowing whether these or other types of automation will be developed in the next half century. At this stage it will suffice to show that several options are available, although others may of course arise.

General observation

There are many technical options available, although it may well be that the least attention is paid to those of greatest importance to the future of guided transport. The utmost attention should be paid to the improvement of operating systems and provision of adequate information to users. Indeed, much remains to be done in these spheres. The scope for new guidance systems, such as magnetic levitation, does not depend solely on technical success but also on the future structure of the rail system. It is better to bear this in mind from the outset, instead of subsequently concluding that a good system has been developed, although it cannot be used in the existing context.

Chapter 6

ENVIRONMENTAL CONSTRAINTS

The future role of guided transport does not depend solely on the demand for rail transport but also on the demand for transport in general and on the capacity of other modes to cater for their share. For instance, a lack of capacity on the urban road system may mean that some urban passenger trips are made by rail instead of road if the appropriate rail services are available.

Capacity problems are related to particular places and times because a transport system is never used to capacity *all* the time and everywhere. There is however another type of constraint that has a far wider influence, namely the effects of transport infrastructure and its use on the environment. There is growing awareness that the population of the planet is gradually destroying it as a place to live and is making life unpleasant or even dangerous. While not suggesting that transport is the prime factor in this process, it cannot be denied that transport activity ranks high among the factors that are determining the future quality of life.

Many countries are now preparing or at least considering policies to limit the use of certain modes of transport (mainly road transport) in order to protect the environment, or at any rate to reduce detrimental effects to levels lower than would otherwise be the case. Certain trends suggest that technical developments will in future help to reduce negative effects without changing the behaviour of those who travel or dispatch goods. This outlook is highly speculative, however, and in the long-term future it is most likely that environmental constraints will be a major factor determining both the extent to which demand for transport can be met and the ways in which this can be done. Technical improvements to vehicles, including new types of motor and new energy sources, may help to curb pollution. All use of fossil energy inevitably contributes to the production of CO_2, however, and so to global warming. Energy efficiency will therefore be of the utmost importance.

There is no reason to suppose that the different forms of rail transport that now exist and may be developed in the future will have no harmful effects on the environment. From the standpoint of energy efficiency, the steel-wheel on steel-rail system offers minimum resistance in movement, and large numbers of passengers and huge quantities of freight can be carried in one train, while use can be made of electricity that can itself be generated under far better circumstances than energy generated in relatively small units. For these reasons rail transport is usually less detrimental to the environment than road and air transport, more particularly when the capacity of rail vehicles is used to a reasonable degree.

It may very well be that the volume of road and air traffic cannot in future be allowed to pursue its normal rate of expansion, not only because infrastructure capacity cannot reasonably be provided but also because the environmental effects of these loads are unacceptable. Rail transport can help by catering for at least some of the demand that needs to be shifted away from other modes.

In this connection it is often argued that the present volume of rail traffic is such that even by doubling or trebling it one could cater for only a small proportion of the expected increase in road traffic. Indeed, a one for one substitution between modes is not a reasonable solution. Some of the demand for road transport has been created by the spatial distribution of activities and, in fact, by the organisation of human life. If road transport is to play a less important role in future than at present, a number of activity patterns that can only be maintained by an extensive use of road traffic will have to be adapted. Moreover, non-motorised modes -- first of all the bicycle -- would be the most important replacements for shorter car trips. In the meantime, in a number of European countries at any rate, it is quite possible to have a pattern of activities covering a wide area without relying on the passenger car. In this respect it should be noted that public passenger transport tends to become better as more people use it, just as services become more frequent. This also applies to certain categories of goods transport, such as trains carrying containers direct between two stations.

Any measures that can be taken to switch demand away from modes that have considerable negative effects on the environment cannot bring about a major shift in modal split overnight. At this stage it will suffice to say that guided transport may be called on to play a far more important role in a few decades from now than could have been expected some ten years ago. It is sufficient to draw up strategies now in order to cope with a much higher demand and to refrain from the closure of routes that may not be needed now but may be essential in the future. The availability of a right of way may be of great value if rail services have to be expanded or re-opened in the future.

While the 19th century may be characterised as the century of the railways, the 20th certainly will be considered as the century of the car. It is of course too early to say what the general image of transport in the 21st century will be, but at this moment the most likely development is that several modes of transport will work in parallel to cope with demand. The direct financial cost of providing the services will continue to play a role in orientating demand, but the environmental cost can be expected to become an overwhelming factor. One crucial requirement for the success of an environment-conscious transport policy will be the establishment of standards for all modes of transport in order to protect the environment. These standards may relate to noise, air pollution, ecology and other factors, and can be complied with by reducing vehicle emissions or by modifications to infrastructure. The cost of complying with these standards will push up the price of modes of transport which have potentially negative effects on the environment, thus becoming part of the financial cost to be borne by users.

Even with appropriate standards, some negative effects will remain and the costs of these must be internalised by some form of environmental taxation that will directly influence decisions as to whether or not a transport operation is to be performed and by which mode. There will be no question of automatically choosing a particular mode. The quality offered by the mode will have to be assessed in the light of its cost in the broadest sense, while the importance of the journey will have to be established before it is undertaken. It would be extremely detrimental if only one option were available for many types of transport. This would also be the case if there were other options but many people were unaware of them. However, a transport system consisting of several modes which overlap in their coverage of the market and are all acceptable in principle to the majority will make it possible to opt for the most appropriate one in each case, due account being taken of any constraint imposed for environmental reasons.

Under these conditions it can be assumed that an important role will be played by guided transport, that is to say traditional railways and tramways as known at present, high-speed railways or automated urban systems now existing and new guided transport systems that are under development or still have to be invented. There is no reason to think that guided transport cannot play

a far more important role than at present because it now has only a small share of the market. After the systems have been developed appropriately, capacity can be increased considerably. Those in doubt should bear in mind that, in the present circumstances, urban rail systems are the only way to keep people moving in large conurbations and they take a large share of peak traffic. If this can be achieved in a densely populated urban environment, there is no reason why it cannot be done for inter-urban traffic. It is not of course suggested *that* guided transport alone can ensure the mobility of people and goods, but that has never been the case.

If raii transport is to be able to play this role in the future, a number of measures will have to be taken:

- strategies for quickly increasing the capacity of existing systems need to be developed;
- rights of way need to be preserved, even if they are not going to be used immediately;
- infrastructure extensions should be prepared (in this context it is important to note that a more than proportional increase in capacity can be achieved by separating different types of train);
- users should be made aware that the train is available as a reasonable option for at least certain types of transport.

If these steps are taken in time it will be possible to respond promptly to any needs arising without disrupting the transport system as a whole.

Chapter 7

THE ORGANISATION OF GUIDED TRANSPORT

European railways are organised at present in national undertakings which are usually owned by -- and in some countries in fact a part of -- the central government. They operate goods and passenger transport on a national scale and provide regional and even urban services. Aside from a few minor exceptions, the scope of their operations is limited to national territory. International transport therefore involves at least two operators.

Some countries have separate railway undertakings that operate regional or urban services, sometimes jointly with the national operator. These may be called private railways but this often means no more than that they are not owned by the central government but by regional or local. authorities. There is one private undertaking in Europe which operates national and international services, namely the Swiss BLS (Bern-Lötschberg-Simplon Bahu), and the TGV from Paris to Bern uses the track of the BN -- a member of the BLS group -- to reach its destination.

Track and vehicles are in most cases integrated within a single undertaking, but where separate companies exist the use of the track is usually confined to one operator. This means that when an international train moves from one network to another, it is conventionally considered to have become the train of another railway.

The situation outlined above leads to a number of drawbacks that have now become quite familiar and will, if they continue to exist, prevent the railways from playing the future role that would otherwise be open to them.

A fundamental issue is that an "administration" (and indeed, the term railway administration is still used for the top management of a railway) is not well suited to operation in a competitive market. Both the style of management and the organisation around a technology (running trains rather than carrying goods or passengers from a point of departure to a destination) are no longer geared to the transport market.

Since a railway is a national undertaking it is often seen as a shop window for the country's industry. It is in fact remarkable that railways serve this purpose even more than national airlines. Since the vehicles are usually designed by the users themselves rather than by industry, it is perhaps difficult to accept a foreign design, at any rate for equipment that is attracting a lot of attention. The European standardization of goods wagons has met with some success, while the Pennsylvania bogie has been built for many decades and is used under the vehicles of a lot of operators. The European standardization of long-distance passenger coaches has however been a failure.

It seems at present that at least the larger European railways consider it necessary to develop their own type of high-speed train and also to keep the equipment they have themselves designed for international services. It is hoped that the work done by the European Communities will help to

establish a situation in which the choice of equipment is not determined on the basis of the nationality of the operator and producer but according to suitability, quality and price,

Perhaps the most fundamental feature in Europe is the fact that rail transport is organised on the basis of national undertakings. Given the recent political developments, it can be expected that Europe will form a single social and economic space, perhaps even including certain parts of Asia and Africa. Freedom of movement of people and goods will be the rule, and international transport will assume even greater importance than it already has. If international rail transport were to continue to operate under the present system of complicated arrangements among national railways, there must be serious doubts about its ability to compete for an appropriate share of the market with other modes in which a single operator handles the complete service offered. Some solution is clearly needed here.

Some years ago it was suggested that a European railway undertaking be established. Little is heard about that idea at present, possibly owing to the experience of the larger national railways which are in fact somewhat over optimum size and call for some decentralisation. Indeed, a single European railway undertaking would be such a colossal entity that it certainly could not work efficiently.

Separate, perhaps private, companies might be formed to operate international services. These would then use -- while of course complying with technical requirements and making an appropriate payment -- the tracks of national. railways or of the national infrastructure companies if the infrastructure and operational sides are to be separated. These companies may have their own vehicles and personnel, or hire them from the national operators, but should always be responsible for their commercial operations. They should decide what services are to be offered and at what price, and receive the revenue from them. While this solution would certainly give international services a better position on the transport market, it would maintain the separation between national and international transport and, accordingly, the role of national frontiers, whereas that role is going to be reduced in other spheres.

In order to eliminate the frontier effect and follow the pattern of development of the market, consideration might be given to an organisation based on that of British Rail whose activities are separated, thereby adapting railway operations to the structure of the market, a solution that is perhaps too obvious to have been considered up to now. What this would call for is a commercial undertaking to operate and market long-distance passenger transport in a certain area or corridor, or combined transport in a particular area, or Europe-wide bulk transport of grain, etc. These undertakings would then quite naturally consider transport within a single country or the crossing of frontiers on the same basis and do their best to gear capacity to demand. Other undertakings could be formed for regional and urban transport and would work beneath the national level, just as the British and French railways now operate suburban and regional passenger services under contract from regional authorities.

If the traditional organisation of European railways is so strong that it cannot be changed even over half a century, one final option remains open: the existing rail systems can be left to continue catering for local, regional and part of national demand -- with perhaps some minor international links -- while entirely new railway lines can be constructed essentially for international traffic but, as with other modes, also of course carrying national traffic on their routes. While this solution would be very costly, it cannot be excluded entirely because the demand for international transport will increase substantially and wholly new routes would be free of all the constraints on existing systems. Indeed, an optimum technical solution can be selected and a large degree of automation is possible. However, access to city centres will be difficult to ensure.

Chapter 8

THE ECONOMICS OF GUIDED TRANSPORT

A breakdown of the costs of guided transport shows an extremely high proportion under capacity costs, including virtually all infrastructure costs and a large share of vehicle costs, with a correspondingly low proportion of use costs. Moreover, infrastructure capacity is necessarily fixed in a specific geographical context and, accordingly, can only to a limited extent serve purposes other than those for which it was originally intended. Vehicles may be shifted to other routes although the possibilities for doing so, where they exist, are limited.

What this means is that, once the decision to build a system has been implemented, the difference between the economic results obtained by using it or by letting it lay idle is largely represented by the revenues that can be earned and not by cost. This has been the basis for policies designed to achieve maximum passenger-kms and tonne-kms at almost any price. There is likewise little incentive to curb operations if revenues diminish.

Alternative uses for railway rights of way are few. The so-called railway "conversionists" in the United Kingdom advocate their use for road construction, but they are usually too narrow and not appropriately located. In rural areas, disused rail lines are sometimes changed into foot-paths or cycle-paths, which are not forms of use that can command a high purchase price.

However, huge quantities of goods and passengers can be carried in one train for a relatively low operating cost. If such volumes can be carried, it is possible to achieve satisfactory financial results provided there is no competition between two routes owned by companies competing for the same traffic.

Another factor that influences cost structure is the extremely long useful life of most assets. Rights of way can of course last forever, while many buildings and structures are being used for over a century, and even vehicles have a useful life of 30 years or more.

The two factors together imply that starting up in the rail transport business is a commitment to the long-term future, with all the uncertainties inherent in such a step. The history of railway development shows that a major proportion of network development has been done by or on behalf of central or local government, since private investors would only undertake the most lucrative projects. This state of affairs is likely to persist in the future. While the construction of the Channel Tunnel is being funded privately at the risk of the future operator, it is very unlikely that all "missing links" in the European rail network can be completed in the same way.

The production of rail transport services is itself subject to major economies of scale, quite independently of infrastructure-related influences. Fast trains running over long distances without stopping are very productive (at least when they are reasonably well filled), while local trains stopping at many intermediate stations cost far more per unit of traffic. Quite apart from being slower, which

results in fewer kilometres per shift for personnel and vehicles, they may be heavily loaded at one end of the journey but less so at the other end. Another point has to be taken into account in the case of goods transport: a complete train load needs no shunting during its journey, whereas individual wagons or small groups of wagons need to be sorted in marshalling yards for collection and delivery by local trains. The railways therefore hold strong market positions for heavy flows of traffic and weak positions (both as regards quality of service and cost) for light flows. Beyond a certain point, there is no reason for railways to stay in the market, and indeed many regional and local services have been closed down. On the other hand, the policy of achieving maximum traffic at almost any cost leads to the continuance of services that are not really viable.

There are two ways of resolving this problem: first, the railways can behave in the market not as suppliers of rail transport but as suppliers of transport, without specifying the mode, so that they can decide which mode is appropriate in each case and use (mainly) road transport for the carriage of people and goods where rail is uneconomic; secondly, they can refrain from entering into contracts with users themselves and act through a forwarding agent who would also use other modes as and when required. The second solution is not uncommon for freight transport but can also be used in the passenger sector through an organisation like the "Verkehrsverbunde" in Germany and the "Transport Authorities" in the United Kingdom.

This present state of affairs is likely to continue in the future and, with the developments in society outlined in Chapter 3, the natural market for rail transport can be expected to continue to exist but will handle smaller volumes of freight traffic, owing to the diminishing importance of heavy industries, and more passenger traffic. The actual pattern of development will of course depend on the way in which the railways are able to adapt to changes in demand, the future distribution of activities, and the development of alternative modes. By and large, however, while it is uncertain how big a slice of the market the railways can capture, they will at least be able to make some money out of these operations.

The latter cannot be said, even in general terms, for segments of the market where the economic advantages of guided transport are only marginal, if they exist at all. Whether the railways will be able to provide short-distance passenger services or carry wagonload consignments profitably will depend in changes in the costing and pricing systems of competing modes. If these services are to survive, it may well be that financial mechanisms will be needed to ensure that the public purse bears part of the cost. The actual survival of rail services can of course only be warranted if they show real advantages over other modes.

The above arguments have been developed on the basis of past experience with rail transport. They will however continue to be valid in the future, even if new technologies are applied. The scale of network costs in relation to operating costs will be even greater for some of these technologies if automated systems and heavy infrastructure (tunnels) have to be built.

Since such a large proportion of the cost relates to the availability of guided transport and not to its use, it is worth asking whether the system of charging which relies solely on payments by users is a good one. Perhaps the serving of a city or region with rail transport should be subject to a payment by that geographical entity to the organisation providing the rail service so as to cover at least part of the cost of the infrastructure, Users would then only have to pay the cost of operating the system. Such a system already exists for private sidings in that the firm linked up with the public network bears the cost of building and maintaining a siding and also pays for the transport services it uses. Could not this system of payment also be applied for public access to the rail network?

Chapter 9

SCENARIOS FOR 2040

There is no way of determining the most likely course of development of guided transport up to 2040, so a number of different scenarios will be examined here. They relate first to the geographical scope of guided transport systems and, secondly, to the form to be taken by those systems.

While the scenarios are intentionally set out as contrasting developments, they should not be seen its mutually exclusive. Some elements of one scenario may be combined with elements of another, even in the same group. Developments may also differ from one country to another, depending on the prevailing situations and policies pursued.

The geographical scope of guided transport is given in two scenarios:

THE CONCENTRATED RAILWAY

THE OMNIPRESENT RAILWAY

Within each of these two scenarios, guided transport systems can take a different form. The following three types will be differentiated, but others -- and combinations -- are of course possible:

THE TRADITIONAL RAILWAY

THE AUTOMATED RAILWAY

THE NEW EUROPEAN RAILWAY

These scenarios will each be discussed in turn and they will then be compared and assessed from a general standpoint.

a) The concentrated railway

Railways are at their best for heavy flows of traffic -- which are most likely to be found in intercity transport of passengers and goods over distances of some 100 to 500 kms -- and in passenger transport in and around large conurbations. If market forces alone were left to operate, it is not unlikely that the railways would concentrate on such movements and leave others to competing modes, as has already occurred in the United States.

This scenario gives rise to a considerable reduction in the overall length of line, but a much smaller reduction in volume of traffic because the most heavily used lines are kept in service, or even extended, while those carrying light traffic are closed down. The most important change is however that the train is no longer the mode for longer-haul transport but is available only within and between major conurbations or where heavy flows of goods traffic exist.

A special function that railways may also retain and develop further in this scenario is that of bridging geographical areas that are difficult to pass by road, such as sea channels and mountainous areas. In these places road vehicles can be loaded on a train to be carried to the other side much more easily than if they have to travel on their own wheels. Accordingly, crossing these barriers is quicker and cheaper and also calls for less energy and less infrastructure.

The contribution made by guided transport to help relieve congestion and reduce environmental damage can be significant even with the concentrated network since the train is operating in a context of maximum traffic and where it is most competitive. One disadvantage is that passenger cars and lorries are needed if one is to be able to move about everywhere, so it may be difficult to establish a context in which these vehicles are not also used in parallel with the train. One observation about international transport is called for: if railways continue to be operated as national systems within national frontiers which for other purposes will have almost ceased to exist, there are less likely to be services between cities in different countries and the rail system in Europe will develop into a number of regional systems, generally within one country, and a few international links which carry very heavy flows of traffic, possibly more in the goods sector than that of passengers.

b) The omnipresent railway

The name of this scenario should not of course be taken literally since there can be no question of serving all possible destinations by guided bansport. It indicates however that such transport will be available throughout a country, at least reaching places where there is some minimum level of demand. It will be supplemented by other modes (road, water and air) for types of traffic that rail transport cannot cater fox, or flows that are too light to warrant a rail service.

The networks of this scenario will look like the rail systems now existing in most European countries, although that is not to say that they will be unchanged in 50 years' time. Lines and stations that are no longer used sufficiently as a result of changes in the geographical distribution of activities and the organisation of production may very well close down, while new lines and stations will be built to cater for new demand. New types of systems may also develop, such as high-speed lines for passengers and/or freight and automated urban systems. One characteristic will remain in that rail transport can be used on any corridor carrying heavy traffic within each country and, it is to be hoped, also between countries.

In this scenario the train, irrespective of its form or size, can remain or become once again, if not the, at least *one* of the natural modes for carrying passengers or goods, and not simply be the mode taken into consideration for a small number of special situations. There is however an economic problem: if traffic is heavy the full cost of a rail service, including the cost of the fixed track or guideway, can be covered by revenue, at any rate if the pricing system is appropriate. That is not necessarily the case for services carrying light traffic. It is quite clearly beyond the scope of this report to deal with this matter in full, but attention has to be drawn to the fact that, if one wants a national system of guided transport, some kind of national financial back-up or solidarity also has to be developed. This need does not stop at frontiers, although the responsibilities of European railway undertakings do. If the railway is to be present, not only in each individual country but also in Europe as a whole, then Europe also needs *to* show its solidarity.

c) The traditional railway

The least challenging assumption is of course that guided transport will not change very much over the next 50 years. That is to say that, as at present, trains consisting of locomotive hauled non-motorised vehicles or of motor sets will run between fixed destinations. Vehicles may be added or left en route or be marshalled into other trains, but the running of trains will continue to be the normal practice.

This scenario does not assume that trains will look as they do now or even that they will run on steel rails or be electrically powered, but simply accepts that their operating system will have changed very little from the present me.

d) The automated railway

Trains are at present operated by an automated system on a number of urban rail networks, with the train personnel having only a supervisory role. In some cases there are no personnel at all and remote supervision is practised. There is also considerable automation in routing and signalling rail traffic. It would in principle be possible to extend the application of these systems but that is not the intention in this scenario.

Instead of running trains, that is to say one or more rail vehicles running together from a point of departure to a destination, individual vehicles might be routed through a system, running physically or electronically coupled to other vehicles for part of the way but each having its own point of departure and destination as determined on the basis of demand. Such systems are being developed at present under the name "people movers" for short-distance traffic but they might also be developed for longer distances and for goods.

Another option is to have vehicle bodies carrying passengers or goods which are systematically separated from the undercarriage, as is already the case for container transport. The bearer vehicles continue to be operated in trains but, instead of having the passengers walk across the platform to a connecting train, the vehicle bodies are lifted off one train and placed on another at the connecting point.

Both systems do depart quite a lot from current practice in rail operations, indeed to a much greater extent than the idea of replacing or supplementing high-speed trains on steel rails by trains supported by an air cushion or magnetic levitation. It is also for this reason that it is not easy to say what the system might look like. Designers have a maximum amount of freedom and are sometimes able to make the most of their opportunity.

It should be pointed out, however, that the principal aim of the above systems is to avoid the drawbacks involved in changing trains. In a particularly sparse system which has trains running in only a few corridors carrying heavy traffic, opportunities to change are limited by the fact that there are few other trains to change to. As a general rule, the denser the system, the greater the advantages of this type of automation, but the cost of changing from the present system to a new one is also that much higher.

e) The new European railway

One might be inclined to think that demand in the mid-21st century can be catered for satisfactorily by the current developments in rail traffic such as:

- high-speed trains running at 300 km/h or perhaps even faster in the near future;
- better monitoring of goods traffic;
- double-deck trains for high density passenger traffic;
- roll-on/roll-off trains to bridge geographical barriers.

New systems are being developed, moreover, while there are clearly obstacles to increases in the quality and capacity of existing rail systems such as:

- growing opposition to the building of new infrastructure, whether it be a new railway line or the extension of an existing line;
- the combination of different types of train. in the vicinity of large cities makes services unreliable;
- the national character of railway undertakings is not well suited to cater for a European market;
- the maintenance of common standards for all rail vehicles makes it difficult to take full advantage of technical developments.

Given the fact that the market for guided transport can be expected to grow substantially over the coming decades, there may be scope for a new European system of guided transport, quite separate from existing railways, to cater for long-distance passenger and goods traffic, not only between European countries but also on longer distances within them.

In fact, the construction of such a system is precisely what Japan decided to do some 30 years ago, albeit for passengers only, when it built standard gauge high-speed lines which are by definition not accessible to the existing narrow gauge trains.

Such a European system would not replace but supplement the existing systems, which would continue to cater for traffic over shorter distances and even long-distance national ox international traffic on routes where demand does not warrant the construction of a new line.

It would be an advantage to have a European undertaking responsible for the construction and operation of the system, but it is beyond the scope of this report to argue whether it should be publicly or privately owned.

When constructing a new system, the choice of technology is almost entirety open. Some may consider it should be an air cushion or magnetic levitation train on a viaduct such as France and Germany have been developing. Others will be in favour of a train running in tunnels to avoid detrimental effects on the landscape and eliminate air resistance at the same time (the Swiss metro could develop into the Euro-metro!). Still others would prefer to remain with the good old steel-wheel on steel-rail technology -- at present the fastest of all. forms of guided transport -- in order to make use of the new high-speed lines that have just been constructed.

It would be unwise to identify this scenario with one technology only, Why construct a tunnel under an almost uninhabited plain? On the other hand, in mountainous areas and city centres, tunnels will be needed in any event. The basic idea is that of a system of routes linking large city centres and airports and also catering for very heavy flows of goods transport by means of a European network which provides high-quality service and leaves existing railways to cater for more local demand.

f) Comparison of scenarios

If market forces are left to operate, the outcome will most likely be a scenario something like the first one. 'The market" includes not only relations between users and providers of transport services but also, for instance, a city wishing to have an urban rail system or be connected with other cities by an inter urban one, or a port or industry wishing to have rail access and willing to pay (part of) the cost of getting it.

Relatively little state intervention is called for because there is no overall goal with respect to the provision of rail services. In order to establish the "omnipresent" railway, however, some national body should supervise developments and ensure that all regions and cities are served appropriately. As Europe is becoming a single economic and social space, this activity should not stop at national frontiers but should at least cover all EC Member states and preferably other European countries as well.

The omnipresent railway could cater better for tourism travel with the exception of that between urban areas. As non-urban tourism is determined by climate (winter sports or summer beaches), a dense rail network makes it easier to satisfy temporary demand (TGV-neige or Badehosezilge).

Technical standards can be changed more readily in a rail system that consists of a small number of long-distance routes, worked by passenger trains, freight trains or both, and short-distance systems for urban and suburban passenger transport. Relatively little through working is then needed, and a break in technology is not too inconvenient. In a national or international network, however, it is very important to maintain the possibility of through running and a change from the existing situation is both costly and complicated.

The automated system described above can be implemented more readily in a scenario that would otherwise resemble the "concentrated railway", but the need for this type of automation arises mainly in a network with a large number of connections. There however it is extremely difficult to introduce gradually and one cannot of course close down the system for several years and re-open it after rebuilding.

One means of making a gradual transition would be to start with the segment of the market in which most problems arise in traditional operations, namely the carriage of goods in single wagon loads. Passengers are at least capable of walking from one side of the platform to the other to change trains, while large quantities of goods can be carried in through train loads, but single wagon loads have to be shunted en route, which is costly, time consuming and a source of delay. If use is made of vehicles that run on existing track, dedicated services may be introduced in a network which can be developed gradually on the basis of demand. Such a network could very well be set up by a separate company which will pay the railways for the use of track and other equipment.

The "new European railway" outlined above would take quite some time to set up, so decisions would have to be taken soon. The greater the expansion to be expected of guided transport in the long-term future, the greater the likelihood that this scenario would be viable.

The European railway is not a solution in its own right, but must be considered as an option to be taken in parallel with a scenario for traditional railways. In fact, for the following two reasons it combines better with the omnipresent railway than with the concentrated one: first, the viability of a separate European system clearly depends on the role that guided transport is expected to play in the future, so it would be very strange if this role should develop only on the links that might be part of a European system; secondly, *existing* railway networks would be cut down too much if they were to concentrate on high density intercity corridors and suburban traffic, on the one hand, while on the other the long-distance traffic was taken over by a new system. In that event, they would remain simply as regional undertakings and, in the case of large countries, one might even query whether it would be warranted to have a single national undertaking.

Chapter 10

POLICY IMPLICATIONS

The aim in this final chapter is to take the arguments set out earlier as a basis for indicating a number of possible approaches to transport policy in the future, either in the ECMT countries taken as a whole or in individual countries.

1) If governments consider that the fact that railways exist in the long-term future will be in the general interests of society, rather than purely in the interest of the operators and their workforce, they should help to create a climate in which it can be felt that rail transport is worth using.

This cannot and should not be done by promoting the use of the train by means of advertising. Steps must be taken to ensure that guided transport is seen as a good means of providing at least some types of transport service and that potential users become aware of this fact.

What this approach implies is that, if governments wish rail transport to continue to exist, they must take an interest in the quality of service provided by operators and also in the question as to whether these services are geared to users' needs.

2) In at least some countries there is general agreement that, in the long-term future, road transport cannot cater for all the demand that would arise for it in normal circumstances. This may be attributed in part to the fact that the space required for an adequate extension of the road system is unavailable but it is mainly due to the environmental effects of motor-powered road transport.

While there is no general agreement on this issue at this moment, no government can at present look towards the future and say that it is certain that there will never be a need to shift demand away from road transport.

Accordingly, every effort should be made to preserve rail systems for the future and leave open a reasonable number of options for extending them. If consideration is being given to the closure of a railway line or the reduction of capacity (for example, by taking up one of the two tracks), care should be taken to determine whether there might subsequently be a greater need for the route in question and, even though it may not be desirable to keep the line in service, the right of way should be preserved at any rate. Similarly, it may be worthwhile opening new rights of way that are not to be used immediately. This procedure can be particularly appropriate when adopted in conjunction with the construction of a motorway.

3) The organisation of railways on the basis of national undertakings is detrimental to the provision of adequate international rail services and infrastructure, a situation that cannot be allowed to continue in view of the fact that international transport can be expected to become increasingly important in Europe, not only within the Member States of the EC or ECMT but also within Europe as a whole. It is necessary to find ways of ensuring that the user deals with a single spokesman for the railways on the international transport market.

At the present time there are two steps that governments might take in order to provide for the possibility of establishing a maximum number of viable international rail services. In this connection, it would be particularly advisable to consider the scope offered by changes in national legislation with a view to:

- enabling an undertaking of any nationality to build a railway line crossing one or more frontiers;

- allowing an operator who wishes to run international rail services to use the networks of national undertakings on payment of an appropriate charge.

Aside from these measures -- which will call for changes in legislation in some countries -- there is also scope for an international approach to the future structure of networks, and indeed the first steps have already been taken in *this* direction, although they cannot be fully effective until the organisation itself has been changed.

4) Technical research on railway operating systems and user information has to be further developed, and this can be done by widening the scope of current European systems such as DRIVE and/or EURET or by setting out new co-operative arrangements.

N.B.

There has so far been no fundamental discussion of cost or finance. The provision of rail infrastructure and services is not of course free although, in principle, there is no reason why the cost should not be charged to users. A break-even point may not be achieved in sparsely populated areas or where access is difficult, but this is also the case for road transport and other services.

However, it is important to bear one point in mind: while, in the road transport sector, the market mechanism operates for vehicles only but not for infrastructure, satisfactory results cannot be expected from the application of the market mechanism to rail transport.

ANNEX 1

REPORTS PRESENTED AT THE 17th PTRC SUMMER ANNUAL MEETING

CHANGES IN THE STRUCTURE OF PRODUCTION AND THE ORGANISATION OF SOCIETY AND DEVELOPMENTS IN THE TRANSPORT SECTOR

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In understanding the long-term forecasting exercise proposed by the ECMT, the authors are not taking much of a risk. It is very unlikely that anyone will read these papers again for their entertainment value in the year 2040. Even if they did the authors could always invoke the law of limitations. However, though risk-free, it is still an interesting challenge. Just as interesting, for example, as it would have been to have asked transport economists in the late 30s what they thought rail transport would be like by 1990.

One would have been allowed an ironic smile at the expense of those who had forecast the linear motor being taken into general use, travolators replacing Metro services and the disappearance of railway systems. Our respect, however, would have been due to those predicting general improvements in rail performance through technological progress coupled, nevertheless, with some loss of ground to road and air transport and to those forecasting a fivefold increase in the number of towns equipped with a Metro system. Our greatest admiration, of course, would have to be reserved for those who had foreseen the advent of very high-speed services, combined transport and wholly automated Metro systems.

More generally, those forecasts would have stood up best to the test of time that backed continuity rather than any revolutionary breakthroughs and concentrated on deducing the implications of trends already apparent and interpretable 50 years ago, widening the field of study to include the future of competing modes and allowing for developments in systems of which transport is only a sub-system, e.g. urban organisation, for example.

These are precautions that we shall observe in this paper. In other words, for each main segment of transport activity, we shall try to explore firstly developments in transport needs as determined by foreseeable changes in society and secondly the technical and organisational changes that may be expected in the different modes of transport. The comparison of these *two* areas of development will be used to assess the capacity of each mode -- and rail in particular -- to face the challenges of the future.

Three segments of activity will be considered, the three age-old markets fur rail transport: goods transport, intercity passenger transport and urban transport.

I. PRODUCTION AND DISTRIBUTION OF GOODS

I.1. The space/time characteristics of production

There is today a measure of consensus about long-term developments in the production sector and its geographical distribution. Though the phenomena of financial concentration and internationalisation seem likely to continue for a considerable time, some geographical deconcentration will accompany these developments. Thus the predominant model, 50 years ago, was that of an industrial complex manufacturing a whole range of finished and most of its intermediate products in one and the same place for markets that rarely extended beyond the national boundary. The model which is gradually imposing itself today -- and seems unlikely to be dethroned in the foreseeable future -- is one of production units specialising in a single product so that the total range is made in various places and often in several countries, the same of course also applying to intermediate products. These specialised production units are therefore required to distribute to much broader geographical areas, while the plants supplying intermediate products have to cover a greater number

of units over longer distances. The transition from one model to the another is of course by no means automatic, the description given here being simply of the broad trends.

Production locations are therefore tending to become more scattered and that makes a difference to the flows of goods that are generated they come from farther away and consignments tend to be smaller. On the European continent this tendency is quickened by the fact that an increasing share of the heavy raw material comes from other continents. Whether raw materials arrive as extracted or after beneficiation they are increasingly being processed in the hinterland behind the ports, hence the finished or semi-finished products leave for a very large number of destinations.

The products, which are sent further but in smaller batches, are also changing in nature following a trend which may be described by saying that a given volume of product incorporates less and less raw material and more and more value added. This relates not just to the spatial organisation and distribution of production but also to trends in the structure of demand for consumer and capital goods with fewer candles being transported and more video cameras, fewer pick-axes and more electronic components.

The implications for the organisation of transport flows are considerable. The era of lowest cost is being overtaken by the era of highest speed or perhaps the right term is lowest cost -- but generalised. Any immobilisation of high value added products is costly and thus shortening transit time becomes a major economic factor €or the same reasons as stock minimisation. The logic of shipping the largest possible quantity is out and that of rapid flows is in.

1.2. Modal and nodal responses

Modes of transport at continental level are clearly differently equipped to cope with the challenge of these structural changes in the demand for goods transport and yet, in every case there have been major technological changes though market shares have not for all that departed from their underlying trends.

Inland waterway transport, in spite of a significant extension in the widened canal network, growth in push-tow convoys, heavy investment in logistic services and the relative success of sea-going craft, is seeing its market shares eroded, even where networks are exceptionally dense and industrial areas well-watered. Its vocation is to serve heavy industry over a number of long, narrow corridors, traditional features of the geography of Europe. Its future cannot be predicted without noting the fact that freight carried on the Saint Lawrence, for example, has declined at a time when the areas served have, since 1983, been experiencing one of the most spectacular periods of industrial growth in their history and that this is an arterial waterway which has fewer locks along the 3 500 km from the ocean to the far side of Lake Superior than are planned for the 200 km Saône-Rhine project and carries craft of over ten times the tonnage of those that European conditions permit. There are some experts (1) who think the comparison needs to be treated with caution but it does suggest that the other modes have little to fear from waterway transport as a competitor for their markets.

Road transport on the other hand has had the benefit of remarkable improvements, with the development of motorway networks, in its infrastructures and considerable technological progress in its vehicles in a matter of a new generation. Together these changes have meant a big increase in commercial speeds whilst retaining the basic advantage of road transport, namely its ability to serve all useful destinations without exception, and have enabled this mode to compete for the long-haul business which traditionally was the railways' market.

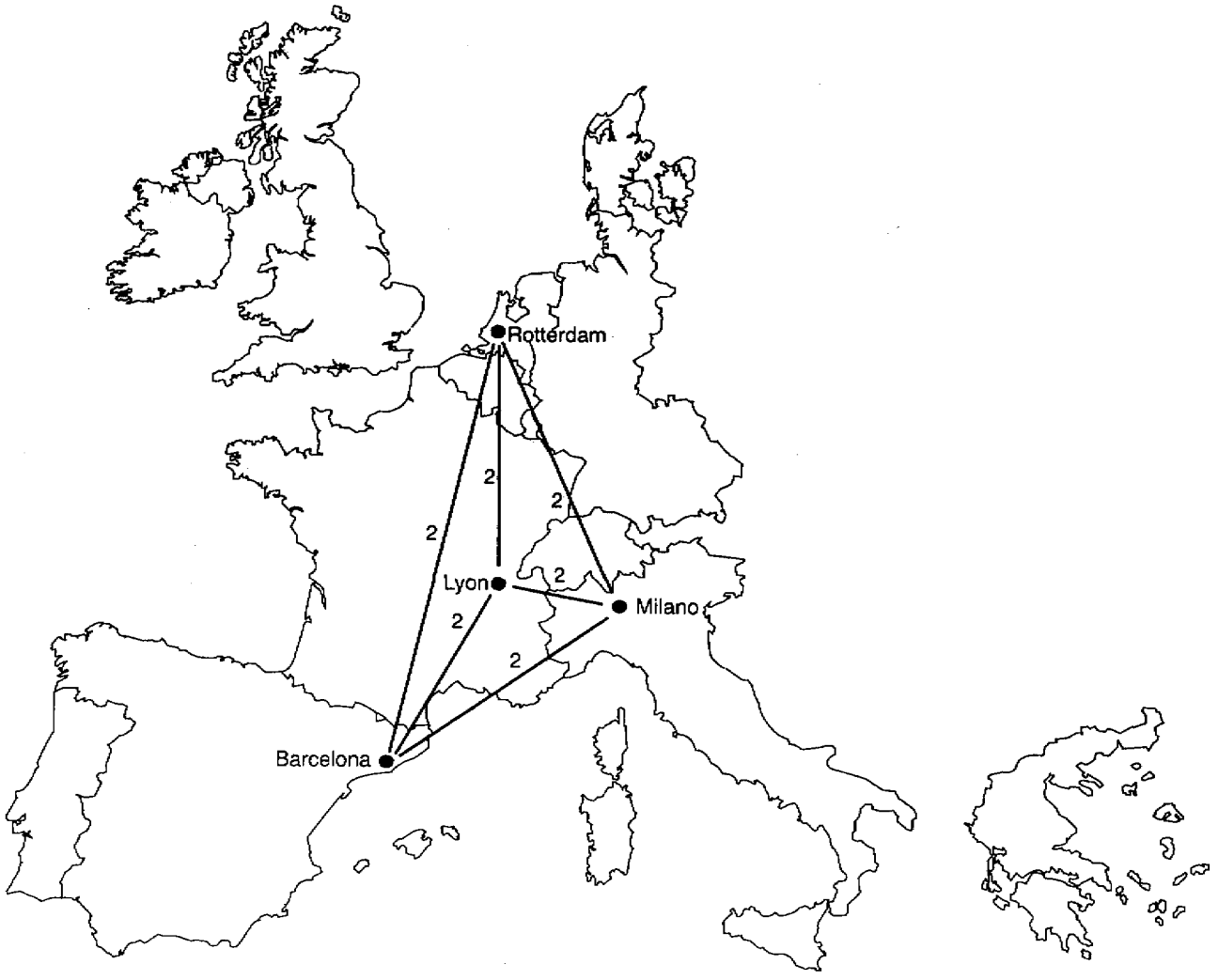
The future is unlikely to see any great qualitative breakthroughs in the efficiency of road transport. Admittedly, the motorway networks will be extended and ordinary roads will probably be improved. More powerful engines will come on the market and allow higher speeds in hilly regions. However, weight, axle load and dimensional standards are approaching the limits of international consensus (2) and are not likely to change for a very long time. So the only factor where there is any great scope for improvement is speed particularly since, where it becomes crucial in order to meet demand, the carrier can switch to vehicles which are smaller but authorised to travel at higher speeds: 130 km/hour for vehicles under 10 tonnes in France, for example. The time saved will mean that the distances covered can be longer, provided legal limits on driving time are not exceeded. Competition from road transport in the long-haul sector can therefore be expected to increase for a long time to come, in particular for the tight delivery freight market.

It should also be noted that air freight too will be in competition with rail for this particular market although, at the level of the European continent, only very long-haul services and high value added products will be concerned and it will be necessary for terminal hauls and transhipment delays to be such as to allow competitive door-to-door times, Air freight's ideal market will therefore be intercontinental transport.

As to the railways there is no doubt that they will benefit from major technological advances. There are no insurmountable difficulties in the way of the generalised raising of speeds, automated train marshalling, real-time wagon movement monitoring, progress in multimodal techniques, the introduction of high-speed good lines and automated train piloting. Operating costs will be as low as those of the inland waterways or even lower provided that rail activity is concentrated on its trunk lines. But will that be sufficient to enable the railways to fight off the challenge of road transport?

To answer that question we have to go back to the space-time dimension of the problem which, as we have seen, points towards faster and longer-distance transport. To assess the advantages of the two main modes in competition, two strategic and inter-related aspects have to be defined -- critical occupation ratio and nodal efficiency -- which seem to us to explain the current term of radialisation or "hub and spokes".

Let us take an imaginary and ultra-simple illustration. We shall suppose that an operator has to provide six transport services over the six links shown in Figure 1 and that he has found sufficient freight business for two trips per week per direction on each. That means that the critical occupation ratio for each trip (one full train or truck load) does not allow him to increase his frequency because then he would not cover his costs.



We shall now suppose that the operator is able to re-assemble his shipments in the town at the centre of the system (Figure 2) by re-grouping consignments (road transport) or re-marshalling wagons (rail). This radialisation of traffic flows gives a critical occupation ratio of six services per week per direction and the advantage for shippers, in terms of frequency, is considerable. Whereas in the first case they could count on only two shipments a week, in the second they have a one-day service on each of the radial links and a daily depart-day-A/arrive-day-B service on each of the peripheral links in Figure 1.

Naturally, the phenomenon gets more complicated, though without any change in its nature, when a greater number of links or several "hubs" are involved. The value of this radialisation system also lies in the fact that if "n" radial links (the spokes) are served once a day, one additional spoke means there will be "n" new two-way links.

This logic has long been familiar to the railways and, of course, to operators of road parcels services. The railway companies have long been operating services in which full trains are broken down and then reformed and road hauliers have been doing the same with truck-loads. Now, it is in these nodal functions that the two competing modes are out of balance, particularly when the demand is for very tight delivery times.

The difference between road and rail on this score has four aspects:

- The flows required to satisfy the critical occupation ratio can be on a much smaller scale for road than for rail transport. That makes short "spokes" less suitable for rail and makes road transport more advantageous the more activities are dispersed in space.

- Measured not in tonnes handed but in number of "critical occupations", breaking down and re-grouping truckloads is a much faster operation than re-forming trains. In the highly likely eventuality that both functions would be wholly automated, road transport would retain its edge in terms of rapidity, an advantage that would have its effect on door-to-door shipment time.

- Existing infrastructures -- and those to come -- leave road transport much more freedom in geographical organisation for the location of a new spoke or hub. The SNCF road parcels subsidiary SERNAM, for example, decided to locate its national transhipment centre near a small town at the centre of Metropolitan France. Wholly automated and run by a staff of under 50 persons, a centre like this could be moved elsewhere without any real difficulty -- which is clearly not true in the case of the railways.

- The market most suitable for radialisation is parcel traffic limited to small-size units, i.e. not bigger than one pallet load (smaller batches often being palletised too). Larger consignments diminish the advantage of road transport because the automatic sorting equipment can no longer cope.

1.3. The future of rail freight

In these conditions, the freight market should be split even more sharply than it is now between low-mass, diffuse and high-speed traffic, the domain of road transport, and rail transport reduced to heavy-traffic arterial but high-performance services in the sense that depart-day-A/arrive-day-B will be the minimum standard and productivity levels will be substantially higher than they are today. This process is already a pronounced feature in several countries and is beginning to spread to international freight where progress is likely to quicken sharply with the gradual implementation of the single market. It is clear, for example, that whereas the pattern of organisation shown in Figure 1 is favoured by the system of bilateral licences, the radialisation model is easier to operate with a multilateral licensing system. It is no accident that radialisation in the United States followed on the heels of the deregulation of inter-state road haulage.

Offsetting this contraction in rail freight there are several segments where rail services could have privileged prospects. First there is combined transport which is on a growth curve and which, based on the hard core of the rail system and equipped with high-performance multimodal handling yards, should in the future be in excellent conditions for competing over long distances.

A particular type of piggyback transport which I would call "ferry-bridge" is also likely to develop for similar reasons to those of the channel tunnel wherever through routes for road traffic have difficulties or are subject to physical restrictions. That, after all, is the logic of the project for a north-south rail route across Switzerland (3) and it also provides the solution to which countries with saturated communications corridors -- like the valleys of the Rhine and the Rhône -- may be forced to adopt. Crosslinks like these will only partly fit into a rail network and their role will be more to supplement the road infrastructure and fulfil a bridging purpose -- which is what a ferry does.

Lastly, rail goods transport could well be transformed by the arrival of the high-speed train. The lengthwise profiles of some new high-speed rail track are already being designed for goods trains by limiting gradients to 1.2 per thousand. The future European high-speed rail system, which will probably be a close-mesh network in fifty years time, will probably therefore be able to offer services at commercial speeds of 200 km per hour or more which could give a new importance to the modal dimension in relation to the nodal dimension. That presupposes that a demand for point-to-point links

will emerge because the time taken by marshalling operations could destroy the whole advantage of high speed. One would therefore suppose that these services will relate to very specific parts of the network attracting sufficient freight demand to guarantee that the critical occupation ratio is met with products whose value warrants the high-speed treatment -- so a small number of busy trunk routes will probably be involved.

All in all therefore, the geography of rail goods transport supply will be very different from what it is today: a network limited to a number of heavily trafficked trunk routes specialising in bulk goods and combined transport and equipped for the purpose with concentrated and powerful logistic installations including big rail-road yards, a number of high throughput "ferry bridge" routes and lastly certain long-haul high speed links between major European centres.

II. PERSONAL MOBILITY AND PASSENGER TRANSPORT

II.1. The changing face of town and country

The half century horizon means making allowance for the spatial changes that may reasonably be foreseen, for the traditional distinction between urban and interurban levels cannot be expected to go on exactly as it is. The space for economic activities and that for social relations are changing in a continuous interaction as developments in the transport system release them from the constraints of space and time.

In the Europe taking shape before our eyes the spatial picture is no longer that of an urban structure imprinted on an area of rural land. The very notion of town being replaced by that of employment basin or urban region now crossed from side to side in less time than it took to cross Paris hardly more than a century ago. Regardless of the stagnation or even decline in population that should go on for a few more decades at least, urban growth is likely to continue provided the term is extended to cover the employment basins and the populations they relate to (and not in the sense of the population registered within a fixed administration perimeter). This growth will be augmented both by the once rural areas that each urban region is able to appropriate around its periphery and by immigration from the regions in decline, under-urbanised areas or possibly other continents. So Europe should experience a consolidated growth of these urban regions which will be both the scene of intensive daily mobility and powerful poles of inward and outward inter-regional movements. Naturally these centres with populations running into the millions will be part of a hierarchy of urban structures spanning the whole range of town sizes, from secondary poles to rural hamlets.

The difference from spatial distribution as it is today will not be too great except in the spread and number of urban regions. The result will be an appreciable increase in the flows between them and an intensification of the internal daily movements through them.

Certainly personal mobility will be far greater than it is today. The mounting social pressure for mobility that has been observed ever since opinion surveys on transport have existed is likely to be confirmed for two main reasons. Firstly the difference in mobility which is observed as between social categories and may vary by at least 1 to 3 at the extremes, suggests that the probable raising of the educational level and standard of living of the underprivileged will bring with it a very substantial increase in their mobility, even at the inter-regional level. Secondly, it is highly important to take the effects of the aging of the population into account.

We know that personal mobility decreases steeply after the age of 50 and it could therefore be deducted, over-hastily, that the aging of the European population which current demographic statistics imply between now and the year 2040 could cause a stagnation or even a reduction in mobility. In fact, exactly the opposite is to be expected because of the behaviourial changes now being observed as between the generations. The work by Jean-Loup Madre on the behaviour of the French with regard to car ownership and the use is particularly convincing in that regard. Based on surveys carried out in 1966 and 1986, his analysis shows that the average number of cars per adult of a given age has been steadily increasing from generation to generation. Persons aged seventy, for example, had:

- 0.12 vehicle per person for the generation born in 1902 or before,
- 0.25 vehicle per person for the generation born between 1903 and 1912, and
- 0.38 vehicle per person for the generation born between 1913 and 1922.

The differences are less appreciable of course for younger generations and some convergence may be expected towards a ceiling ownership ratio for the generations not yet born, but in the light of the probable age structure of the population in 2040 everything suggests that the phenomenon will hardly have stabilised by then.

A further and comparable phenomenon is found if mobility by car is considered. Although, as J.L. Madre notes, "average mileage falls practically throughout the life cycle", for a given age mobility is higher for recent generations though the convergence towards homogeneous behaviour is more rapid. This is already more or less the case for generations born since the second world war which means that the limit in behaviour will probably be reached between 2020 and 2040. From then on, the aging population factor will probably outweigh the generation effect and a stabilisation or even a slight decline in mobility will set in. Even so, the general level of mobility is likely to be much higher than it is today as will that of the general ratio of private cars per household.

We now have to see what the role of rail transport could be in the presence of these spatial and social changes. In so doing, we shall make a distinction between daily travel in urban areas and inter-regional travel.

11.2. Track-guided transport in urban areas

The basic difficulty with urban transport systems is that urban growth and improving standards of living both lead to increases in the amount of travel whereas the urban fabric is inflexible and the space given over to roads difficult to extend. Own-track rail systems have provided an answer. The number of Metros in the world has gone up from 20 in 1939 to nearly a hundred today. Will there be twice or ten times that number by 2040? I am not sure that that is the right way to put the question.

Studying the future of rail transport in urban areas is more a question of considering how this mode will stand in relation to the spatial and social changes in store. Two basic factors are still

favourable to the growth of rail systems in the urban environment, on top of which there is the technical breakthrough of automation.

The first factor stems from the fact that in the precise area where the increase in travel will continue, the only way to solve the congestion problems will be by high-volume own-track transport once the traffic demand on the trunk routes can no longer be met by the car-bus combination. A time comes when congestion difficulties pose the problem of the centre's survival in acute terms. What is at stake in economic terms then justifies the financial effort required to create or extend a high-volume system. Now, as car ownership and the urge for mobility increase in a society the number of conurbations afflicted by this critical situation rises. In the 70s in France the critical situation applied only in those cities with populations of a million or more. Twenty years later, the critical threshold is being reached in conurbations with populations of only 0.4 - 0.5 million. This critical threshold is not, of course, the same the world over and the way it varies seems to depend on three commonsense principles:

- The higher the standard of living the smaller the size of conurbation affected by the critical threshold.

- The narrower the roads in the centre, the lower the critical threshold.

- In town centres of limited surface area, banning cars from the centre may be an adequate remedy.

This last fact suggests that own-track systems will not invade every single European town during the next half-century although the first two imply that the number affected is likely to be high.

The second factor in favour of urban rail transport has to do with the way urban regions develop. They generally take the form of vast polycentric conurbations and large volumes of people travel daily between the old city centres now merged into one that only trunk services of the "regional express" type, e.g. the Hamburg rail network, the Paris Réseau Express Regional (RER) and the Randstad inter-city railway, or else high-frequency bipolar links like that between Lyons and St. Etienne, can handle.

Lastly, account has to be taken of the breaktbrough of automatic Metro operation. Not only will automatic train control make possible a big increase in maximum peak-hour frequency, as on RER line A equipped with the SACEM system, but also and above all wholly automatic operation presents the enormous advantage of adjusting train supply to demand free of minimum line manning constraints. As is known, the allocation of crews is rigidified by constraints bound up with work regulations. Rail systems are therefore compelled to tailor supply to suit peak traffic requirements and, conversely, do not find it easy to adjust to unexpected fluctuations in demand in the later evening, for instance, or at certain times on public holidays. Released from these staff constraints, the system would gain in flexibility and therefore productivity.

This will be the principal advantage of own-track systems over public road transport facilities. The former will very likely become highly automated. Whereas today they are a labour-intensive activity, in the future their output will be far more capital-intensive and that should help to ease the financial problems of the public urban transport *(5)* and, by that very fact, favour the rail solution even as against own-track public road transport.

However, not all current developments are favourable to rail transport. There are two foreseeable and powerful movements that might be described as "exploded" forms of the organisation of time and of space.

First, the more flexible approach to working hours and the growth in voluntary mobility accompanying the improvement in living standards are generating more complicated programmes of activity. Thus, little by little, commuting is being replaced by trips from home for a far more elaborate range of purposes and a detailed analysis of these trips shows that they are largely based on the use of the car (6). The reason is that the user is faced with the need to manage relations with space that are not necessarily compatible with what public transport has to offer, dominated as it is by the logic of fixed routes. Even if these routes form a closeknit network, the supply system is very difficult to adapt to the diversity of demand.

So, a user having to programme an activity made up of 4 or 5 trips in succession will, first of all, come up against the problem of the legibility of the network available and then the considerable likelihood of having to change each time. The deterrent effect of this inconvenience on the non-captive user is well known and it will mount in the future as the increase in car use reduces the captive proportion of public transport users.

In the very long term, however, track-guided transport could provide a new answer to this weakness inherent in the fixed-route logic and the ARAMIS system (7) designed and built by Matra (also responsible for the VAL automatic Metro that went into service for the first time in Lille) has been developed with precisely that problem in mind. The main characteristics of ARAMIS are of less interest to us here than its general philosophy -- the rail vehicles are very small with sitting room for ten or slightly more passengers and formed into "trains" by connecting the cars together, not physically but in a way that allows sets to be switched and reformed "en route". This kind of wholly automated operation allows cars to be guided over a succession of routes with no intermediate stops between points of departure and arrival. In theory this would offer passengers a transport service free of the fixed-route constraint (and therefore with no interchanges) and subject only to the station location constraint.

This type of system, based on the principle of a track-guided vehicle instead of that of a "route" or "line", automated or otherwise, could well be the answer of own-track systems to the challenge of the motorcar in urban conditions.

The second feature of structural development that is unfavourable to rail transport is the direction that new urban patterns seem to be taking. Studies on activity locations and series of surveys on urban travel both point to the existence of two underlying trends: diversification of peripheral activities and growth of low-density settlement patterns. Thus, not only is the relative importance of peripheral trips increasing by comparison with central or radial travel but also, and more generally, flow systems are developing that are less dense and less ideal for the introduction of high-performance public transport services.

One possibility would be to cater for the peripheral flows with light railborne systems of the tramway type which could provide a satisfactory network between the high-volume radial routes. The low-density settlement challenge, however, will require innovative systems such as own-track guided buses. I will not dwell on this system (there is a specific paper on the subject also presented at the 17th PTRC Summer Annual Meeting) except to say that its very high performance/cost ratio and the fact that it is not confined to its dedicated track make it a very promising mode, particularly for peripheral areas.

Over the next fifty years, therefore, it may reasonably be expected that development in rail or, more generally, track-guided passenger transport systems will be practically the reverse of development in rail freight transport: no concentration purely and simply on the main trunk routes but instead of increasing geographical dispersal made possible by radical technological innovation; no specialisation in a number of specific functions but instead a hierarchy of complementary solutions descending to relatively low levels in terms of flow density. These trends depend, of course, on the alternative to the congestion crisis, namely the crisis of the financing of public transport, being overcome. In that debate, support for public transport will need to be weighed out against the safeguarding of urban functions and indicators of the quality of life in towns and their environment to which a new importance is clearly being attached.

II.3. Inter-regional passenger transport

The mounting social pressure for mobility will not, of course, be limited to the urban areas. Residential mobility -- which no doubt will itself increase and become more international -- is bound to generate more and longer trips for personal reasons. Holiday travel will continue to grow and business travel, encouraged by the increasing availability of high-speed transport and the inward and outward movement caused by the urban regions, will turn a relatively cold shoulder to the alternatives offered by telecommunications (8).

To attract these buoyant markets, competitive modes are not going to sleep on their laurels. Cars, with a further rise in ownership ratios, will have the benefit of new infrastructural improvements and in particular an expanded motorway network. Buses and coaches will also benefit and become more comfortable and powerful. Air transport will have reduced its costs considerably and fully automated air traffic control will have substantially overcome problems of congestion in the sky. One new mode of travel will become established -- the convertible helicopter, a kind of small capacity air liner capable of vertical take-off and landing and thus carrying its passengers from city centre to city centre. Lastly rail transport will be able to offer its very high-speed services for the main line links to which it will have deliberately reduced its activity.

So in these circumstances, what will be the primary attractions of the different modes for the main segments of the market? In our answer to this question, we shall confine ourselves to the rudimentary distinction between personal or holiday travel and business trips.

For the first of these two categories we know that the choice of mode largely depends on the nature and characteristics of the stay away from home: a family of 4 or 5 on a visit to another member of the family in a rural area a long way away will use the car, a retired couple on a package holiday will go by coach and a family that enjoys caravan holidays will clearly not go by air. Because of this rigidity of demand, the railways will have to concentrate on long-distance intercity travel or market special holiday packages -- as they already do, for example, with "trains neige" for winter holidays. In these market slots, high speeds are a powerful selling argument and with fast night trains, the holiday areas feasibly reachable by rail can be extended to the very distant destinations.

On the short and medium-haul market (up to about 300 km) the high-speed argument will be ineffectual in competition with the car or coach travelling by motorway and the same applies to rail routes with low-density traffic where the construction of high-speed lines would be uneconomical. The choice between slow, infrequent and thinly occupied trains and more frequent bus or coach services that are more competitive in terms of both fares and time will systematically go to the latter. The retreat of rail transport to the high-output trunk routes is even more inevitable in the case of passenger transport than for goods, remembering that it will be accompanied, for everyone's benefit,

by fall-back road transport arrangements. There is no doubt that the social problems inherent in these cutting-back strategies will be easier to settle the longer the period they are spread over, particularly if they raise the railways to a sufficient level of profitability for the social costs of the cuts to be satisfactorily met.

As regards business travel, it has to be noted that this is a durable and high-growth market, a powerful factor in that development being the increasing spread of locations for industrial activities and the financial concentration accompanying that trend. With high speed {by rail or air), to encourage it, travel for purposes of internal contacts within multi-centre companies is mushrooming (9) so that growth in this type of traffic should climb to a very high level. The speed factor is also extending the boundaries of the business services market, particularly that of highly specialised services (10). The dismantling of national frontiers can only accentuate this trend.

Business travel will be the ideal market for high-speed trains. In the 300-1 000 km range (1 to 3 hours travel at the most) rail transport will be offering centre-to-centre links in conditions in which travel time can be used as working time particularly since the rolling stock will be equipped with the computer and telecommunications facilities necessary for the purpose. When it is realised that the TGV Sud-Est already accounts for more business trips than all the air services serving French territory put together, it is easy to imagine the effect of a fullscale network equipped with special facilities and covering the whole of Europe.

Among users who are particularly sensitive to the efficient use of time, air transport will lose market share on links also served by very high-speed trains but gain ground on others and on their very long-haul services and also by introducing new centre-to-centre services by convertible helicopters. Lastly, the airways will maintain intensive feeder services at inter-continental airports.

The fact remains that high-speed technology, combined with the legacy of rail transport's existing urban infrastructures (stations and corridors penetrating to city centres) and traditional electrified routes used for extending new lines, offers the railways a future that was unhoped for only a short time ago.

That is yet another reason to end this long-term forecasting exercise on a note of caution. In the future as it is really going to unfold what parts of the major developments have we succeeded in foreseeing and what parts are still hidden? We shall have to be patient for a long time before we know. In any event, I will end this attempt at trying to tell the future of track-guided transport by accepting, in advance, the criticism of being too short-sighted. I think it is less dangerous to admit one cannot see too clearly than to imagine things.

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TECHNICAL DEVELOPMENTS IN GUIDED TRANSPORT

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1. Introduction

A report (January 1988) from the Round Table of European Industrialists (ERT) called "Keeping Europe Mobile" (1) states:

> "In theory, then, railways stand at the threshold of a brave new world, offering clean, safe, fuel-efficient technology and the ability to carry substantially more passengers and goods without making additional claims on precious land."

The ERT study looked at the European situation regarding car traffic, air traffic and rail traffic. It concluded that due to rapidly increasing traffic congestion on the roads and in the cities and the growing air traffic control problems there should be very good business prospects for railways. But this potential will only be fully realised if railways can manage research and development so as to secure the advantages of new technology. As is pointed out in a paper (2) by Dr. Alan Wickens, Director of Engineering Development and Research of British Rail, it is necessary to shift the perspectives of R & D from short-term to long-term which is targeted 10 to 20 years hence and which reflects the aspirations of the traveller to have transport services of high and reliable quality.

2. The "Silent Revolution"

During the 1970's and '80's, fast trains were being developed mainly in Japan, France, the Federal Republic of Germany, Italy and the United Kingdom. In 1964, the Shinkansen was already operating commercially between Tokyo and Osaka. In 1966, France opened a high speed train service on the Paris-Toulouse line.

This started what has been called a "silent revolution". When it comes to train development, we are in the unusual situation of looking to Europe and Japan €or technological leadership rather than the United States.

However, the renaissance which the railways can look forward to is not attributable solely to technical advances. As a matter of fact, the first phase of the "silent revolution" (Japan and France) can be characterized by technical pragmatism rather than technical sophistication.

When we visited SNCF in France last year in connection with the study 'Development trends in Railway Technology" which the Innovation Institute carried out for the Swedish State Railways, it was pointed out to us that nothing revolutionary was introduced in the first and second generations of the French high speed trains. Both Shinkansen in Japan (240 km/h) and TGV-SE (270 km/h) represent rather conventional technology. The most significant improvements were made to the quality of the track and only to a lesser extent to the rolling stock (aerodynamics, suspension and design).

It is important to point out at this time in the history of guided transports that the renaissance is still more dependent on public opinion and political attitudes than on technology, but it is also dependent on organisational and institutional changes. If the infrastructure and services around the railways cannot be improved significantly in Europe, high speeds as such will have only a technological curiosity value. We shall find that technology will be subordinated to these other values and conditions. A "need pull" rather than "technology push".

A recent report (April 1989) by the ERT called "Need for Renewing Transport Infrastructure in Europe" (3) discusses cases of success and failure in the decision-making process concerning the European transport system. The Channel Tunnel is referred to as a success because of the following factors:

- a clearly identifiable project;
- creation of a concession for project operation on a commercially viable basis;
- political support at the highest level;
- establishment of an identifiable owner;
- generation of sufficient cash.

In its report the ERT states that the High-speed Railway Network is a failure, at least so far, because:

> "It appears that for domestic political reasons the responsibility for financing, developing and managing each national segment of the network would in principle be a national responsibility. If fact, it will be under the jurisdiction of the national railways. This approach represents a lost opportunity of considerable magnitude".

Let us be clear on one point before we discuss technical development: technology alone will not ensure a breakthrough in guided transport.

3. The "Second Step"

We can only hope that market realities will improve the decision-making process. The rest of the paper will now be devoted to technology. Railway technology is long-term (10-20 years) and multidisciplinary. It should thus make sense to take a careful look at the "state of the art" of today, in order to be able to say something about the next 10 years. In the above-mentioned study by the Innovation Institute for the Swedish State Railways, we tried to identify contemporary trends and issues which would indicate the future directions to be taken by railway technology.

What we would like to call the "second step" is discussed below, and we will then consider the longer-term perspective, the "third step". The "second step" comprises what has happened in several countries stimulated by the successful development ("first step") in Japan and France in the '60's and '70's. The first country after Japan and France to attempt an advanced "total" concept was the United Kingdom in the early '70's with the Advanced Passenger Train (APT), if we exclude the Talgo train in Spain which used a passive tilting mechanism, light weight materials and new design already in the late '60's.

Owing to a series of unlucky circumstances, some of which were administrative, the APT-concept was however abandoned after a few years of testing. Experts in the United Kingdom and elsewhere claim that the AFT-concept became a victim of "trying to introduce too many sophisticated technologies at the same time". The "second step" represents those projects which were conceived and indeed began around 1975 or earlier in countries like France (TGV-SE, TGV-A), West Germany (ICE, Transrapid), Italy (ETR450, ETR500), Denmark (IC3), Sweden (X2), the United Kingdom (HST-2) and Canada (LRC). Only three of these use active tilting mechanisms to compensate for the curves on existing tracks. In the United States, Switzerland and Austria, too, advanced high-speed train projects are under consideration or have been approved for implementation.

These "second step" trains are or will be put into commercial traffic in the early '90's. By "second step" we mean that the high speeds (200-300 km/h) have forced the manufacturers to introduce to an increasing extent more compact traction systems, new braking systems, advanced suspension, new materials in the bogies and the coaches, new design concepts and, last but not least, microelectronics and computers. It should also be mentioned that, as early as 1974, a consortium of West German industries had already started to develop the magnetic levitation train, Transrapid, for speeds higher than 300 km/h. The first passenger-carrying trial of this train with linear motor and magnetic levitation track took place ten years ago at the IVA-exhibition in Hamburg in 1979. The Japanese began their development of Maglev trains much later. They use superconducting magnets with much stronger magnetic fields. To achieve higher speeds and acceleration, new materials such as aluminium, composites and polymer sandwich have been introduced. Optical fibres for signal transmission within and outside the trains have also been introduced in a few instances.

Lighter bogies with active steering and suspension provide for more comfortable and efficient travel both for passengers and goods at high speeds. Perhaps the most significant step in the development, however, is the pace at which electronics is being introduced both in the traction systems (GTU-thyristors) and in the internal and external communications and safety systems. For the French TGV-A, it is estimated that maintenance costs per seat can be reduced by 20 per cent by means of a sophisticated computerized microelectronic survey and diagnostic system called Tornad.

At very high speeds (> 300 km/h) it is necessary to have automatic systems take over much of the information handling which is normally the responsibility of the driver. In the United Kingdom the Automatic Route-setting System, ARS can handle 120 train movements every hour all over the country. The introduction of computerized microelectronics for internal information handling and communication with the operations centre represents the first step towards a system which has been used for many years by airplanes. The experts at SNCF and Alsthom in France claim that this is only the beginning as regards technical improvements. With the Tornad system used in TGV-A and the ARS in the United Kingdom it is already possible to use unmanned trains. It is a first step towards Artificial Intelligence and Expert systems for train traffic control. The French have also experimented with satellite localization systems for trains, but it is unlikely that these will be able to compete with computerized so-called "data highways" along the track. In this connection it is worth mentioning the Eureka project "Prometheus" for automobile traffic in Europe. This project is conducted by the largest car manufacturers in Europe. It will last eight years and has been budgeted at 400 million ECU. The purpose of the Prometheus project is to develop an advanced electronic communications and guidance system in order to smooth traffic flows and improve safety. It is too early to say how far it will go.

4. The "Third Step" -- towards guided transport in 2040

Some selected technical developments which we think will be indicative for the long-term evolution of guided transport are set out belong. These developments will, of course, be ultimately determined by the needs of the market which in turn are determined by prices, public opinion (eg environmental concern) and policy decisions.

Let us assume that the main development started by the "First and Second Step" of the silent railway revolution will continue, but now as an open revolution. If so, we shall see a persistent technical development towards cheaper and more efficient and reliable guided transport systems. A self-fulfilling prophecy?

4.1. The track

It is perhaps astonishing that the track has had the same structure for the past two centuries. Steel rails nailed to sleepers which rest on a 300 mm ballast of crushed rock. Admittedly, there have been improvements in rail steel quality, wood sleepers have been replaced by prestressed concrete sleepers and track alignment techniques are better, but the concept has remained the same. Only Japan and West Germany have introduced and tested new track concepts and components. In Japan, massive concrete slabs have replaced the sleeper-ballast structure and Germany has tested Y-shaped steel sleepers on asphalt support. During the next few years the EC countries will build 3 000 km of new track for high-speed trains. This represents an enormous investment, but given the fact that rail infrastructure is three times more economical in terms of land use than the motorway, there should be no hesitation about developing new track concepts for the future.

For speeds up to 300-500 km/h the steel wheel on a steel rail is likely to prevail. At higher speeds than 350 km/h, the magnetic levitation technique may become economically competitive. For the German Transrapid, it is said that twin tracks built above ground require only 30 per cent of the land area that a six-lane highway requires. The cost of a twin-track Transrapid has been estimated at 15 million DM per 1 000 metres, which is about 75 per cent of the cost of a six-lane highway. For the lower speeds of guided transport in *metropolitan* areas, it is more certain that completely new track concepts will be introduced. Steel and/or concrete structures will be placed on or above ground with monorail or double rail. To reduce noise, the contact surface between the wheels and the track will consist of rubber (tyres) or new polymer materials. The train will be guided by a side-guide system steering bogie or by central guide wheels. Construction costs will be considerably lower (70-80 per cent) than for subway systems. Operating speeds will be 50-100 km/h. The development of new track concepts must be closely bound up with the development of new traction technology and control and communications systems (see below). Whatever the developments as regards new track concepts, there will be great opportunities for steel and concrete manufacturers to introduce new grades and composites which will cater for the requirements of greater strength and low-cost maintenance.

4.2. The chassis

As wagons became longer and speeds and loads were increased, it was necessary to invent a new type of wheel-axle arrangement. The bogie was introduced as early as 1834 but it was not until the 1950's and '60's that sophisticated methods of calculation and the use of computers permitted more advanced design.

With the introduction of new steel grades and active bogie-steering and suspension systems, problems relating to wheel-rail contact were to some extent resolved.

As speeds become increasingly high and as the need for greater acceleration and lower energy consumption also increases, it will be necessary to use lighter and stronger materials in the chassis. Carbon fibre reinforced steel grades have already been used in wheels, axles and bogies but are still considered too expensive.

In the future, however, we shall see a combination of high-grade, light composites in the chassis and active bogie-steering which allows for better adaptation to track curves and also reduces wear on wheels and rail.

New types of sensors and microprocessors will be part of the mechanical chassis systems for easy turning on curves with radii as small as 30 metres, so that tracks can be used above roadways. The absence of gears and other drive transfer equipment will mean low noise levels even on elevated tracks and in tunnels. A futuristic version of the linear motor train was demonstrated at the Science Fair at Tskuba in Japan in 1984.

4.3. The coach body

With the requirements for higher speeds, better acceleration, lower energy consumption and far more comfort, the body must have less weight, better aerodynamics, better noise insulation and higher mechanical strength. The design must also result in lower maintenance costs.

In order to reduce weight, fibre reinforced polymers have been suggested for subway coaches in Stockholm and elsewhere. Sandwich constructions of such material can be made very strong and stiff.

The German Maglev train, Transrapid, has an aluminium sandwich system of construction which has many similarities with that used for modem aircraft. For high-speed trains, the aerodynamics and interior air-conditioning will be very important for comfort. Again the airplane will serve as a model. The Danish IC3 is a compact train which consists of coaches that can be coupled and uncoupled in only a few minutes. It even allows docking while the train is in service. Docking may well become one of the features of high-speed trains in the future in order to let the passengers change from a feeder train to the high-speed train without stopping at a station. In the future we will therefore have coaches whose design will be very similar to that of modern airplanes in terms of structure and materials but which offer much greater interior comfort.

4.4. The traction system

The traction motors for guided transport both AC- and DC-systems, have been radically improved over the past decade, Both are compact and reliable and require little maintenance. This has been achieved by the combined effects of adopting a new high-power solid state switching device called GTO-thyristor (GTO = Gate Turn Off) and using precise microprocessor control. On-board microprocessor systerns also provide automatic train control, monitoring and other "intelligent" functions.

As regards power systems, power electronic and microelectronic technologies have provided a stable base for the precise control and regenerative braking of the new high-power trains.

As there is no commutator, induction motors are maintenance-free and they are very compact and light.

Furthermore, Computer Aided Design (CAD) offers a means of simulating real train running conditions, thus speeding up the production of motors which can be made to almost precisely the customers' specifications.

Future research in traction-systems is being focused on greater use of solid state electronics, closer matching of substation operation to in-service train conditions, and automated maintenance-data management. Given the radical improvement of electric motors, there is no doubt that they will be predominant in the future. Today 75 per cent of the rail network in Europe is already electrified.

It should be pointed out, however, that even if electric motors become predominant in both intercity traffic and metropolitan transit lines, ***diesel*** engines will keep their position for many years, especially in countries where it takes a long time to build an electric infrastructure and/or where less emphasis is laid on environmental considerations than in Europe. ***Gus turbines*** for trains have been used with some success in a few countries but they do not seem to have a future. The main advantage of turbines is that they can operate at very high rotation speeds which results in low weight per installed unit of power. Maintenance costs are high however.

Another system that many believe should have a promising future is ***hydrostatic transmission*** of the power from electric or diesel engines. It has been tested in Sweden and promises smooth regulation of power and speed over a large range. However, it is still considered too expensive.

Lastly, mention should be made of the ***long-stator linear motor*** traction system applied in the **MAGLEV** (magnetic levitation) trains which now operate experimentally in Germany and Japan. In the linear stator system a travelling magnetic field is created which generates a reactive force between the stator and the rotor. The travelling field is distributed along the entire track and the induction magnet is mounted inside the train.

The system is used for the power, braking and levitation of the train. An auxiliary eddy-current 'system is used for emergency 'braking in the German Transrapid. When the Transrapid stops it rests on a suspended gliding system on the track. Transrapid uses an ordinary electromagnetic system while the Maglev in Japan is electrodynamic and employs superconductive magnets. Transrapid is elevated about 10 mm above the track and the Japanese train as much as 100 mm owing to the much stronger magnetic field.

The main advantages of linear motor magnetic levitation systems are:

1) No mechanical friction and noise, a particularly important factor at very high speeds (> 300 km/h);

2) All the power needed is distributed along the track and not concentrated in one traction unit;

3) Small curve radii and the ability to climb steeper gradients (10 per cent) provides for much better adaptation to landscape topography than is the case for ordinary wheel-rail trains.

At the test facility for Transrapid in Emsland in Germany the voltage is 4.5 kV, the maximum current is 1 200 A and the frequency 0-215 Hz.

The maximum speed is 400 km/h, weight 120 tonnes, length 54 m (two sections) and number of passengers 200.

it remains to be seen whether the MAGLEV trains will take the market at speeds higher than 300 km/h or if the "third step" wheel-rail trains will win. France is said to have a new generation of TGV under development for speeds up to 350 km/h.

4.5. The communications and safety systems

We mentioned above that the experts who developed the Tornad system for TGV-Atlantique were convinced that this was only the start of automation in train traffic. Now we already have a few completely unmanned computer-controlled metropolitan trains in use in Japan and France.

Modem railway and transit systems are increasingly designed with emphasis on speed and passenger/freight capacity, prompt and accurate relay of information concerning train operation and safety. At the same time, the more general move towards networking, digital signal processing and optical communication is making an impact on railway data-communication systems. Computer-based automation and communication systems are installed in depots and other fixed facilities as well as on very high-speed rolling stock and provide benefits not only in terms of reduced manning but also operational efficiency and the improvement of customer services. "*Artificial* intelligence" and "Expert systems" are being tested for train scheduling, rolling stock rotation and diagnostics relating to many different functions of the train.

Previously, such planning and diagnostics took several hours of exhaustive work by specialists. Today, the same results can be obtained in minutes. Microprocessors are used to control equipment, including GTO-thyristors, insulation between high and low voltages of transmission signals, etc. Optical fibres have recently been introduced for signal transmission between high and low voltage circuitry. For enhanced product reliability, optical signal transmission eliminates the need for a gate preamplifier, as well as making the systems impervious to noise induced by the power circuit. Chopper and inverter control is taken care of by a multisystem of microprocessors, These are but a few examples of ways in which microelectronics are taking over more and more of man's functions and so leading to greater reliability and more efficient and cheaper train servicing.

Digital optical communication systems are also used for communication between the train and the infrastructure outside. For efficiency and reduced manpower inputs as well as for rapid transportation of large volumes of passengers and freight, the communication systems make full use of the low-loss, induction free, wide-band characteristics of optical fibre transmission. The transmission capacity of optical fibre is very high (1 000 Mbps) and there is a trend towards shared use of transmission lines in ground facilities. Particularly in the case of new railway lines, there are many instances of closed-circuit television images from platform monitoring being transmitted on the same lines with voice data and data related to train traffic control systems and to power-supply systems.

Such innovations raise the system efficiency and also enable unmanned or one-man train operation with increasingly high reliability and safety. Remote-control computer communications systems have also been introduced for the power-supply networks.

Reliable power-supply networks are essential if the interruption of train services is to be prevented. In complicated applications where a single central computer cannot meet the processing requirements, smaller computers are installed at substations and are linked to the central computer via a communications network. Such a system permits:

1) Swift response;
2) Rapid fault recovery;
3) Improved power-supply stability and quality;
4) Automatic report generation.

A very long list can be given of ways in which computerized microelectronics are being introduced in guided transport. What is going on here is nothing less than a revolution.

This, more than anything else, characterizes the "third step" in train development.

The "brave new world" fur trains which the Round Table of European Industrialists predicted in the report "Keeping Europe Mobile" (1) is emerging. While many of the systems referred to above can be automatically controlled by computers, rescheduling decisions still depend heavily on flexible information-processing and decision-making by human experts. But we are now witnessing a new era in the development of man-machine interaction. In the future we shall have Artificial Intelligence and Expert systems for both the design and operation of "smart" unmanned trains -- first in metropolitan traffic and later in intercity traffic. This will offer cheaper, more efficient, comfortable and reliable guided transport. We have raised our foot to take the "third step" in the technical revolution -- not so "silent" anymore.

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THE DEMAND FOR RAIL TRANSPORT IN AN ENVIRONMENTALLY AND RESOURCE CONSCIOUS SOCIETY

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In attempting to determine what role rail and other forms of guided traction systems will be playing in the Europe of 50 years ahead, it is advisable to consider not only the changes that have taken place in this role in the last few decades, but also the policy issues affecting patterns of transport that are likely to influence it in the future.

Recent decades have witnessed growing appreciation of the broad range of costs and benefits of different transport modes. A strategy aimed at promoting patterns of transport that reflect the wider public interest more than they do at present would have to conclude that on medium-length journeys, say of distances of 3 to 15 kilometres, the bicycle and, failing this, bus, or a light rail system where the population served can support such a relatively expensive form of public transport, should be preferred to the car for personal travel. And, for longer journeys, rail should be preferred to car or lorry for passenger and freight movements. (The definitions of 'medium' and 'longer' journeys will of course vary with technological change and perceptions of the benefits of restricting the number of public transport stops in order to increase average speed, and provision of a more frequent service to those people and organisations who can conveniently gain access to an intermediate stop).

If one takes each of the characteristics of the modes for journeys beyond an acceptable walking distance, it is apparent that public interest objectives are better served where shared forms of transport are used. Compared with the car, all forms of public transport are potentially far more widely accessible to the whole population, and on longer journeys, speed is generally greater. They have much lower accident rates and cause less danger -- the two elements are not synonymous. They incur relatively low costs in making provision for them, and their use of land is much more efficient than private road or air transport if all the associated infrastructure is taken into account. Moreover, buildings can be constructed over stations. Their environmental impact in terms of pollution and noise nuisance are also much lower. Indeed, it has been calculated that accidents, congestion and pollution from road vehicles cost each household in the Community about f800 a year. Finally, their finite fuel consumption is not only much lower but they allow for far more versatility terms of the type of fuel used as they can run on diesel, coal or electricity.

All these relative advantages are likely to be increased considerably in the future as a consequence of developments of existing and new types of guided traction. For intra-urban travel, sophisticated tramway and light rail systems on dedicated rights of way providing quieter, faster and more comfortable journeys than buses, and with stations at close intervals, are being introduced or are under consideration in many Member States of the Community. And other new forms of electric traction, with solid state power devices and built-in diagnostic systems, traffic managed by centralised computer control, new guidance and propulsion technology exploring magnetic levitation on cheap guideways, automation enabling a higher frequency of service with single vehicles, are certain to be introduced within the next few decades.

In these circumstances, one could have expected that far more effort would have been made through the medium of public policy, regulation, investment to encourage development and use of guided traction systems than has occurred. Instead, the focus of transport policy within the Community has been on increasing provision for private transport.

The growth of road transport

A key dement accounting for the growth of road transport, and forecast increases in it, stems from the fact that, in the field of decision-making on the preferred mode for personal travel and for the carriage of freight, the choice has simply to reflect *personal* interest in terms of convenience, cost, safety and so on, and in almost total isolation from the consequences for what could be generally categorised as 'the public interest' -- raising or lowering the levels of risk of accident among other road users, affecting the convenience and time that others spend in their travel, altering levels of noise or air pollution, incurring public expenditure costs, influencing the consumption of finite fuels, and so on. There is a clear need for the 'market' to better reflect these social, environmental and economic costs. Indeed, it is particularly appropriate to apply market forces in this area of the economy and to ensure that the implications of the use of each transport mode is fully reflected in the decision-making process so that the use of those modes with high costs are reduced.

At present, however, the marginal running costs of cars and road freight vehicles -- fuel and wear and tear are very low and bear little relationship to the external impacts, whereas their capital costs are high. In addition, in the case of freight vehicles, the payment of the annual vehicle licence fee encourages their use as, in most Member States of the Community, the unit cost per kilometre travelled is thereby lowered. This generally contrasts sharply with rail use, the costs of which are much more closely related to the distance that people travel or that goods are transported.

As a consequence, a rising proportion of the general population and of businesses have adopted increasingly space-extensive patterns of activity to take advantage of the range of opportunities opened up by the increasing speed, comfort, safety and convenience of private transport which allow for much higher distances to be covered within a specific time period, and to take advantage of this distortion of the charging mechanism. The changes have made it progressively difficult for successive governments to alter the rules in such a way that they better reflect the immediate costs of travel by alternative modes. In this way, greater dependence on road-based private transport has been both encouraged and interpreted as reflecting public preference.

There is now a widely-held belief that the benefits of increasing motorisation can be gained without that conflicting inordinately with the pursuit of these objectives. It remains the conventional wisdom that the growth of road transport, and increase in the capacity of the infrastructure to accommodate this, is part of a quasi-natural evolutionary process, and that material benefits and other improvements in the quality of life of the population come in their wake. In these terms, more traffic movement and more construction are reflections of success and, conversely, less movement and lower expenditure are reflections of failure. This could be described as a demand-led and promotion-oriented approach to transport policy.

The British National Travel Survey shows that the average motorised mileage travelled per person now stands at well over 160 kilometres each week, with the proportion of this travelled by car having risen to about three-quarters of the total. The increase is largely explained by the traffic-generating effects of car ownership: compared with people in households without a car, those in one-car and multi-car households cover two and a half and four times as much mileage respectively. In the ten years from the mid-1970's to the mid-1980's, the average length of work journeys has increased by over 50 per cent and that for other journey purposes by 10 to 15 per cent. At the same time, the frequency of these latter journeys, particularly for shopping and personal business, has been rising sharply.

To take advantage of the distorting charging mechanism noted above, freight haulage too has steadily been transferred from rail to road so that, in Britain, over four-fifths of freight tonnes and three-fifths of freight tonne-kilometres are now carried by road.

In the light of these trends, it is not surprising that transport authorities predict further substantial rises in road traffic demand well into the future. However, how accurate the traffic forecasts are likely to prove depends far more upon political and public perceptions of the importance of the social, environmental and economic consequences of traffic growth which brings in its wake many adverse effects running counter to the objectives of public policy than it does upon traffic demand.

Public interest objectives

It has been a basic tenet of the democratic approach that there should be the minimum of public intervention or interference in the conduct of life in the private domain. Only when it has been sufficiently demonstrated that the exercise of personal preference is prejudicial to public interest objectives, is society prepared to countenance change. Some would argue that that situation has already been reached and that the case for a radical re-appraisal of the appropriateness of catering for traffic growth has already been made.

Nevertheless, it is clear that, in considering prospects for the future, public interest objectives need to be set out. It would appear that there is a wide consensus on what they should be -- although it is rare for them to be stated explicitly. They simply reflect the contribution that transport could make to improving the quality of life: lowering the risk and fear of avoidable death or injury, improving the environment, conserving finite resources, economising on expenditure, and extending opportunities for groups in the population with low personal mobility -- all characteristics which it has been seen rail generally scores handsomely over road.

However, the recent 'sea-change' in our understanding of the full ramifications of the impacts of our actions is inexorably leading to a recognition that the luxury of arguing about a balanced trade-off between the benefits of economic growth dependent upon rising fuel consumption and the 'quality of life' can be enjoyed no longer.

Toxic pollutants

In the first instance, there is the issue of toxic pollutants from transport sources. Sulphur dioxide and nitrogen oxides are known to cause damage to trees, rivers, lakes, plants and buildings. In combination with hydrocarbons from vehicle exhausts, nitrogen oxides also produce photo-chemical smog. Carbon monoxide is another by-product of fuel use which is injurious to health.

To date, this has been seen largely in a national or local context, with each country legislating on the extent to which it wishes to reduce pollution, and decisions being largely determined according to what its economy is prepared to afford. Now, however, these problems are better understood, as it is the fact that many of them transcend national boundaries.

Not surprisingly, considerable efforts have been made to minimise these undesirable outcomes. There are a variety of ways of doing so. Whilst in each case it has been recognised that they generally lead to higher transport costs, it now looks certain that, during the outcoming decade, catalytic converters which eliminate most current toxic emissions will become mandatory equipment on new motor vehicles used in Member States of the Community, as they have been for many years

in countries such as the United States and Japan whose politicians are more sensitive to environmental issues.

Global warming

Until fairly recently, concern about fossil fuels has been focused on the extent of world reserves, with questions raised about their availability for future generations. However, this concern has been superseded: the burning of these fuels has the undesirable effect of contributing to heating the ahnosphere -- a process paradoxically intensified by the use of catalytic converters which transform most of the toxic gases into additional carbon dioxide.

This potentially far larger and more intractable problem, described by the Executive Director of UNEP as 'the greatest challenge facing the international community', stems from the fact that there is a powerful and disturbing link between fossil fuel use and global warming. Some authorities on the subject have explained the latter phenomenon as simply a reflection of unpredictable fluctuations in weather patterns. But most are sure of the link -- a scientific judgement that appears to be confirmed by the extraordinary coincidence of major climatic changes in recent years, including the fact that the six warmest years this century have all occurred in the 1980's.

Several gases contribute to global warming. Over half of it at present is attributed to carbon dioxide. The problem is caused by the relatively sudden release of carbon fixed over millions of years. Concentrations are increasing alarmingly. It has been calculated that the level of carbon dioxide emissions in the world is now between three and four times the level of 1950, and rising progressively sharply. At the current rate of increase, the present level of five billion tonnes per annum is forecast to double by 2010 unless drastic action is taken around the world. There are predictions of a global temperature increase of 3 to 5 degrees centigrade in the next 50 years.

These dramatic climatic and atmospheric changes will not only alter patterns of agricultural production around the world but also sea levels, which are expected to rise by 50 to 165 centimetres. Last year, an international conference in Hamburg concluded that, by 2050, land inhabited by a third of the world's population will be subject to constant floods and droughts, making barren much of the earth's grain-growing area, though the temperature rise may lead to an increase in crop production in more northerly latitudes, albeit on poorer soils. There is also a distinct possibility that much of the cultivatable land in river deltas, such as the Nile and the Ganges, and other low-lying areas around the world, will have to be abandoned unless astronomically high sums of money are spent on sea defences to prevent their inundation.

Not surprisingly, the scale of the problem is now recognised to be of such significance that the issues raised by the wider use of fossil fuels, including that for transport purposes, intensive agricultural practices and, associated with this, demands from a burgeoning world population, are almost certain to dominate international political agendas in the next decades.

The difficulties of lowering carbon dioxide levels make those of reducing sulphur dioxide and nitrogen oxide emissions, and damage to the ozone layer, appear comparatively easy to solve. In order to meet the target set at last year's Toronto conference on the changing atmosphere, which called for a 20 per cent cut in levels of carbon dioxide by 2005 as an initial global goal, far more attention will need to be paid to *all* available options.

Global warming, even more than toxic emissions, is essentially a world-wide problem. The causes lie in the sum total of fossil fuel consumption in all countries combined, and the remedies require effective collaboration in the face of conflicting national interests and priorities.

The contribution that each country can make to resolving these problems through its policy on energy is of course small -- for instance, the United Kingdom is responsible for only three per cent of total carbon dioxide emissions -- and the contribution of any particular activity within that country is smaller still. For this reason, the degree of international co-operation will have to be higher than has ever been contemplated in the past, and national 'rule-keeping' will have to be very effectively monitored.

The Third World

There are two major problems associated with such an approach. The first is that demographic projections indicate a near doubling of the world population over the next 50 years, nearly all of the increase occurring in the developing world. (The developing regions of Asia, Africa and Latin America have accounted for 85 per cent of the increase of the world population since 1950.)

The second is that developing countries will be expecting to increase their energy consumption to nearer the present levels of the industrialised world, and they will not think it reasonable to be constrained in this when their contribution to the problem of global warming is so much smaller: at present, for instance, the average production of carbon dioxide by people in the United Kingdom is eight times as high as that of people in the Third World, and that in the United States is twice as high as in the United Kingdom. Indeed, the United States alone produces 50 per cent more carbon dioxide than all of the developing countries combined. Consequently, if the international community is to come to terms with this problem of excessive fossil fuel consumption, and the populations of the developing world are to enjoy more of the lighting, heating, motor transport and other features of higher living standards of the developed world, it is essential that an actual reduction in energy consumption in the developed world is achieved, rather than a forecast substantial increase.

Policy options

Many means are currently available for extracting more usable energy from a given quantity of fuel. They are either in the process of being adopted or are the subject of major research and development programmes in most of which new technologies are playing an increasingly significant role. They have the prospect of achieving considerable savings in energy in virtually all sectors of the economy, especially transport, and there is every likelihood of them being widely applied in the next decade as their appropriateness to meeting many of the *full* range of policy interest objectives noted earlier is recognised.

Environmental considerations, particularly the threat of global warming, will bring a new dimension to the economics of energy, shifting the focus from local and national decision-making to international collaboration and regulation. In recent years, there has been important new evidence which has led to significant changes in public opinion and government policies in Europe and elsewhere. What is not yet clear is how quickly these changes in perception will take place and how quickly they will be translated into policy.

What is certain, however, is that the objective of attempting to accommodate further and faster travel by car and road freight vehicles is no longer a realistic option for it cannot be sustained, Lowering energy consumption solely through improved efficiency in use looks very likely to prove

an insufficient way of meeting the looming crisis. Every possible means will have to be applied. Transport policies will have to be aimed at reducing the demand for motorised travel through land use changes and the prioritising of provision for modes according to the degree of environmental impact that their use incurs.

Prospects for guided traction

When translated into the policies and practices that this logically leads to, the outcome will have a dramatic impact on the currently perceived attractions of road or air rather than guided traction systems for medium and longer distance personal travel and freight transport. However, it cannot be doubted that change is rendered far more difficult by the increasingly space-extensive lifestyles and patterns of commercial organisation that private motorised transport enables and encourages.

There are many measures that can be taken to bring about far greater use of rail and other energy-efficient forms of guided traction. In the case of road traffic, these include an energy, environmental or 'carbon' tax on fuel to reflect the extent of carbon dioxide production (combined with the transfer of vehicle excise duty to an additional *tax* on petrol), lower speed limits, supplementary or area licensing, and strict control and regulation of both public and private parking -- all of which could be applied in the short-term, that is within a few years. In the medium-term, however, some form of road pricing, such as using sensors under the surface of the road actuated by electronic number plates on motor vehicles, may be necessary. Such a system would be relatively cheap. However, the change would have to be instituted on a slowly rising scale in order to achieve the long-term goal of encouraging transfer to less energy-intensive patterns of travel and transport.

This objective will be promoted when different transport modes are appraised according to similar criteria, and with a common base for investment. At present, rail derives little 'benefit' from its much lower environmental impacts, including the production of far less carbon dioxide per unit of carriage, its much higher safety record, and its far more equitable accessibility to the general population. In marked contrast to roads, at present, rail has to be operated according to financial targets set by Governments which take relatively little account of these public interest issues.

A further contributory measure which will need to be taken is the incorporation of transport and environmental impact analysis statements in the planning process so that the effects of any proposed change on the wider objectives of policy, such as energy conservation, reducing traffic congestion, lowering the risk of accidents and improving environmental quality, are appreciated before decisions affecting the objectives are made. The effect of this too will be to reverse the process seen over the years of trends towards more scattered and low-density settlements which are very difficult to serve by fixed route transport systems, and of increasing rationalisation of commercial and public outlets -- an increase in their size and a reduction in their number -- with greater distances having to be covered to reach them. The logical outcome of such changes will be that people and organisations will respond by modifying their patterns of use of motorised transport, particularly by relocation of job or home to minimise commuter distances. The effects of this are likely to completely invalidate traffic forecasts for these are predicated on demand unrestrained by consideration of the objectives noted above.

It may be concluded that the combination of the substantial increase in world population over the next 50 years, and the absolute requirement for international collaborative intervention to offset as much as possible of the damage to the earth's ecology caused by man-directed processes, must lead to a fundamental re-appraisal of the desirability of extending the energy-intensive patterns of activity of the industrialised world and of adopting these patterns in the developing world.

In the sphere of transport, this suggests that governments and individuals will have to dedicate themselves to minimising demand for the carriage of freight and travel of people over longer distances, and then to meeting outstanding demand by the most energy-efficient and environmentally-desirable modes. This will inevitably result in far greater use of guided transport systems in the future. Auspicious prospects for such systems during the next 50 years cannot be in doubt.

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BENEFITS OF USING GUIDED TRANSPORT FOR THE MOVEMENT OF PEOPLE AND GOODS

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1. Introduction

There is growing awareness by politicians and the public at large that there are intrinsic advantages for rail transport and we may be at the dawn of a new era of transportation. The further option of using guided transport other than steel wheel on steel rail has been technically possible for many years. However, the difficulty of integrating the new track with existing rail or road systems has limited its application to special and discrete projects.

The fundamental advantages of rail ttansport are:

- it is safer,
- it is environmentally friendly (notwithstanding the protests against new lines!),
- it is flexible in the use of different sources of energy,
- it possesses, in many cases, under-utilised infrastructure and right-of-way (note this is not the case for other forms of guided transport),
- it is an efficient form of transport if there is a high corridor demand flow and high load factors are achieved.

The disadvantages are that railways, especially for interurban journeys are in the control of nationalised bodies and thus, do not actively promote a "door to door" transport service. This limited role in the journey chain for the movement of people and goods makes it difficult to achieve the high load factors that would make rail more competitive.

The current development of faster and more reliable trains with more intelligent signalling and control systems will improve the relative advantages of trains.

These points are developed in this paper, in particular context to the situation in Great Britain, although many aspects have a wider international relevance.

2. Supply and demand

One of the basic discussions amongst people involved with transport is whether traffic growth is created by socio-economic factors or by the opportunities provided by enhanced infrastructure. Obviously there is some underlying truth in both sides of the debate. Economic growth undoubtedly increases peoples' aspirations for more travel. Travel, on the other hand, cannot happen if there are no facilities. However, if there are no transport facilities, it is difficult to see how there can be economic growth!

The amount of travel by people and goods in Great Britain has increased substantially (see Figures 1 and 2). Over the thirty five-year period 1952 to 1987 (1);

- passenger traffic increased from 194 to 545 billion passenger-kilometres, i.e. at 3.0 per cent per annum,
- freight traffic increased from 88 to 195.3 billion tonne-kilometres, i.e. at 2.3 per cent per annum.

Modes of transport have changed significantly over the same time period (see Table 1). This shows that in the thirty five year-period 1952 to 1987 rail's market share dropped from;

- 20 per cent to 7 per cent for passenger travel,
- 42 per cent to 9 per cent for freight movement.

During a similar time period the amount and quality of highway in Great Britain has increased. This contrasts with the situation on the railways (see Table 2). It can be seen that the total length of highways has increased by some 18 per cent. Virtually all the increase (84 per cent) in road length being in unclassified roads; these, in the main, giving access to new housing and other developments. Nevertheless, there has been the development of a completely new hierarchy of roads, i.e. motorways. The first section of motorway in Great Britain was opened in 1959. In 1987, although motorways are only some 0.8 per cent of the British road system, they carry 15.3 per cent of the vehicular traffic (expressed in vehicle-kilometres). More particularly, they carry about 13 per cent of road passenger and 32 per cent of heavy goods vehicles traffic. In contrast, the length of railways expressed in route kilometres or length of running track has reduced. In the period 1965 to 1987/88, the seductions have been;

- Passenger routes: 17.5 to 14.3 thousand kilometres,
- Total routes: 24.0 to 16.6 thousand kilometres,
- Running lines: 48.1 to 32.7 thousand kilometres.

On the other hand, the amount of electrified routes has increased from 2 890 to 4 210 kilometres.

As stated above, it is debatable whether the fall in the rail market share is due to the reduction in rail infrastructure or the reduction in rail infrastructure is due to British Rail's perception of the potential demand bearing in mind competition from other modes, especially roads.

Another interesting comparison is that;

- 2 980 kilometres of motorways carries approximately 65 billion passenger-kilometres and 36 billion tonne-kilometres;

- 16 633 route kilometres of railway carries 141 billion passenger-kilometres and 17.3 billion tonne-kilometres.

The motorways have been developed as an additional hierarchial level to the then road system during the 1970s. It is interesting to speculate what an additional hierarchical level to the rail network, i.e. high speed lines, could achieve!

In this context, it is perhaps relevant that the DTp produces national road traffic forecasts and also air traffic forecasts. It does not produce forecasts for rail traffic, although British Rail does give some predictions for the next five years for some of its market sectors. The latest British forecasts (2) for road traffic cover the period up to 2025. In these forecasts, total vehicle-kilometres are expected to increase by 27 and 47 per cent by 2000 and between 83 and 147 per cent by 2023 compared with 1988 (a slightly lower growth than in the last 35 years!). The latest British forecasts for air traffic (3) cover the period up to 2005. In these forecasts, air passenger movements are expected to increase to between 164 to 234.5 million passenger movements per year in 2005 compared with 86.0 million passenger movement per year in 1987, i.e. an average annual growth rate of 3.7 to 5.7 per cent. Both these forecasts indicate substantial increases in traffic. Both forecasts procedures, however, appear to exclude the expected level of provision of infrastructure in their forecasting methodology. This has

given rise to a series of consultation documents (4), reports, etc. dealing with the problem how can the requisite infrastructure be developed to provide a reasonable level of service; or conversely, what are the likely economic consequences if the demand is not "satisfied". At the present time, the consensus appears to be that;

- roads, especially motorways/strategic routes and within urban areas, will become more congested, journey times will become more unreliable and unit transport costs will increase;

- there will be a growing number of airports operating at capacity (Heathrow already is) and there will be increasing air traffic control problems.

The forecasts produced by DTp for road and air traffic have only recently considered competing modes. However, this has been limited to comments on the potential effect of the Channel Tunnel. The air traffic forecasts have made an allowance for diversion from air to the through rail services. The most recent traffic forecasts include the following:

> "There are no obvious trends which are likely to significantly disturb this relatively fixed share of road in total tonne-kilometres. The Channel Tunnel may improve the prospects €or rail movement, but the impact on total domestic road movement is not expected to be significant."

In contrast, British Rail prepares a Corporate Plan each year which covers the following five years. In this plan, traffic forecasts and the means to achieve these forecasts within operational and financial requirements are balanced. These forecasts are based upon marketing considerations of the competing forms of transport. In the 1988 Corporate Plan the demand for:

- InterCity passenger-miles to increase by 6.5 per cent by 1992/93,

- provincial services train-miles would increase by 2 per cent by 1992/93 with an increase in average load factor by 11 per cent (this would appear to indicate a 13 per cent increase in passenger-miles),

- Network SouthEast, i.e. services in the South East of England around London was expected to increase by 8 per cent by 1991 and another 7 per cent by the mid 1990s (note: the actual increase in 1987/88 was 4 per cent!),

- freight to increase from 136 million tonnes in 1988/89 to reach a plateau of 142-143 million tonnes through to 1992/93 (i.e. an increase of 4.4 to 5.0 per cent).

These growth rates (apart from Network SE) are below the recent growth rates for total passenger and freight movements and thus indicate a planned loss in overall market share.

To summarise:

- road traffic has established a dominant market share for passenger and freight traffic,

- rail market share has reduced significantly; from 20 per cent to 7 per cent €or passengers and from 42 per cent to 9 per cent for freight over the last 35 years,

- air traffic has a very small market share of domestic traffic, but has increased significantly over the last 35 years (it is currently the market leader in traffic between Great Britain and Continental Europe),

- the latest national traffic forecasts for road and air show substantial growth over the next decades,

- there is a concern that the present road and air networks are overloaded now and the rate of enhancement of the road and air infrastructure currently planned will not be able to cope with the increase in demand,

- British Rail is planning for a growth in traffic demand which is at a lower rate than that for total traffic, i.e. a "planned reduction in overall market share".

3. Potential for guided transport

It can be seen from the above analysis that the future for rail transport in Great Britain is for an expansion of services and traffic volumes but at a lower rate than the demand for road and air transport. If the current plans for future inter-urban roads (5) are implemented, it is considered by many that road congestion will increase, i.e. it is not enough to deal with the expected demand. Similarly, the air forecasts indicate the need for additional runway capacity in the South East of England which will be strongly opposed by various environmental groups.

At present, there does not seem to be positive plans for dealing with traffic in the large metropolitan areas. Many of the cities, outside London, are at various stages of developing many forms of tracked-based system. London is still considering proposals for a significant enhancement of the British Rail/London Underground system although there is now a commitment to extend the Dockland Light Railway. Various route assessment studies are still being developed for some of &he key transport corridors in Inner London. However, there is already strong opposition being organised to oppose any road proposals that may be promoted by the DTp.

It is in the political framework that the assessment of the potential €or the future guided transport systems to play a much bigger role in:

- inter-urban and trans-urban (i.e. journeys that have to bypass intervening cities)journeys for passengers and freight. These would be developed to utilise the existing rail infrastructure, in particular the routes within urban areas. It is therefore highly probable that these services will be by rail;

- passenger trips within the large (say over a third of a million inhabitants) cities. These systems could be free standing and therefore could use new technologies. (The possibility of having automated freight movements in urban areas is currently technically possible but the institutional problems for introducing a scheme into even a limited area are extreme. Examples, nevertheless, do exist within large production plants and could be implemented within a single comprehensive development).

The key question is why haven't these rail schemes been developed? In my view, this is because of different institutions involved in developing the various transport modes. These institutions have adopted different assessment criteria which again, in my view, are strongly influenced by likely political acceptability and expectations.

4. Means for creating the justification of rail transport systems

It is a fundamental criterion of the current British Government that there should be "undistorted competition" between the various modes of transport. Having said that, the assessment criteria are

different and the payment by users is very different for the various forms of transport. For example, highway investment is justified, in the main, by cost-benefit analysis; benefits in this case include users and non-users, Railway investment has to be justified on a financial basis with the criterion currently being a minimum 8 per cent rate of return. Road users pay for the use of roads by indirect means, rail users pay at point of consumption. In this context, a senior civil servant recently stated (6) to the Transport Committee of the House of Parliament:

> "The Government has said that, where necessary, it is prepared to look at grants to new investment projects (for InterCity rail services) to recognise, (and) compensate for, the benefits of non-users."

However, on closer examination by the Committee he admitted that such a grant would be unlikely and the principle was more likely to apply to rail services for commuters where there was relief to road congestion. Notwithstanding his subsequent comments, I think the opportunity now exists for rail investments to be justified because of the benefits to users and non-users. This will also require a change in aspiration for the railway companies. They will have to promote the advantages, not only to existing and potential users, but also specific non-users and the community at large.

If this change did occur, and, for example, there was a comprehensive introduction of high speed rail services then this would initiate a new transport age. Each age commenced when demand justified a threshold in average speeds for significant journeys (i.e. including access time). The threshold changes being more or less a doubling of the previous speeds.

1850s: Turnpikes for stage carriages increased average speed from 5 to 10 miles per hour.

1900s: Trains increased speeds to 30 miles per hour.

1950s: Motorways increased speeds to 60 miles per hour,

1990s: High Speed Rail increased speeds to 120 miles per hour.

(Note: Air is still a relatively minor mode for most journeys -- it will always be dominant for the very long but infrequent trips.)

In this new era, rail transport systems would have significant benefits compared with their competing modes both in terms of the medium/long distance trips and for urban journeys. For example, they would be;

- safer, the Japanese Shinkansen has never had a passenger injured or killed in 25 years of operations. During that time, the system has carried almost three billion passengers. The French TGV, in almost a decade, has a similar perfect record;

- more energy efficient as well as being able to use a wide variety of fuels indirectly through electric power units. The relative energy consumption for various forms of transport depend crucially on assumed load factors. Within a reasonable range of assumptions high-speed rail is compatible with coach but significantly better than car or aeroplane;

- less polluting. Transport accounts for about 40 per cent of the emission of gaseous pollutants -- carbon monoxide, nitrous oxides, hydro-carbons and sulphur dioxide. As railways move increasingly to electric-powered operations, they create no direct air pollution, relying on power stations which can be sited in accordance with environmental policies and

subjected to emission-cleaning requirements. This distancing of the nuisance from the community is not technically possible for road or air transport;

- **arguably less noisy. High** speed trains on purpose built tracks are no noisier than the best combination of conventional trains on existing tracks. The major sources of noise being from aerodynamic sources rather than from wheel/rail interaction or pantograph/conductor wire. Good design can minimise these effects. The general perception is that they are less intrusive than the general roar of road traffic or the passage of low-flying aircrafts;

- **able to utilise existing corridors** within existing urban areas. Most city centres were developed during the industrial revolution when rail (and canals) were the prime forms of transport. Developments since then have respected the existence of the railways lines. In Britain track closures and selling off railway land did not really commence until the early 1970s. This has meant that access corridors still exist to allow rail services to access the core of the built-up areas. In general, these access corridors can carry substantially more traffic if relatively minor improvements are made to track layouts, signalling systems, power, stations, terminals, etc. Thus, rail is compatible with existing "townscape"; motorways are perceived to be incompatible and there can never be sufficient space for parked vehicles;

- **can provide relative priorities** to different types of traffic, At the present time the vast majority of passenger and freight movements are carried by road, the longer distance movements being carried on the motorway/strategic road system. Unfortunately, this key part of the road system is dominated in areas adjacent to major urban areas by short distance trips. This causes congestion and delays to all traffic. It is very difficult, short of only permitting infrequent access to give priority to long-distance trips. The uncertainty in journey times means that freight hauliers have to build this into the service they offer. Road congestion has recently been estimated to cost the community some £15 billion per year. In this context, it is of interest to note the developments of various technologies fox organising safer road transport on motorways by forming "quasi-trains".

5. Conclusion

However, the development of a new transport era, the renaissance of the train can only come about if it is promoted as being in the interest of the community at large. This requires, in my view, a change in the current organisation of railways whose objective is to minimise their losses to one that can see the opportunities available because of the difficulties in providing effective road and air services. This implies that it has to become consumer-orientated and recognise that rail transport is a service. The rail element of a journey is only part of a trip and the new rail promoter has to provide an acceptable and easily understood door-to-door service that meets customers' needs and transcends current national and system boundaries. This could well be achieved by a "mixed-economy" joint venture between the private and public sectors. The time is right, the traffic demand awaits, the technology exists, there is no shortage of money for the "right scheme", the only problem is the development of the implementing institutions.

Table 1. Great Britain Traffic Movements by Mode of Transport (percentage)

a) Passengers (based upon passenger-kilometres)

Year	Road*			Rail	Air
	Car, Taxi Motorcycle	Pedal Cycle	Bus and Coach		
1952	28	10	42	20	0.1
1955	36	8	38	18	0.1
1960	51	4	28	16	0.3
1965	67	2	19	11	0.6
1970	74	1	15	10	0.6
1975	76	1	14	9	0.6
1980	81	1	10	7	1.0
1985	82	1	8	7	1.0
1987	84	1	8	7	1.0

* Walking trips are not included in quoted statistics.

b) Freight (based upon tonne-kilometres)

Year	Road	Rail	Water	Pipeline
1952	35	42	23	
1955	41	38	21	
1960	49	30	20	
1965	57	21	21	1
1978	63	18	17	2
		*		
1980	53(57)	10(11)	31(26)	6(6)
1985	55(60)	8(9)	31(24)	6(7)
1987	58	9	28	5

* Definition for Water-bourn transport was changed from commodities in competition with other transport modes within Great Britain to total freight within the United Kingdom, i.e. including Northern Ireland. Figures in ( ) relate to the earlier definition.

Source: "Transport Statistics Great Britain", 1977-87 and earlier editions.

Table 2. Great Britain: Transport Infrastructure

a) Roads (thousand kilometres)

Year	Trunk		Principal		Classified Non-Principal	Unclassified	Total
1952	13.3	(0) (-)	31.5	(0) (-)	106.8	147.0	298.6
1955	13.3	(0) (-)	31.5	(0) (-)	107.0	150.9	302.7
1960	**13.6**	(0.15) (-)	31.8	(0) (-)	107.0	160.1	312.5
1965	14.0	(0.56) (-)	32.0	(0.01) (-)	107.3	170.3	323.6
1970	14.5	(1.02) (1.75)	32.6	(0.04) **(0.99)**	107.3	168.2	322.5
1975	15.2	(1.88) (2.42)	33.1	(0.09) (1.68)	107.8	173.9	330.0
1980	14.8	(2.44) (2.78)	34.3	(0.11) (1.95)	108.9	181.6	339.6
1985	15.0	(2.72) (3.06)	34.9	(0.13) (2.16)	109.5	189.4	348.8
1987	15.3	(2.88)	35.0	(0.10)	109.9	192.0	352.3
Increase 1952/1987	2.03		3.52		3.13	45.04	53.7
Percentage	15%		11%		3%	30.6%	**18%**

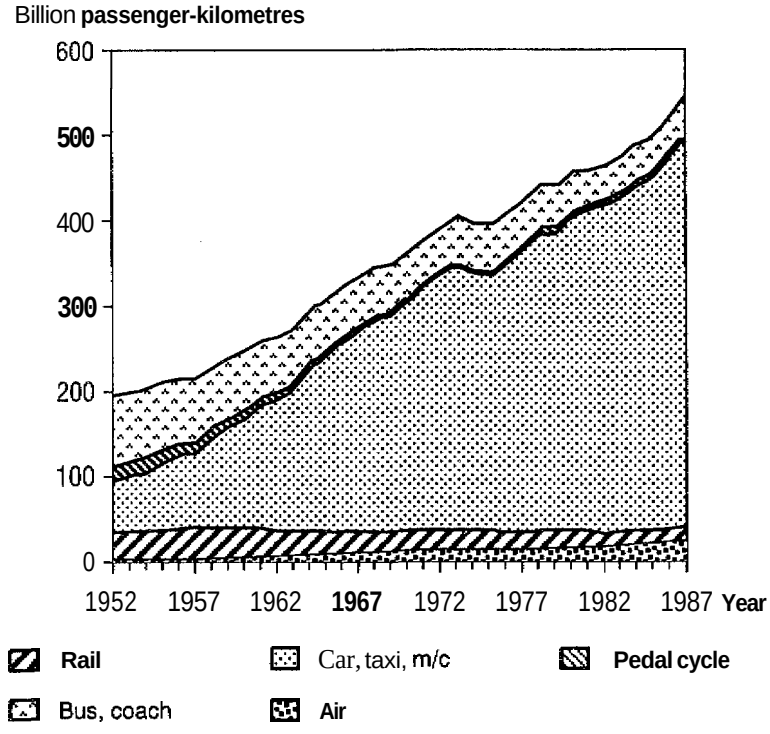
Figures in ( ) are dual carriageways, the upper figure being motorways and the lower figure being "all purpose" (data before 1970 not available). These lengths are included in the relevant road length.

b) Rail (thousand kilometres)

Year	Route			Track		
	Passenger	Total	(of which electrified)	Running Lines	Sidings	Total
1965	17.5	24.0	(2.89)	48.1	18.4	66.5
1970	14.6	19.0	(3.16)	38.2	12.1	50.3
1975	14.4	18.1	(3.66)	36.1	10.4	46.5
1980	14.4	17.6	(3.72)	35.1	8.8	43.9

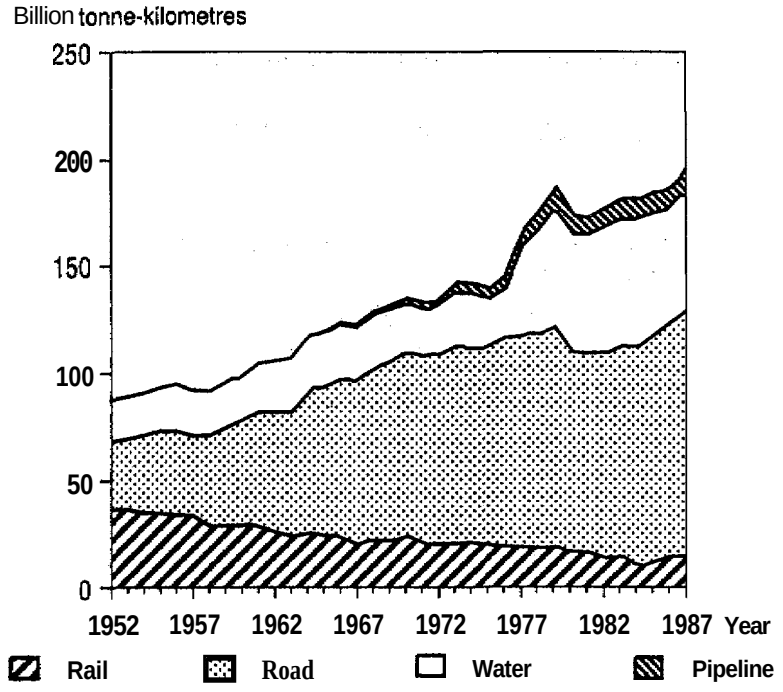
Source: "Transport Statistics Great Britain", 1977-87 and earlier editions.

Figure 1. **Growth of passenger transport by mode, Great Britain**



Source : Transport **Statistics Great** Britain, 1977-87.

Figure 2. Growth of freight transport by mode, Great Britain



Source : Transport Statistics Great Britain, 1977.87. Definition change for water: seeTable 1

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2. "National Road Traffic Forecasts (Great Britain)", HMSO, 1989.

3. "Air Traffic Forecasts for the United Kingdom", HMSO, 1988.

4. For example:
   - "(Air) Traffic distribution policy for the London area and strategic options for the long term", CAP548, Civil Aviation Authority, January 1989.
   - "Congestion", the Institution of Civil Engineers, 1989.
   - "Need for Renewing Transport Infrastructure in Europe", the Round Table of European Industrialists, 1989.

5. The recent policy statement "Roads for Prosperity", HMSO, May 1989, added £6 billion of schemes to the road programme which more than doubled the then list.

6. "Report on The Government's Expenditure Plans for Transport 1989-90 to 1991-92", Transport Committee, HMSO, 18 July 1989, page 23.

ANNEX 2

REPORT ON A DISCUSSION ON EUROPEAN GUIDED TRANSPORT IN 2040, HELD DURING THE 17TH PTRC SUMMER ANNUAL MEETING ON 13TH SEPTEMBER 1989 AT THE UNIVERSITY OF SUSSEX, BRIGHTON, UNITED KINGDOM

The day followed the usual pattern of the PTRC Summer Annual Meeting, that is six one-hour sessions in which papers were delivered on the structure of production and organisation of society, behavioural aspects, technical developments, aspects related to the environment and resources, and the economics of guided transport. A general debate was held during the last session and was chaired by Dr. P.B. Goodwin of Oxford University.

The papers delivered are published with this report, with the exception of that on behavioural aspects by Mr. Waschke.

Professor A. Bonnafous of the Lumière University in Lyons, France, pointed out that current developments in production, whereby a complicated pattern of intermediate products were moved about all over Europe, is going to continue. Products would also tend to become lighter in weight but heavier in terms of value-added, so the traditional market of bulk goods - on which railways and both sea and inland navigation services hold strong positions - will gradually diminish in scale.

Given this sparse pattern of movements, the lorry will hold a strong position, while the railways can also serve to ferry lorries or their containers/bodies at points in their journeys where there are geographical barriers such as through the tunnels under the Channel and the Alps. However, where transport can be organised on the basis of a hub and spoke system, in particular, rail can play a role on the major routes carrying heavy traffic. In such situations it may be of value to use high-speed trains designed for freight and for small consignments in particular.

It is important for passenger transport that the population of urban areas is increasing. While the population of inner cities is now showing a tendency to diminish, that of particular urban areas as a whole is increasing at the same time as there is a drift away from rural areas. A further important factor is that car ownership and use will continue to expand owing to the fact that those now members of the active population who have become used to driving cars will continue to do so after retirement, whereas among today's elderly people there are many who have never driven a car. In addition, they tend to be more complicated journeys rather than simple outward and return journeys from home to a single destination, and railways are not particularly well suited for the complicated journey.

Professor Bonnafous is convinced that a European network of high-speed trains will be developed, although nobody at the present time knows what it will look like. Any city that wishes to have a role in international life will find it important to be part of this network and can therefore be expected to be prepared to help cover its costs.

The size of a city at which its authorities consider an urban rapid transit system to be warranted is diminishing, although automated people-movers and guided buses may also have a role to play. Financing such facilities may be a problem, but the introduction of road pricing can help to provide funds.

Mr. Waschke of Daimler Benz A.G., Berlin, Germany, stressed that the opinions of the prospective users of a system's services are extremely important and should therefore be examined carefully at the outset.

Some of the positive aspects of railways are that they arrive in the centre of cities, are reliable and can be fast. They are also safe and cause little pollution. The fact that many schoolboys once dreamed of becoming an engine driver may indeed by a sign of public attachment to the mode.

The train's negative aspects include high deficits, low standard of service in rural areas, a national approach to the resolution of technical problems, bureaucratic organisation, low level of personal

service, trains that may sometimes be crowded, and the fact that interchanges may be called for. It was found during the discussion that personal feelings of insecurity were also involved.

New technologies can do a lot to promote the image, but that is not the main problem. A positive image of the train should be developed now so as to provide a source of further impetus in the future, While overall travel will not increase very much, road and rail transport will be recording higher speeds. Railways cannot be dispensed with but they should be organised in different ways. The integration of car and train travel is called for.

Mr. Waschke thought that the market for long-distance passenger traffic would mainly involve business trips. It was stressed during the discussion, however, that the railways can also have a major role in holiday traffic if appropriate services are offered.

Mr. Nilsson, Innovation AB, Stockholm, Sweden, who dealt with technical developments, began by giving some of the conclusions reached at the Round Table of European Industrialists. He thought it worth noting that the conclusion to the effect that the train should have a greater role had been reached in a group chaired by Mr. Agnelli of Fiat which, although a producer of rail vehicles, was essentially known as a car manufacturer. In this report, Eurotunnel was considered to be a success while the international high-speed rail system was regarded as a failure, at any rate at present owing to the national character of the railways.

Technical developments in the wheel-on-rail technology came about relatively slowly. The British advanced passenger train had not succeeded because it tried to achieve too many things at the same time. Magnetic levitation may be used in the future for services calling for very high speeds.

The author considered it unlikely that passenger cars would in future be linked together to form trains to be driven by automatic means, since one of the main reasons people like so much to drive cars is that they have freedom, and that would no longer be the case if the driving were to be done by an electronic system.

One important technological development for the future will be more efficient automated signalling and information systems.

During the discussion, Mr. Chappuis of the Swiss Federal Department of Transport described a project under consideration in his country for the construction of a train network using magnetic levitation and running entirely through tunnels in a vacuum at very high speeds of some 500 km/h. All trains would travel from one station to the next in 12 minutes with stops lasting 3 minutes for picking up and dropping passengers. The tunnels would cost approximately the same as a four-lane motorway or a normal double-track railway.

In his paper and address, Dr. M. Hillman set out the various reasons why the existing patterns of traffic, largely based on motor-powered road transport, cannot be maintained. The argument here is particularly relevant in view of the fact that developing countries will in future wish to catch up with those regions of the world that now have the highest levels of road use.

A number of factors argue in favour of less road traffic: safety, limited stocks of fossil energy, air pollution. It now seems that global warming will be the most decisive factor. If no firm international steps are taken to curb the production of carbon dioxide, there may be major climatic changes that will influence the living conditions of up to one-third of the world's population. While there can be no certainty about the effects, it is highly likely that they may have a substantial impact within the next 50 years.

Accordingly, it would be desirable to maintain the rail system in a condition that would enable it to handle at least some of the traffic that can no longer use the roads. However, the railways cannot replace road transport entirely.

Walking and cycling are means of replacing some short-distance passenger travel by road, while some of the current longer-distance passenger and freight traffic by road or air can be taken over by the railways. Overall, however, a new spatial organisation of activities is called for in order to change the patterns of traffic so that less long-distance transport is needed.

While the discussion showed that there was general agreement on the analyses made in the paper, some doubt was voiced concerning the political will to take the necessary measures. It was concluded, however, that there is growing awareness of environmental problems in many countries and that this awareness might provide the point of departure for concerted action.

It was pointed out that railways also use fossil energy, essentially through electricity generating plants, but the figures given showed that carbon dioxide exhausts from rail transport came to about only 10 per cent of that from road and air traffic.

If the price of fossil fuels is raised, this would simply mean that those who are better off can continue to travel by road, whereas lower income groups will no longer be able to do so. Attention is drawn to the fact that such arguments apply in general. For example, the same is true for housing. It would be conceivable, however, to allocate a given number of carbon dioxide units to each member of the public to use as he sees fit or even sell.

While it was not the main purpose of the session to discuss policies for restricting the use of road transport, it was agreed that railways are likely to play a far more important role in transport than at present, so it is even worth ensuring that branch lines in rural areas are maintained.

Mr. A. Dick, a consultant currently working for the Eurotunnel Company, first pointed out that the Eurotunnel concession extends beyond the year 2040, so it is quite relevant to look that far into the future. However, the initial data given in his paper covered the development of transport over the past few decades and showed that rail traffic, while remaining at about the same volume, had lost considerable ground in terms of its share of total traffic. Nonetheless, the arguments set out by the previous speaker had been in favour of an increase in the volume of rail traffic. However, the projections included in the long-term plans drawn up by the railways themselves usually showed a slower rate of growth than that fur all modes taken together. He was therefore somewhat pessimistic about the possibility of the railways obtaining an increasing share of traffic, as would clearly be required for environmental reasons.

Using the expansion of the motorway system as a point of reference, Mr. Dick pointed out that, if a rail system of high quality but limited mileage were to be developed, a high proportion of total traffic could in principle be obtained, For the reasons set out by Mr. Hillman, this would certainly be necessary.

The most important role of guided transport concerned inter-city, or rather trans-city, transport of passengers and goods and intra-city passenger transport. Its role is strongest in the latter category, and traditional heavy rail can be supplemented by the new people-mover technologies. For the reasons given earlier, the inter-city transport situation is critical, but is in fact ideal for entrepreneurial approaches; a declining industry with good prospects for new development can be very attractive from the standpoint of private enterprise. Mr. Dick said that his own experience showed that both the air transport industry and road transport operators are eager to enter the field of rail transport. One optimistic possibility for the development of rail transport might see operators from the road and air sectors joining forces with government authorities who would always be handling the infrastructure side. If joint action of this kind could be achieved, one might indeed take an optimistic view of the future of guided transport.

It was pointed out during the discussion that it would be inadvisable to focus attention; on the railways' share of total traffic. A better approach is to look at markets for which railways are particularly well suited. Changes in land use patterns have meant that demand for transport has shifted away from routes carrying heavy traffic in which rail transport can play a major role, although the railways still have a substantial share of the market on such routes. In reply to this observation, Mr. Dick said that one of the main shortcomings of railways at present is their failure to take account of the journey in its entirety. In principle, they should become transport operators who offer services that use whatever mode is most suitable.

Questions were asked about the possibility of using the Channel Tunnel for new technologies and about the way in which future traffic might be influenced by scarce resources. In view of the very large cross-section of the Tunnel, which is needed to accommodate heavy lorries for carriage inside a rail vehicle, virtually any new form of guided transport can be accommodated as a replacement for the traditional railway. As regards traffic forecasts, especially for the latter half of the concession period, account was taken of the impact of environmental considerations on the development of traffic and the Tunnel was accordingly linked up with the existing rail systems on both sides of the Channel. It was however stressed that the highly efficient shuttle services that are to be organised between the two ends of the Tunnel might very well be extended further into the countries on either side.

The *general* debate concluding the day saw three convergent views put forward as potential conclusions of the earlier sessions, namely that rail use ought to, must or will increase.

The following observations were also made during the debate which, in contrast with the above conclusions, had not been mentioned earlier, perhaps owing to the specific responsibilities of the participants:

- railway undertakings are organisations which *play* trains in real life;
- expansion will only be possible if management is changed, but management is so powerful that this will not happen;
- the structure of national undertakings should be dispensed with;
- railways waste public funds;
- even if rail traffic were to double or treble it would be equivalent to only a small proportion of road traffic.

The suggestion was then made that railways might in future be privately owned, commercially operated and receive subsidies far public service activities. In addition, infrastructure might be separated from the operational side, as has already been done in Sweden. It was pointed out that considerable caution had to be shown with respect to the commercial operation of railways, since the present style of management worked against such operation and it would not be enough simply to

change top management. However, if railways do not learn to operate on a commercial market, they cannot expect to be still surviving in 2040.

Other speakers stressed the importance of technical innovation as a means of promoting further progress in rail transport.

If one looks to the long-term future, however, the fundamental question is to know whether people are prepared to pay the cost of having a railway, a payment that can be made by the users themselves but also by the cities to be served by a rail system.

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