1 Transport Infrastructure and European Union Developments

PETER NIJKAMP and JAAP VLEUGEL
Free University of Amsterdam, The Netherlands

1.1 THE CRITICAL ROLE OF TRANSPORT

Transportation plays a critical role in the spatial–economic evolution of our economies. The development of the transport sector—and spatial interaction in general—mirrors the socio-economic, spatial and political dynamics of our societies. Research in transportation planning has in past decades devoted much attention to demand analysis, e.g. mode choice, route choice etc. In particular, the behavioural models in transport research dealt mainly with the demand side. The supply side has received far less attention, especially in a modelling context.

In recent years the profound changes in economic and spatial policy have brought about a re-orientation in transportation with a clear focus on supply-driven mechanisms, in which the role of the public sector is increasingly at stake.

This trend is reinforced by various force-fields emerging in many countries, such as public budget deficits, the need for more competitiveness in (semi-) public goods delivery in order to enhance efficiency, the need for more customized service supply at a local (decentralized) level, and the drastic re-orientation in former centrally planned economies where privatization is a sine qua non for bureaucratic inefficiencies, insufficient fiscal revenues and new equity and ownership considerations.

In view of the skyrocketing mobility at the demand side and the strategic role of transport infrastructure as a critical success factor for competitive advantage and internationalization at the supply side, transport policy deserves full-scale attention. The positive externalities of transport networks and operations run the risk of being offset by negative externalities in the form of pollution, congestion and lack of safety. As a result, various types of government interventions (initiating, regulatory, financial or market-oriented) have emerged. However, the high costs of modern transport infrastructure in all modes have at the same time put an unprecedented burden on the government budget, so that in recent years the debate has started on private financing of infrastructure, based e.g. on ‘user charge’ principles. Thus, in our era
transportation planning requires a balanced implementation of actions which ensure a consideration of both private and social costs and benefits, and a network orientation which exceeds local or single-modal policy interests.

The present chapter aims to offer a sketch of modern transportation policy issues, taking Europe as a frame of reference. In recent years, the completion of the European market has provoked much interest in transportation and infrastructure as an integrative strategy for socio-economic cohesion. And therefore, much attention will be given to the structuring role of infrastructure networks, using, *inter alia*, the notions of missing links and missing networks. Particular emphasis will be placed on the identification of critical success factors, using the so-called Pentagon model. The arguments will be illustrated by considering two important European transport issues, viz. international freight transport and high-speed trains.

### 1.2 EUROPEAN INTEGRATION, MISSING LINKS AND MISSING NETWORKS

#### 1.2.1 INTRODUCTION

The completion of the internal EC market, the increasing linkages with EFTA countries followed by the extension of the EC, and the socio-political and socio-economic accessibility of East-European countries have drastically changed the face of European cities, regions and countries. Openness, competitiveness, innovation, infrastructure connections and private–public initiatives have become new magical words in economic development strategies at all spatial levels in Europe. All these terms suggest that regional development policy is entering a new stage in which the *indigenous potential* of regions based on self-reliance strategies will come to the fore (cf. Suarez-Villa and Cuadrado-Roura 1993).

The new situation in Europe also provokes new policy questions which are directly linked to the three-tier structure of the new Europe, viz. the *competence of various actors involved in regional development policy*: European (i.e. supranational), national (i.e. supraregional) and regional policy-makers. Especially after the Maastricht Treaty and the Danish referendum, this question of institutional competence has played an important role in many countries. The fear of new supranational and bureaucratic authority in Brussels which would take over many responsibilities of lower-level actors has prompted many Europeans to resist the glamour of a new Europe, and as a reaction against the widespread ‘Europhoria’ many have recently called for sound policy principles based on bottom-up initiatives and decentralization. The *subsidiarity principle* has become an important institutional paradigm which suggests that the responsibility for policy initiatives should rest with authorities at the lowest possible decision level,
while reasons of efficiency, coherence, equity and standardization may necessitate policy coordination at a higher level.

Another problem concerns spatial–economic equity in Europe. The completion of the internal EC market will likely aggravate the problem of socio-economic disparities between regions in the EC. It is generally expected that the relatively weak competitive position of peripheral regions will prevent them from a full participation in the process of European integration, so that the integration gains will most likely show up in the central regions in Europe (cf. Gaudard 1971; Ratti and Alberton 1993). For example, Quévit (1991) states: ‘The main effect of the attainment of the European market will be the concentration of economic activity in a limited number of locations’ (p. 34).

A situation of interregional convergence and divergence after a market integration will depend on:

1. the degree of cost reduction in each region as a result of economies of scale and market expansion;
2. the efficiency rise in firms as a result of rationalization and of a price policy that is more in accordance with production costs in a competitive market;
3. the degree of industrial restructuring and specialization as a result of more pronounced comparative advantages in an integrated market;
4. the degree of product and process innovation following investments in research and development (R&D) as a competitive tool in an integrated market.

The above observations point at serious questions on the interregional distribution of benefits of a unified Europe, as it seems plausible that the strong, central and highly competitive regions will become the winners in the new Europe, absorbing the lion’s share of the economic activity at the expense of the peripheral, weaker regions. This issue of efficiency versus equity is even more important, as the efficiency–equity dilemma is likely to generate a competition which may be at odds with environmental quality. Therefore, it is likely that the following questions will emerge in the European setting of the 1990s:

1. the distribution of integration benefits between nations and regions;
2. the degree of socio-economic disparity between central and peripheral areas;
3. the threat to ecologically sustainable economic development at both regional and national scales;
4. the development of proper policy strategies at supranational, supra-regional and regional levels which alleviate the conflicts between economic efficiency, social equity and environmental conservation.
It goes without saying that transport is the blood circulation in an economy and hence infrastructure plays a critical role in performing the multiplicity of functions in an economy. In this section infrastructure policy in Europe will be discussed in the context of economic integration in Europe. It starts with a brief overview of conventional policy-making commonly found in most European countries until recently (Section 1.2.2), followed by an introduction to more recent and new ways of infrastructure policy-making (Section 1.2.3).

1.2.2 NATURE AND BACKGROUND OF MISSING LINKS

In the literature a distinction is usually made between demand-oriented policies on the one hand and supply-oriented policies on the other. Demand-oriented policies are reactive in response to transport demand, meaning that an increase in mobility is followed by expansion of physical infrastructure. Supply-oriented policies on the other hand are proactive, since supply of infrastructure is used as a tool to manage and influence transport demand.

Infrastructure policy-making in Europe (and elsewhere) has mainly been demand-oriented. In light of the vast problems related to growing infrastructure networks and use—notably congestion and deterioration of the environment and living conditions in general—one would expect a bias in current transport policy-making towards supply-oriented policies. In reality, an emphasis on supply policies is not very common in most countries.

There are various reasons why this change in policy-making has not happened. The first reason is inertia: in most European countries the political will for such a policy change is lacking, for both political (pressure groups) and financial—economical reasons (excise-duty income). The position of transport policy in the context of a so-called political life-cycle leads to short-sighted transport policies. A second reason can be found in the fact that the transportation sector has become one of the vital parts of the modern service and information economy; economic development in most countries has become transport- and distribution-oriented. Changing this situation is both very difficult and expensive. A third reason is that it is very hard to change old habits and behaviour (inertia), not only in policy-making, but also in user behaviour; car use is more highly valued (in terms of travel time, flexibility and quality) than the use of other modes of transport, in both passenger and goods transport.

A second feature of European transport policy-making is its rather nationalistic character. In general, policies are developed and implemented in a segmented way, each country seeking its own solution for each transport mode without keeping an eye on the synergetic effects of a coordinated design and use of advanced infrastructures. National infrastructure building companies, vehicle producers and transportation companies are often given
a competitive advantage at the cost of their foreign counterparts. As other countries will use the same tactics, however, in most cases all parties will be losers in this way, since efficient scale is not reached and large sums of public investments are lost. A consequence of such inefficient behaviour may be that external competitors (e.g. Far Eastern or American companies)—while having large home markets—may outperform European companies. The problems created by the reduced efficiency of infrastructure have often been viewed as pure infrastructure bottlenecks with only two dimensions, viz. physical infrastructure and financial funding, while neglecting demand management and institutional and organizational aspects as well as ecological implications. Examples of the effects of neglecting these important infrastructure development criteria include, inter alia, inefficient use of vehicles because of cabotage restrictions, protection of national carriers, segmented European railway companies and lack of multi-modal transport facilities. In fact, efficient border crossing is a test case for most infrastructure networks.

As a result, the European transport scene is characterized by many bottlenecks; so-called 'missing links'. They are partly caused by the absence of efficient border-crossing operations and regulations. Since 1993 a gradual removal of such impediments is taking place, but there is still a long way to go.

Until recently, transportation policies in European countries have in most cases been short-term-oriented and demand-following, since they did not take into account that expanding physical infrastructure in most cases means attracting additional traffic and transport; the removal of missing links often created new missing links elsewhere. However, such policies do not deal with the real causes of mobility growth and tend to cope with symptoms rather than with underlying structural processes.

1.2.3 THE NOTION OF MISSING NETWORKS

Crossing geographical borders in Europe is not (made) easy, even nowadays. Long queues of freight trucks at border crossings have become normal phenomena. Cross-border infrastructure has always been an underdeveloped area. There are various reasons for this situation (see Giaoutzi and Nijkamp 1993). The first reason relates to the fact that cross-border traffic and transport used to be a minor part of total traffic; national borders appear to act as barriers to transport (see also Bruinsma and Rietveld 1993). Since investment costs in border infrastructure were only partly met by additional traffic and since the neighbouring country would also benefit from such investments, a lot of cross-border links were of poor quality. The second reason is that the planning of cross-border infrastructure incorporates international planning, whereas infrastructure planning used to be based on national, segmented policy-making. European integration will remove some of these
problems. It will also lead to additional international transport. International planning of railway lines—but not of networks—is also beginning to emerge.

In strong contrast to the planning world, the economic and political arena in Europe has changed dramatically, as was shown in Section 1.1. Globalization is the keyword in this context, stressing the importance of linkages between economic and political developments and decision-making in all regions of the world. As economic and political borders are reduced and finally removed—a ‘Europe without internal borders’ is one of the goals—increasingly, however, the need for multinationally planned and implemented networks will arise, instead of conventional policies based on piecemeal and ad hoc linking of national networks. In some, especially southern, countries this will lead to major expansions of existing networks, which in turn will lead to important quality gains in transport, at least in the medium term, given the vast growth of transport and vehicles. In most countries in Europe, especially in the northern part with its relatively high quality and dense networks, this might mean a shift from quantity to quality in network planning and use.

As transport planning by firms becomes more and more a process of planning of transport chains, each link of this chain is critically dependent on the other edges. This holds especially true for areas where major harbours or airports are located and for areas crossed by through traffic. Their local decisions will then increasingly obtain a higher-level importance.

Since economic growth in Europe tends to be concentrated along one or more axes or corridors with high concentrations of population (witness, e.g., the well-known ‘blue banana’ concept), it is foreseeable that network and corridor planning becomes a new field of infrastructure planning (see Vickers 1992). In this context the notion of missing networks has emerged. ‘Missing networks’—as a general term for a substandard functioning of infrastructure—refers to the absence of various strategic components and necessary conditions of transportation and/or communication infrastructure. Missing networks may refer to both single-mode networks and multi-mode networks. The concept may concern (1) the physical absence of a given infrastructure (e.g. inland waterways), (2) the lack of strategic linkages between various modes of transportation (e.g. absence of combined transport for road and rail), (3) absence of critical success factors for the proper functioning of a given network (e.g. absence of a sophisticated logistic system for international container transport). Central to the concept of missing networks is the idea that the performance of infrastructure is far below the maximum potential in terms of services delivered. The way in which a network can be designed and developed can be assessed and evaluated by means of five types of success factors, which may be summarized in a so-called pentagon prism (see Figure 1.1). In the context of missing networks this pentagon prism can be interpreted as follows.
Figure 1.1. Pentagon of long-term infrastructure development criteria

1. **Hard ware** refers to the tangible material aspects of transportation infrastructure (e.g. technical equipment, terminals, railways, road networks or harbours). They serve to physically facilitate transport services or flows generated by consumers or firms. A great many problems in the hard ware of transport systems can be seen in Europe. For example:

(a) a lack of a network of standard quality international transport connections between European countries (the so-called Trans European Networks);
(b) many missing links in major European networks (e.g. north–south connections, sea crossings, Alpine crossings);
(c) a lack of intermodal transport opportunities on both short and long distances;
(d) an absence of mechanisms promoting advanced new infrastructure systems (e.g. Maglev, high-speed tube networks).

2. **Soft ware** refers both to computer soft ware used to control sophisticated hard ware facilities and the services (viz. information systems, communication facilities, data services/banks, route guidance systems) offered to the user of infrastructure. In the area of soft ware various problematic cases can be seen in Europe today:

(a) unequal speeds of introduction of new logistic systems (e.g. route planning) in European countries;
(b) lack of coordinated and standardized information systems for both users and operators of transport infrastructure (the so-called electronic data interchange (EDI)).
(c) insufficient use of new tools for transport planning (e.g. geographic information systems).

3. **Org ware** comprises all regulatory, administrative, legal, management, and coordination activities and structures regarding both the demand and the supply side of transport (in terms of legislation, regulations, fares, procedures etc.) which form the private and public institutional framework of the transport system. Features of devolution (e.g. liberalization, decentralization, deregulation or privatization) are also important in Europe at present.

Problems related to org ware include:

(a) lack of political will and non-engagement in decision making;
(b) lack of coordination between regional, national and international infrastructure plans in all modes;
(c) lack of institutional frameworks for designing, using, operating and managing transport infrastructure, with a special view on saturation trends in various infrastructures;
(d) lack of a European ('holistic') view on market entry and transport behaviour (especially in a transnational setting);
(e) lack of a proper international organization to support combined transport, including rules for standardization and harmonization of weight and size limits;
(f) overemphasis on technological characteristics of advanced transport systems to the detriment of the services to be rendered.

4. **Fin ware** refers not only to the socio-economic cost–benefit aspects of new investments, but also to the ways of financing and maintaining new infrastructures, to fare structures, to state contracts for guaranteed finances for public transport deficits, etc. Projects which cross national borders are of course very relevant here.

Examples of problems in a European context include:

(a) lack of private initiatives for financing major (transnational) transport infrastructure;
(b) lack of a uniform European system for user charges (e.g. road pricing, tolls);
(c) insufficient use of the potential offered by market contestability, for instance, making a distinction between the operational and capital costs of transport infrastructure;
(d) lack of an evaluation framework for infrastructure appraisal seen from a European perspective.

5. **Eco ware** refers to environmental and ecological concerns (including safety and energy questions) in transport systems, as well as to abatement
measures for environmental degradation (e.g. user charge principles). It concerns both the infrastructure owner (e.g. landscape deterioration caused by visual pollution) and the infrastructure user (e.g. emission of exhaust fumes of cars). Problems here include:

(a) lack of a European view and planning system regarding the environmental deterioration caused by transportation;
(b) lack of standard rules and control regarding the transport of hazardous materials;
(c) lack of European-wide incentives for the development and use of more environment-friendly transport systems;
(d) lack of coordination between physical planning, land-use planning and environmental policy (including separation of work and home places);
(e) unsatisfactory application of ‘polluter pays’ principles in European transport systems;
(f) insufficient use of market incentives for improving current vehicle technology.

It is clear that using the pentagon as a practical evaluation tool for transport planning is not an easy task, since fulfilling all five criteria simultaneously seems possible only when using compromise solutions. Another important caveat is the need for quantification (e.g. via indicators) and weighting of these five criteria. The pentagon prism will be used in this study to evaluate major problems in European transport infrastructure, with a particular view to identifying critical success factors and policy lessons to be learned. In the sequel of this study the attention will be focused on freight transport (by road and rail) and on the European high-speed trains in order to test the above Pentagon model from the viewpoint of failure and success stories in European transport development.

1.3 EUROPEAN FREIGHT TRANSPORT (ROAD AND RAIL)

1.3.1 GENERAL TRENDS

The steady increase in the level of economic activity within and between the EC countries has been accompanied by the ever-increasing need to haul industrial goods and agricultural products over long distances, mainly across national borders of EC or non-EC countries. For various reasons, over two-thirds of this traffic is being carried by heavy trailer-trucks while only 20–25 per cent of all freight is carried by rail transport and this share is still declining. In practical terms this pattern of transport implies under-utiliza-
tion of available rail capacity, despite its seemingly economic and other advantages, and over-utilization of roads and highways.

The problem of under-utilization of rail capacity is a complicated one, however, since in many cases the lack of sufficient supporting facilities is a major barrier to further growth of rail activities. In the case of Germany, for example, the expected growth of 1.8 billion tonne-kilometres of freight volume over the next ten years will be feasible only if the capacity of goods storage facilities and container terminals is increased drastically and the concept of block-trains is further developed.

Heavy trailer freight trucks travel over surface local roads and major highways and concentrate in large numbers in trailer parks and other parking areas. Given the limited available capacity of these infrastructure facilities, congestion due to truck movements within general motorized traffic is rapidly becoming the number one traffic problem in all EC (and adjacent) countries. In order to alleviate this traffic problem various countries are finding it increasingly necessary to invest heavily in highways and other supporting facilities. Moreover, heavy trucks with many axles are known to be the prime cause for highway damage and deterioration, which in turn, calls for additional investments in maintenance and traffic control activities. In general, the position of freight operators in the whole of European commodity transport deserves careful attention.

However, for various reasons such as lack of financial resources, planning delays and geographical and topographical barriers, the expansion of the road capacity to accommodate this growth in truck freight movement is lagging behind the needs at an increasing rate. Consequently, over time, the real cost of hauling a tonne of freight between any given points of origin and destination in the EC markets is continuously rising. The immediate results are additional costs of labour, capital, inventory and spoilage, which eventually are reflected in the final prices of goods borne by the consumers.

Another problem which stems from this pattern of freight transport is that of distribution of equity. The transport of freight between countries at the fringe of the EC market (e.g. Greece to Scandinavia) must pass through the territory of many EC and non-EC countries which bear most of the traffic and environmental costs involved, without directly benefiting from this transport activity. Needless to say, this creates economic and political friction. In some cases, e.g. that of Switzerland, through truck traffic has created unbearable environmental problems threatening the survival of forests and the countryside. The reaction was to ban most of the traffic from Swiss and Austrian highways, diverting it to neighbouring countries with all the economic and political ramifications.

Switzerland has imposed a maximum weight limit of 28 tonnes for trucks as opposed to 40 tonnes in the EC at large. This protective regulation has initially been introduced not because of environmental concerns but in order to protect rail freight traffic. Switzerland and the EC have now agreed on a
quota of 50 trucks of 40 tonnes per day which can be surpassed only if all rail capacity has been used.

The type of goods transported is also a major problem relevant to the overall issue of rail–truck competition and complementarity. To illustrate, in Germany, the share of rail in total haulage, as a function of freight type, varies from 75% for fuel to only 7% for food products. Therefore, changes in regulatory policies will influence modal split between rail and truck in very specific ways, depending on the goods transported and the effective available network structure.

In examining rail networks in Europe it is evident that there is no global European rail network but individual national networks. This reality, in turn, puts rail in a major disadvantaged position next to truck hauling. As a result, international rail shipments in Europe, being affected by operational conditions, level of service and management attitude on individual national rail networks, can hardly provide a reliable and flexible service. The truck, which is in contrast largely a door-to-door type service, does not suffer from such adversities.

Since many studies suggest a continuation of the growth of freight transportation—especially by road—a process amplified by the liberalization process of trade in Europe, intensive policy actions in this area are needed in order to alleviate or to remove the existing bottlenecks in road and rail transport (especially the lack of a commercial attitude of railway companies and the current miscoordination in the area of international commodity transport). These problems also create new opportunities for combined transport by means of road–rail combinations. This type of combined transport may become one of the solutions to tackle current and foreseeable bottlenecks in freight transportation in Europe.

Several attempts to assess the current volume and future trends in goods transport in Europe have been undertaken in the eighties. The picture of the future of goods transport given in different forecasts is rather diverse. There is a certain agreement on income elasticities of goods transport. For domestic goods transport this elasticity is generally found to be below 1 (indicating a less than proportional rise of domestic freight transport as compared to gross national product). For transit transport the elasticity is found to fall somewhere between 1.5 and 2 for the past decades. This finding is accepted in most forecasts, so that in general the growth of freight transport at a European level is expected to be twice as high as general economic growth.

There is a general agreement on several general economic and behavioural trends which determine freight transport demand in Europe.

A first trend that can be identified is the functional/spatial division of labour which results in an increasingly complex European network of production and service units with a growing share of intra-industry trade. It can be expected that this trend is significantly reinforced by European integra-
tion. The goods produced and transported in Europe gain in value per weight. Hence the trend towards transport of high-value goods will persist. Another characteristic of transport that will be increasingly requested is flexibility. The demand in freight transport will most probably be for small deliveries at irregular intervals.

Besides these demand side trends, some other developments clearly show up in goods transport. With the spread of just in time production (JIT) there is an increase in on-line calls for goods kept in stock somewhere on a rolling transport vehicle. An increasing demand for informatics services in the transport sector will be the consequence. There will be a specific need in road hauling, rail freight and combined transport where the introduction of Electronic Data Interchange (EDI) services seems to be more difficult (due to the small-scale and fragmented organizational structure of the branch) than in the case of water transport where most ports seem to have more incentives to supply these services. Another problem linked to just in time production is the problem of partly empty trucks which have to make a trip just because a specific load is being ordered 'just in time'. As a result of modal split, the railway companies will be asked more and more to act as European-wide suppliers of services which in addition are not restricted to their own mode but also comprise door-to-door services. As mentioned before, a shift from a competitors view of the road haulage sector to a partnership view is therefore needed. The collector's and distributor's function of the suppliers in the transport market will gain in importance over the pure transport view.

Finally, various problems need to be identified which are specifically related to the European integration. In an integrated Europe, a simplification of procedures and regulations in crossing the borders concerning transport—specific obstacles which have not been automatically abolished by the end of 1992—is urgent. This relates first of all to technical problems like railway voltage, standardization of wagons, trucks, combined transport infrastructure etc. Besides these technical problems, the logistics will have to develop from paper to screen logistics if the advantages of the open frontiers have to be exploited (see below).

As far as missing European networks in transport are concerned, it will not be sufficient to take a pure EC perspective on Europe. The problem of the Alpine countries in relation to north–south traffic must be solved in order to prevent a successful integration of Europe being hindered by transport problems elsewhere. And the problem of transport infrastructure in Eastern Europe might become an even more important issue in the years to come. For the sake of the economic development of the EC after 1993 it will be vital to solve the transport problems in Europe in general from the viewpoint of European benefits (e.g. a win–win situation for all partners involved).

Finally, institutional issues appear to be very important for the develop-
ment of transportation. It is clear that economic integration—changes in regulation—will lead to economic restructuring and to changes in transport flows in general. This has various implications for transportation by road and rail and for combined transportation. Removal of barriers means an increase in competition, especially between former more or less monopolistic railway operators. But also in road transportation, various forms of regulatory and pricing barriers will be removed. Since transportation is in general a business with high costs and low or even negative returns on investment, economic integration may certainly lead to a 'shake out' process in the transport business. This process may become even stronger, if external costs are to be internalized.

Perhaps the main problem regarding road freight transportation lies in the lack of freedom for cabotage; international road freight traffic is still restricted by a system of permits. Since there are far fewer permits than needed in most countries, the EC has adopted a policy of a step-wise increase of permits until 1995, when cabotage should become unrestricted; only a qualitative regime will then be used to regulate the market (Commission of the European Communities 1992a,b).

3.2 BOTTLENECKS AND MISSING NETWORKS

In view of the difficult problems confronting road and rail transport (not to mention the opposition to road traffic caused by its environmental impacts (eco ware)), the issue of combined transport has become an important argument in recent transport discussions. Above all, the railway companies and the combined transport firms which are more or less closely linked to the railways push this 'alternative'. In February 1990 the European railways and the combined transport operators issued their common 'Brussels declaration' where they presented a common strategy on design, operation and marketing of combined transport.

A.T. Kearney & Co. demonstrate in their report (1989) that there are important problems which limit the capacity of this network and which relate to things like terminal capacity and loading profiles (hard ware). Besides these problems of terminal capacity and profile differences there are others which hinder a European-wide performance of combined transport. They relate to organizational issues (org ware), logistics (soft ware) and technical coordination of the wagons and the loading techniques.

It is clear that missing networks in the field of combined transport cannot be identified simply on the basis of maps of infrastructure networks. First, a strategic view on networks should be intermodal. Except for road haulage, the goods are generally not transported from door to door by the same vehicle. Therefore, if some modal parts of the network are weaker than others (or even absent), this influences the performance of the whole network for a certain type of transport. A second dimension which has to be
recognized is the *multi-layer view*. Transport networks do not only consist of *hard ware* (infrastructure). They are also a function of the organizational structure of the service suppliers (*org ware*) and of the logistics that guarantee a smooth functioning of the operations (*soft ware*). In addition, the financial implications (*fin ware*) and the ecological impact (*eco ware*) of the networks have to be taken into account.

The intermodal and multi-layer view can best be illustrated if we start by looking for missing networks in the domain of combined transport. A good impression of the elements that are missing on a European level in combined transport is given by the elements of the Brussels Declaration of the European railways and combined transport operators. In the framework of a common strategy of design, operation and marketing they propose the following fields of action:

1. block trains  
2. service contracts and guarantees  
3. equal treatment regarding rates  
4. tariff contracts  
5. European network  
6. terminals  
7. wagons  
8. new techniques.

Among these fields we find infrastructural domains (*hard ware*) like the foreseen investments in new railway infrastructure and the adaptation of existing installations in order to cope with additional traffic as well as the realization of new terminals and the expansion of existing ones. Another infrastructure issue is the intention to coordinate future innovations in combined transport technologies. Organizational issues (*org ware*; until recently unsolved and now given priority in this Declaration) are the predicted Europe-wide tariff structure, the equal treatment of railways and operators regarding rates, and the coordination of the selection of wagons.

On the *soft ware* level, the engaged parties judge several elements of a European network as being absent. These relate to the promotion of block trains and service contracts and guarantees. It is interesting to note that there is no mention of the logistics needed for the European control over the wagon fleet, which is a basic requirement for the operation of a European combined transport network. This regards the monitoring of the units (wagons, containers etc.), their routing and their repair. Thus there is not only the technical and organizational lack of a network that would provide a universal wagon and container type for combined transport, but there is also a missing network to be diagnosed in the logistic control of combined transport movements. In order to solve these problems it will be
vital to consider all elements making up combined transport, viz. the traction, the carrying, the handling and the containers. There is a strong feeling that a hub and spoke system—consisting of performing links with unified rolling stock and nodes which are multimodal multiservice freight terminals—is what is needed in Europe. Only if this missing network is realized is there a fair chance that centralized logistic solutions will be feasible.

While the realization of a true European combined transport network might solve some problems of freight transport in Europe, other problems will remain. One of these is the limited additional capacity that can be provided by such a network. A.T. Kearney & Co. foresee a tripling of combined transport until the end of the century with a doubling of the market share from 4 to 8 per cent. Hence, the combined transport network will not be able to solve the problems in the short run. Important infrastructure investments, like new Alpine rail axes, investment in countries with limited free profiles like Italy and the adaptation of the Spanish gauge to the normal European standard, will significantly raise the capacity in combined transport.

It follows that the missing networks in combined transport with a short-term character are to be found on the org ware and soft ware level. Creating these networks would help to solve some problems. This means that national railway companies have to learn to behave like market-oriented enterprises, instead of being controlled to a large extent by their nationalistic bias.

1.3.3 POLICY ISSUES

From the foregoing observations various policy questions arise, which are of interest in an analysis of missing networks. In general, the major bottleneck in road transport does not merely lie in crossing the borders, but in a general lack of capacity due to a rising demand for transportation and the combination of a comparatively low user cost of road transport and difficulties in extending the networks (Maggi 1992). A closer look at congestion reveals that, although the number of freight vehicles is growing at a rapid pace, the dominant and still growing use and ownership of private cars is the main cause of congestion. So there is a case for governments to reduce (the growth of) the number of private car owners and users. The problem, however, is that fewer private cars on the roads lead to more freight vehicles instead, increasing the imbalance of the modal split and, in a few years, leading to new congestion.

Another question is related to investments in road networks, especially in the south and the east of Europe. These investments—although reasonable seen from a short-term economic point of view—are likely to favour the ownership and use of road vehicles. In a longer-term perspective, large-scale
investments in rail, water (ports) and combined transportation are likely to offer a far better option.

There is a case for deregulation/reregulation and privatization in rail and combined transport. The main questions in this field relate to the new organization, the logistics, the financing and regulatory regimes by governments.

Seen from the viewpoint of interoperability, an important policy issue is the organization of the railways on a European level. In this regard the liberalization of rail markets to private firms along with the separation of rail operations and infrastructure are relevant policy alternatives. However, such solutions are likely to hinder the stability of existing national railway monopolies. Therefore, a global European view should be considered as superseding national interests. These policies would have to be defined in terms of capital investment, fiscal measures, regulatory changes and organizational changes that countries should undertake to achieve the desired goals. The fragile divide between public actors and private actors is again at stake here.

Regarding the necessity of combined transportation, one should keep in mind that train transportation has its main potential over distances of more than 500 km. In fact, at present 90% of freight transport is on distances of 200 km maximum (Commission of the European Communities 1992c). It is clear that the EU leads to more long distance transport. However, it is also clear that the market share of combined transportation will not grow considerably, especially if more congestion on rails and at terminals is to be expected, thereby raising costs (European Round Table of Industrialists 1992). Thus, this raises intriguing questions on the real potential of combined transportation.

Another problem is the lack of coordination between projects in different countries. Winkelbauer (1992) shows that the foreseen new railway tunnel projects (the ‘Neue Eisenbahn Alpen Transversalen’; NEAT) in Austria and Switzerland are in heavy competition with one another. This means that the cost–benefit ratio of these projects may even be negative, because none of them is able to reach a minimum level of traffic. A related problem concerns the split in monetary costs and benefits between countries; according to EC law each country has to pay the costs of its own infrastructure even if it is mainly used by other countries. For instance, the recent German proposal to levy road taxes on foreign truck owners using its roads has been cancelled by the EC for this reason. However, it should be admitted that more tunnels offer far more capacity, so that they are able to deal with a strong growth of traffic and give truck owners more flexibility.

In European freight transport trucks and delivery vans are the dominant means of transport, leaving very little room for other modes of transport. It is foreseen in various reports that this imbalance in modal split will continue to grow, as will total freight transport. Since it is clear that such a development will lead to an increase of the already high social cost of transport and
the cost of infrastructure—to mention only two of the most important problems—there is a potential market (niche) for combined transportation. Nowadays, combined transportation is not favoured by most shippers because of various bottlenecks, most profoundly in the rail part of combined transportation. At present, growing congestion on the road network is not a sufficient condition to increase the demand for combined transport. Only in combination with a removal of the vast amount of bottlenecks (viz. regarding tariffs, reliability and flexibility), internalization of social costs and in some cases explicit regulation and (preliminary) subsidization, will road congestion act as an incentive for combined transportation.

1.4 EUROPEAN RAPID TRAIN NETWORKS

1.4.1 GENERAL TRENDS

The term ‘high-speed rail’ covers both conventional wheel-on-rail systems with significantly increased maximum (160–200 km/h) and average speeds, the advanced TGV/ICE systems (above 200 km/h) and Maglev systems (500 km/h or more). They open up the possibility of services competing with air transport in terms of journey times, frequency, comfort, reliability and safety. High-speed travel seems to be an excellent solution for Europe because of the relatively short distances between its capitals (from 200 to 1000 km, equivalent to a maximum travel time of only 4–5 h during the day per TGV or ICE). Night-time services in just 8–12 h could be the best solution for longer journeys involving distances of up to 2500 km. Whereas the maximum technical speed of the TGV wheel-on-rail system is some 500 km/h, the maximum economical speed will be around 300 km/h, because of disproportionate maintenance costs for trackage and wheelsets, geographical conditions and the spatial pattern of towns in a country (Massoni, 1988). Running on a magnetic cushion, the TRANSRAPID system—after a period of testing since 1974—is also ready for commercial use, especially for transportation on medium and long distances. Its major drawbacks lie, however, in its fully incompatible infrastructure (forcing the construction of a completely new infrastructure), its noise and its visual intrusion on the landscape.

Only a very small part of the conventional railway network in Europe can stand maximum speeds higher than 140 km/h, as higher speeds lead to much higher construction and maintenance costs, and safety and signalling systems are still inadequate. In densely populated countries, average speeds on longer distances usually do not even exceed 80–90 km/h. Sometimes even lower average speeds are necessary, most notably when lines are operated with single track and diesel units. This is one of the many reasons why railways are in most cases not a real threat to transportation
by other modes of transport, especially by road. Railways are in a better position to compete in long-distance travelling, at least when they do not have to cross national borders. But there are only few large enough countries in Europe.

Aware of this challenge, the community of European railway companies of the twelve EC members plus Austria and Switzerland presented in January 1989 a project for a European high-speed network. This project covers infrastructures, rolling-stock and the timing of future connections, thereby redrawing the European railway network map.

At this moment many technically—and also physically—distinct, high-speed railway networks or connections are being developed in many European countries (for a snapshot, see e.g. Massoni, 1988, Espieussas, 1989); well-known projects are those in France (TGV), Germany (ICE), Italy (Diretissima; Roma–Firenze) and Spain (AVE; Sevilla–Madrid). All these systems are excellent examples of nationalistic transportation policies, as the following two examples from France and Germany convincingly show.

The first French main line, from Paris to Lyon, is an unrivalled success for a railway line, since trains on this main line were able to compete with domestic air transport, both in terms of price and travelling time. Investments in track and equipment have been paid back in 10 years, a situation never previously found in railway history. The demand for TGV services has been far greater than expected and still continues to grow strongly. The success of the TGV is to a large extent due to the favourable spatial pattern of cities and towns in France; major towns and cities lie in the 300–800 km range, which is best served by the TGV. This success induced the French government to plan and execute extensions of its network to all parts of the country, while international extensions are also foreseen before the turn of this century; so supply is also growing strongly—Say’s law is very vivid in railways.

The Paris–Bordeaux and Paris–Geneva lines, although still under construction, are, however, not as successful as the Paris–Lyon line. This is partly due to the fact that TGV trains on those lines have to use parts of conventional track with high traffic density as well, so reductions of travelling time are limited. The importance of the TGV lies not only in the improved travelling quality of railways (equal or better than found in air transportation, including telephone and fax services), but also in its capacity effect. The use of parallel TGV sections has freed capacity which can be used for high-speed freight trains (160 km/h) and regional trains.

The German ICE high-speed train service started in the beginning of 1991 with the operation of the Mannheim–Stuttgart and Hannover–Würzburg lines, lagging more than 10 years behind the French TGV. The ICE and TGV differ in many respects, the first one being conceptual, as the ICE network will be used for both passenger and freight transport, where the TGV is used only for passengers and postal transport. The second major
difference lies in the technical characteristics; the ICE has a higher axle load than common in France and other countries and the train body is wider than the French TGV. As their electrical power supply systems are also incompatible, the ICE and TGV trains are not yet able to run on each other's networks. Germany is, however, developing a multi-circuit-power unit, the ICE-M, for different voltages and frequencies, so one of these problems may be solved in due time. A third difference between the TGV and the ICE is found in the comfort and the service level; the ICE comfort and service level is far higher than that currently found in the TGV-Lyon type (stewards, bidirectional telephone and fax services etc.). However, the latest (third generation) TGV types also offer much more comfort.

The plans for the German railways also include the upgrading of existing tracks for conventional traffic up to 160–200 km/h. Where this is impossible, reconstruction of tracks (Neubaustrecken) is necessary. Some new lines are developed for passenger transport only, whereas other—mainly junctions—are for dual purposes (freight trains up to 120 km/h) (Massoni 1988).

One of the main reasons for the independent development of the high-speed systems in France and Germany is found in government protection of firms producing national railway equipment. In fact, Germany refused to accept the French offer to cooperate in favour of developing its own (yet incompatible) ICE systems (cf. Gérardin 1990). This means that high-speed trains still face the same problems as conventional ones when crossing borders between various countries.

Suppliers of high-speed trains are in close competition to attract customers, as was shown recently with the Spanish purchase of high-speed trains. As this first high-speed project outside both supplying countries could mean a breakthrough in selling high-speed trains and thereby setting a European or world-wide standard, governments were strongly involved in bidding and selling of high-speed trains to other countries. At first the Spanish government opted for Japanese train systems, because these were less expensive. Strong political pressure led to the purchase of the AVE, in fact an excellent mixture of the TGV and ICE state-of-the-art technology.

Planning and running railways in Europe has always been a task of national governments. This explains the large, bureaucratic, non-market-oriented railway organizations in most countries. It also explains to a large extent the lack of private sector involvement in the financing, management and operation of railways. The picture of road transportation is very different. This explains the dominant use of road vehicles in both freight and passenger transportation.

1.4.2 BOTTLENECKS AND MISSING NETWORKS

When dealing with missing networks in European railway systems, a distinction should be made between bottlenecks which have hampered the develop-
ment and use of conventional railways (traditional problems) and those which are specific for high-speed railways (new problems). Solving both types of problems is necessary, because the development of high-speed railways cannot be isolated from the development of conventional railways; they should be viewed as complementary, not as substitutes. Specific high-speed rail problems include the following.

At the hardware level most of the purely technical difficulties of driving at high speeds have been solved. Both the TGV and ICE use sophisticated hardware and the latest electronic and telecommunication technologies (software). The basic hard ware problem is that Europe has two more or less incompatible high-speed train standards. Since none of the two industrial conglomerates is eager to accept the other one’s standards, given their own efforts in terms of time and money spent in developing their own high-speed train systems, only a compromise would help to overcome this problem. This is the case for the Paris–Cologne–Brussels–Amsterdam TGV, for which new multi-current locomotives have to be developed to ensure hardware compatibility, at least for trans-border connections (Community of European Railways 1993). Another important problem is whether the high-speed network should be opened to passenger traffic and postal services only (as is the case in France) or should it also be used for freight trains (as in Germany)? Freight transport demands much higher standards for railway construction and maintenance, and therefore much higher investment.

A further problem is related to the fact that the TGV has a lower axle-load than the ICE. As the French railway infrastructure is built to the TGV axle-load, the standard ICE is at present unable to use the French high-speed rail network. A related question is the use of high-speed tracks for conventional use too; is the high-speed network an extension of the conventional network? The use of conventional trains on high-speed networks has both benefits (higher average speeds, more efficient use of capacity) and costs (lower average speeds of high-speed trains). In the opposite case, high-speed trains may be as slow as conventional trains and sometimes even slower because of track geometry. High-speed trains compete with conventional trains in terms of costs and revenues. This means that the use of high-speed trains may lead to a reduction of conventional train services (lower frequency, fewer passengers, fewer stops).

Conventional train technology is not invariable. The Italian ‘tilting’ train technology for example—which enables driving on existing curved tracks with higher maximum speeds without increasing the risk of derailment—is quite successful and has recently also been put in use in Germany. These and other techniques make maximum speeds of up to 200 km/h or more already possible on a number of tracks in Europe. As soon as the physical (including control) infrastructure is capable of handling these speeds, conventional trains (‘Super-Eurocities’) may even compete with high-speed trains, espe-
cally in terms of economic efficiency. More homogeneity of train flows via separation of local, regional and long-distance trains—as proposed in the Dutch National Railways plan Rail 21—may be part of such a scheme.

**Org ware** problems seem to be the most difficult question in the European context. The identification of a solution for institutional and organizational issues needs a lot of diplomacy and political intuition, because there are some 30 parties involved (and none of them are future users; Sundberg 1990). Three main problems should be mentioned in this connection:

1. The tendency of national governments to protect national producers of both infrastructure and trains, by means of exclusive government contracts incorporating national standards.
2. The tendency of national governments to upgrade their existing networks according to national demands, instead of European ones. In the past this was quite logical, given the profitability and efficiency of domestic investments (Espieussas 1989). Nowadays this is no longer the case, as international traffic and its profitability will rise significantly.
3. Strong differences in time loss because of incompatible procedures between countries. In France, for instance, once a project is under construction, objections of people involved do not stop actual construction, whereas in Germany construction is stopped each time.

Although the first effect may become less important as frontiers vanish in the European integration process and transnational mergers grow in importance, the second effect is harder to overcome, given the degree at which frontiers reduce international transport, particularly for business travel. There is a real chicken–egg problem in this field, as planning and investment are based on actual needs for transnational transportation, which will not develop until rail transportation reaches a higher quality level. Actual construction will therefore show a very diverse pattern between different European countries, thereby hindering the emergence of a transnational network.

One of the major bottlenecks in **fin ware** is the shortage of public funding, while the list of priority projects grows longer. This problem will become even greater, however, since in most countries stabilization or even reducing income tax and social security contributions is favoured. Private funding has already gone some way to solving this problem. The supporters of these projects urge public loan guarantees from the states and the Community, especially when the revenues from transportation are expected to be insignificant on some links. This effect is especially significant in densely populated, yet small, countries such as the Netherlands. Should revenues from more profitable parts of the network be used to finance less profitable parts and to what extent?

Another problem related to budget problems is that they may force
decision-makers to choose between investment in conventional trains and infrastructure, and investment in high-speed trains. Since the latter need vast amounts of money, but cover only a small percentage of traffic, it is an important question whether these investments are worth while, or whether the whole train network should be upgraded.

From an environmental and ecological viewpoint (eco ware) high-speed trains are a better solution compared to air and road transport, most notably in the use of energy and the air pollution. Land use per passenger-kilometre is also smaller than what is needed for road transport. High-speed trains have an environmental and ecological impact and this has a strong effect on recent plans for new high-speed connections in Europe (e.g. in Kent, Flanders and Holland). The local environmental concerns arising from the building of these high-speed links and of the retooling of existing links are immense. Those advantaged are usually different from those who have to accept local environmental deterioration from the building of rail tracks and cargo, especially container, facilities, etc. However, the proposed use of conventional routes will not lead to significant increases in performance, as only significant increases in speed will lead to important savings in travelling time.

1.4.3 POLICY ISSUES

High-speed railways have considerable advantages over conventional ones for customers living in one of the larger towns and one of the richer parts of the country. French experience shows that most small towns and villages are not offered a better service than before. On the contrary, when high-speed trains use conventional track their operation leads to a lower quality of conventional train services. High-speed trains also favour the richer parts of Europe (Gérardin and Viegas 1992). So further economic polarization between urban and rural parts of a country because of the high-speed trains is foreseeable. The split between national (= feeder and regional) and international services can only be justified and implemented against the political opposition of those potentially disadvantaged if compensatory measures are given, most notably fast feeder connections (Commission of the European Communities, 1991).

What are the long-term economic effects of high-speed trains? This question is especially relevant, since French experience suggests that high-speed train usage mainly stems from existing train travellers, who travel more and over longer distances, and from air traffic, not from car traffic. In small countries, the impact of the high-speed train on domestic modal split is (therefore) forecast to be minor, whereas investment outlays are very large. Some argue that it might be a good option to improve the quality of the whole conventional network instead of constructing one single TGV-line.

Although economic integration is a term used by many politicians in
Europe, transport practice shows various signs of nationalism. The future European high-speed train network is a good example. It shows that planning without establishing independent multinational, centralized political decision-making units and centralized funding is a waste of time. A TGV-North is planned to run between Paris-Nord and Amsterdam. The French part of this line is ready for operation, whereas in Belgium and the Netherlands the trajectory, due to local, environmentally induced, resistance, the time-path and the Belgian funding are as yet uncertain. If finished, this TGV will be unable to run at full speed in both countries, thereby reducing its market potential.

Another, but not final, question concerns the deficits of railway companies, which provoke important political questions. Is it reasonable to keep on subsidizing railway companies for services which too few people want to use, just for social reasons? Or should those subsidies be directed towards services with a higher market potential, such as high-speed ones or conventional ones on busier lines?

In this regard it is interesting to note that the management of the German Railways, in the face of its future privatization, is planning to sell the regional train part of its network to the Länder (provinces) and to concentrate on the higher-level services. Such an option has many advantages, including a smaller, more market-oriented organization. It could also help to establish better regional and interregional economic cooperation, instead of competition. On the other hand, there is the fear that many branch lines will soon disappear, since the local and regional communities have no money to provide regional passenger and/or freight services and to invest in maintenance or even new tracks.

The 'explosion' of mobility makes it clear that high-speed trains are only one of the means necessary to cope with mobility growth; overall modal split will not change very much. One of the most important causes of this situation is the fact that most countries have not developed some kind of master plan for public transport. France is still the only country working with these plans, thereby enlarging the potential of both high-speed train and public transport (Rijck et al 1991).

High-speed railways, together with the upgrading of conventional ones, may be one way to attract new customers and to ease the ongoing shift in modal split towards road and air transportation. If competing modes are not able to digest all of the forecast transport growth, railways may be able to attract part of this growth. When all transport modes have to pay the real cost of transportation their market potential may become even larger.

To arrive at such a situation various bottlenecks have to be removed. The central issue is that high-speed rail transport is at its best at long distances. It is precisely long distance international transport that is the weak spot of railway companies, since cross-border cooperation has never been a favoured issue within the railway companies and their national governments.
Integration is an important supply factor for improving the performance of train systems. It can only exploit its full potential once speed is added to the system.

1.5 CONCLUSIONS AND REFLECTIONS

The context and nature of European trade and transport is entering a new era. In recent years, there have been some dramatic changes: integration of the EC market, disintegration of various nation states, and more openness between all countries and regions in Europe. The full benefits of the foreseen internal European Market will only be reaped by means of effective (physical and non-physical) infrastructural adjustments in Europe. What is needed in this context is European, and not national, thinking and action in infrastructural policy, based on the knowledge of past successes and failures in infrastructural planning and the future needs of the economy. The fast emergence of rapid trains as a success story and the slow introduction of intermodal transport as a partial success story illustrate that a focused effective European transport policy is needed.

Although at both national and European levels attention is increasingly focused on Trans-European Networks, for the time being interest in Europe is mainly addressed towards separate, i.e. single-mode, transport solutions. Only recently has it been realized that interconnected networks supported by modern telecommunications technology may offer a realized high value added. Interoperability between different modes to use the transport capacity as efficiently as possible appears to be very difficult to achieve. Two factors of strategic importance have to be considered in this context:

1. complementarity between different modes in order to benefit—in terms of added value networks—from synergy (e.g. rails and waterways, roads and airports etc.);
2. competition between different modes in order to operate under the most cost-efficient conditions (e.g. common carriage).

In view of the role change of actors in the transport sector, complementarity (by means of interconnectivity, intermodality and interoperability) is a sine qua non for competition in the sector.

It has been claimed above that the future of a unified Europe will be critically dependent on the functioning of strategic infrastructure networks which are interconnected in terms of (1) integration between different layers of network (e.g. coordination of high-speed/long-distance networks such as TGV or aircraft and lower-speed local networks such as light rail or roads), and (2) intermodality between different competing or complementary network modalities. In this respect also the quality of nodal centres (term-
inhalts, stations, urban centres) plays an important role, as well as the frequen-
cies of different types of transport (or carriers) in Europe.

The notions of interoperability and interconnectivity of networks, as advo-
cated in the Maastricht Treaty, generate a series of important local points
which deserve thorough attention from the side of policy-makers and the
research community:

1. the operation of transnational networks, seen from the viewpoint of
European cohesion and East-European (re)integration;
2. the close connection between the development of transport networks
and (tele)communications networks (including new logistical systems)
and their potential implications for the European space (e.g. polariza-
tion tendencies towards larger metropolitan areas);
3. the new regulations for competitive behaviour for all actors and modes
with a view of upgrading and increasing the entire European network
performance;
4. the new roles of public and private decision-makers, where a creative
division of tasks has to be found between public authorities (urban/
regional, national, European) and private actors (transport operators
and logistic suppliers) in order to generate value added networks;
5. the interconnectivity of high-speed long-distance networks and new
regional–local infrastructures in central nodes of the European network;
6. the role of physical barriers (and organizational impediments) which
reduce the benefits of economic integration in Europe (including the
connections with Eastern Europe);
7. the emerging conflict between environmental sustainability, infrastructure
expansion and completing networks (notably competing transport modes);
8. the fiscal or regulatory ways of charging to the user all external (social)
costs of transport infrastructures and network use in Europe, not only
locally but also European-wide;
9. the impact of new transportation, logistics and (tele)communication
technologies on both mobility behaviour (demand) and infrastructure
life cycles in the European space (supply);
10. the lack of standardization of transport systems technologies (and uni-
formity in transport systems in general) in Europe, which hamper the
full benefits of an interoperable European network (especially in relation
to intermodal transport);
11. the rather different financing regimes of states and network operators
for European transport modes, which prevent a fair competition;
12. the lack of a strategic viewpoint on the linkage between European net-
works and global networks developed in other regions outside Europe.

Consequently, the policy agenda for interoperable and interconnected
European networks is vast and deserves much attention in the near future.
REFERENCES


Commission of the European Communities (1992a) Verordening (EEG) van de Raad betreffende de Toegang tot de Markt van het Goederenvervoer over de Weg in de Gemeenschap (etc.), COM (92) 104 def., Brussels.

Commission of the European Communities (1992b) Verordening (EEG) van de Raad tot Vaststelling van de Definitieve Regeling voor de Toelating van niet in een Lid-Staat (etc.), COM (92) 283 def., Brussels.


Gérardin, B. (1990) Missing Infrastructure Networks in Europe, A Case Study: The European Rapid Train Network (case study report NECTAR), INRETS, France.


