Strategic Evaluation of new Infrastructure in Europe

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Abstract

Europe is - after the implementation of the internal market - moving toward an integrated network economy, in which network infrastructure will play a crucial role. Apart from policies oriented toward an adjustment of transport demand or an extension of conventional transport modes, we witness an increasing interest in long-term strategic transport systems development in Europe. Various strategic evaluation criteria for such new European infrastructures will be discussed in this paper. In addition a comparative analysis of different new infrastructures (ICE, TGV, Channel Tunnel, etc.) will be given. In particular, attention will be focused on the identification of critical success factors for the implementation of new infrastructure in Europe.
1. Introduction

The emergence of the European network economy in recent years has generated a broad interest in advanced transport systems of a trans-border nature. The quality of transport systems is of decisive importance for economic development, in both the developed and the developing regions of Europe. A recognition of the critical role of transport can already be found in the Treaty of Rome, which heralded the birth of the European Community. In a broader context, some authors (e.g., Andersson and Strömquist, 1958) have even argued that the economic history of Europe can be characterized by four major transport and logistic revolutions:

- the period from the thirteenth century onward; waterways (rivers and coasts) emerged as new transport media, connecting cities along rivers and coastal areas, like Lübeck and Venice (the so-called Hanseatic period). In Northern Europe this development was favoured by the foundation of the Hanseatic League. In the Mediterranean Basin especially Venice benefitted from a vast network of trade relations including (indirect) connections to the Far East.

- the period from the seventeenth century onward, characterized by a drastic improvement in sailing and sea transport systems and by the introduction of new banking systems, through which trade to the Mediterranean, the Baltic region, the East Indies and the West Indies was stimulated, in particular in Western Europe where cities like London and Amsterdam became the new centres of world trade (the so-called Golden Age period).

- the period of the Industrial Revolution, in which the invention of the steam engine generated new transport modes (sea transport, railways) which also created new markets (e.g., North- and Central America, the Far East).

- the period from 1970's onward, which is marked by intensive information exchange and flexibilization; in this framework JIT (just-in-time) systems, telematics, integral logistics and MRP (material requirements planning) emerged as prominent features of the information society (see Giaoutzi and Nijkamp, 1988).

The long history of Europe is essentially based on a close connection between economic growth and development of transport logistics. Europe is nowadays rapidly moving towards an integrated network economy. Especially after the completion of the European market (1992) and the expected integration of (parts of) Eastern Europe, a new map of Europe will emerge, which will show Europe as an interwoven multi-layer and multi-faceted network. It therefore is no surprise that politically independent countries such as Sweden and Austria aim at building stronger economic links with Western Europe. An increasing concern is also voiced on the barriers in Europe caused by missing links or even missing networks (see Round Table of European Industrialists, 1990).

Transport policy favouring a free movement of persons and commodities in the EC is a sine qua non for a single market. The removal of barriers is of great importance for obtaining the highest
possible dynamic integration effects from a network economy. Well organized transport is vital to a smoothly functioning and balanced development of the economy and of society as a whole. Economic development and the development of transport infrastructure and transport means are of great mutual importance. This, for instance, is witnessed by the impact of new sailing techniques in Western Europe a few centuries back, where an increasing transport volume over an increasing distance created an environment in which transport innovations found a fertile seedbed. As indicated above, the steam engine created later on similar new possibilities, as then mass transport of raw materials and mass production came into being due to the central role of railways and steamships in transporting huge amounts of coal, ore etc., thereby connecting the economic structure of Western Europe with that of North America. World wide connections by ship with decreasing transportation times and increasing reliability due to the emergence of the steam engine brought about a global division of labour. Generally the trade patterns were then dominated by an industrializing Europe and North America, while the other continents appeared to become primarily providers of raw materials. Clearly the logistics were focused on Europe.

Nowadays the transport sector is a central component of our modern society: changes in society are reflected in the transportation sector and vice versa. This paper will in particular focus on changes in society and their influence on transportation (needs) in a European context. In the following sections economic, demographic, technological and environmental changes will be reviewed in relation to their expected impacts on transport. Then in subsequent sections new developments in transport and their consequences for society will be dealt with as well (see also Nijkamp, Reichman and Wegener, 1990).

2. Economic Considerations

Missing links - or even more severe: missing networks - mean an inefficient and deficient transport infrastructure, which will definitely lead to a missing economic development. The first economic aspect that comes to mind in this framework is, of course, the completion of the internal market in the European Community in 1992. The European integration will effectively substitute the various national markets that exist in Europe nowadays, for one large market that consists of about 320 mln consumers (in comparison; the USA embodies 245 mln consumers). The European industries will then operate in a both geographically and economically considerably enlarged market. On the one hand this implies increased sales opportunities. On the other hand competition will be more fierce. Consequently internationally operating firms are looking for specialization and concentration possibilities (see NEA, 1989). Witness the growing interest for mergers, joint ventures, associations and buy-outs, e.g. Volvo - Renault, division trimming of Philips and the association of airline companies (Swiss Air - SAS, SABENA - KLM/BA). The industries will be free to choose their own production locations within Europe.
The combination of a free location choice and a growing concentration offers the companies the possibility to split the production process and to locate the different phases of the production process near the necessary resources like manpower and raw materials. Also a pleasant environment and climate will be part of the motivation for certain locations, in particular as far as the service sector, manufacturing of electronics or assembly of semi-manufactured goods is concerned. The Alpine region is such an example of an attractive location in Europe (see Blaas, 1990).

All such developments would place a different emphasis on the kind of transport needed. Rather than raw materials (semi-) manufactured goods will be transported from the various production plants to the general assembly plant; next the manufactured goods have to be transported to the consumers, spread all over Europe. The goods to be transported tend to be smaller in volume and higher in value. Consequently safety and speed of transport will become even more important aspects of modern transport systems. Not only the transport of goods will change, but also passenger transport will exhibit significant changes. The abolition of internal borders in the EC will stimulate a much more intensive crossing of national borders. This will, connected with an ever increasing mobility of the population, stimulate international traffic. The possibility to work in another country will also be possible, although it is as yet uncertain whether international commuter traffic will become a substantial part of the entire European traffic pattern, as culture and language barriers still remain. This also depends inter alia on the harmonisation of fiscal systems and labour market legislation throughout Europe. Migration to rooming regions seems more plausible in the short run than massive international commuting. Perhaps in the next decade, if high speed passenger transport systems have proliferated, transnational commuting might become important. All this means that the existing transport network (or rather layers of networks) will have to cope one way or another with a strongly growing demand. The problem not only consists of a growing transport volume - big enough a problem as it is -, but the transport intensity also induces new problems.

A predominant problem is that of infrastructure capacity and environmental stress. The existing road and air networks will simply not be able to handle a strongly growing transport volume. Nowadays already many airports, air corridors and roads are jammed with traffic, in particular during the morning and evening peak hours in and around the metropolitan areas (like Paris, Rome, London, Athens, the Dutch Randstad and the Ruhr area). Yet, it is alarming that these peak hours tend to stretch, thereby creating semi-rush hours for most of the day time. In other words, the original surplus capacity outside the traditional rush hours will be increasingly occupied by traffic evading rush hours. Some further observations on this subject will be given later on in Section 6. Although an extensive expansion of transport networks might ameliorate this problem, it remains uncertain whether this would really solve the problem or only postpone it. For instance traffic intensity on Dutch intercity roads (including highways) rose with 3.7%
annually between 1980 and 1989. However, the greater part of the increase has taken place since 1984. The last 5 years annual growth of traffic intensity amounted to 5.7% (Rijkswaterstaat, 1990). Even though an expansion of networks would seem a structural solution to the problem (at least technically), there is still the problem of environmental protection. It should be kept in mind that time and again additional transport capacity has attracted so much new demand that congestion re-appears within a few years (the latent demand phenomenon, which forms the basis of the law of Say). It has become clear that even without an increase in the use of the existing transport modes, the pollution is at present already unacceptably high.

Instead of looking for ways to increase the capacity of existing networks (and at the same time increasing the pollution problem), one is increasingly looking into the potential of new transport systems and into the improvement of transport networks with less pollution. In particular rail transport is receiving a great deal of attention lately, because the pollution effects of rail transport are far less than those of, for instance, road and air transport. The ICE (Intercity Express) and the TGV (Train à Grande Vitesse) are good examples of improved existing transport systems. Both the German ICE and the French TGV are high speed trains, capable of using the existing tracks, although they are not able to reach a maximum speed on these tracks. As can be seen from Table 1 both systems have an average velocity (including stops) of over 200 km/h. These are not the only high speed rail projects in Europe. In Italy and Spain high speed trains have been developed as well. In Spain however, this high speed train is not able to run on existing Spanish tracks since the train utilizes standard gauges (like in the rest of Europe), while the existing tracks in Spain are of a different gauge. However, the TGV system itself is suitable only for passenger transport, while the ICE is developed for both passenger and goods transport. This certainly does not mean that the ICE is principally a better system, because the shift towards new tracks will, in both cases, enable the existing tracks to be used more effectively and more intensively by the slower freight trains. Other new transport systems to be mentioned here are the Magnetic Levitation trains (Maglev) which are nowadays being developed in Germany and in Japan. In Germany a commercial test track will be built between the airports of Köln and Düsseldorf. In the Netherlands one is investigating the feasibility of a European underground network of vacuum tubes through which shuttles will run with a velocity of 540 km/h.

A second economic problem concerns the increasing average distance over which goods and passengers will be transported once the integration of the European Community is a fact. As pointed out earlier - from the point of view of both the limited capacity of the infrastructure and the environment - an unrestricted growth of automobile usage should be prevented. The best alternative mode, in the current situation, at least in Europe, seems to be the train, primarily for the longer distances, probably in combination with intermodal transport. As regarding goods, inland shipping has an important potential on several important corridors.
Whether and when a substitution of rail transport and road transport will actually take place, is as yet uncertain, but it is increasingly recognized that a substantial amount of money should be directed towards an expansion of the rail infrastructure, at least to prevent congestion on the tracks. However, to make these investments effective, substantial organisational adaptations should be realised as well. Rail transport over longer distances, in particular when one or more national borders are crossed, faces enormous delays resulting from lack of cooperation. The problem is not merely the physical transport distance, but - more importantly - the situation that every nation has its own national railway company. Almost every railway uses different standards for signalling and electrical equipment which makes the operation of international trains difficult.

Besides these hardware incompatibilities between the national railways also the orgware and software shows a great lack of fine tuning. When a train crosses a national border, the responsibility for the train shifts from the one to the other national railway company. The organisation of international rail transport involves at least two railway companies, each of which has its own separate timetables to be respected. This orgware problem is caused by the fact that not yet all European railway companies are connected to the European railway information system (HERMES). Consequently, the data communication between the different railways is all but flawless, making it rather difficult to get information over the whereabouts of a train and consequently of its expected arrival time. Since combined transportation is of growing importance, one is at present also working towards an information system linking the different hauliers.

When the train has to become the principal transport mode of the future, the nationalistic attitude towards transport networks has to change into a European attitude. The achievement of such an attitude may involve a separation of track ownership and running trains according to the common carrier principle. Also the development of new transport systems should be undertaken at a European scale rather than at a national scale. The necessity hereto can be illustrated - again - by the TGV and the ICE. Both systems were developed almost simultaneously but still the systems differ on one very important aspect. The ICE was developed for both goods and passengers, while the TGV is solely intended for passenger transport. As a consequence the maximum axle load on the ICE tracks is much higher than on the tracks for the TGV. As far as passenger trains are concerned this is no problem, but a high speed ICE commodity train cannot use the fast tracks in France; thus one is building again barriers preventing the birth of one comprehensive European network. It is very important that the transport mode of the future, whether a completely new one or an improved existing one, is based on the idea of a European network, because the utility of a transport system rests to a great extent on its network function. From this point of view a European network is far more preferable than several separate national networks.
Next, it is noteworthy that the integration of the European Community will probably intensify also the relationships between the Western European countries and the southern countries like Spain, Portugal and Greece. The existing transport infrastructure to and inside these countries is not very well developed. This is partly due to the fact that so far the economic connections between these countries and Western Europe were not very intensive. Also various natural boundaries, i.e. the Pyrenees and the Alps, have contributed to this situation. In order to form a real European transport network these countries as well as the Nordic countries would have to be included in the network. This is a clear example of missing networks, needing improvement in order to enhance European cooperation and integration.

And finally, it should be recognized that European transport policy should not only be focused on an improvement of the intra-EC network infrastructure, but should also pay particular attention to external links of this network. An open EC has the highest benefit for both the Community itself and the world economy as a whole. Thus the improvement of cross-frontier routes are extremely important, such as the Trans-European Motorway, the Scandinavian links or the connections with Africa. In the future also major links to East European countries would have to be envisaged. There is also a good case here for cooperation between non-member countries, such as Switzerland, Austria and Yugoslavia, which provide (transit) links between EC-members. It goes without saying that a balanced transport policy is also of critical relevance for regional equilibrium in the Community, a situation which has also become apparent after the inclusion of the DDR in the Community. The current tendency toward major fast links is not by definition beneficial to all regions, and certainly not for those regions which are not served by fast transport lines or only intersected by these lines. To this end several 'missing links' would have to be removed. The Nordic countries are already in the process of constructing several tunnels and bridges, whilst a railway tunnel is being built between France and England. In order to extend the network from Western Europe to South-East Europe and to improve the connections with Italy, one would have to build connecting links through the Alps. It is expected that, even without these improvements, the transport volume over the Alps will increase considerably, and at present already congestion is growing on the main transport routes across the Alps. Provided the transport volume will indeed continue to grow significantly, a very costly situation of long delays due to congestion caused by the lack of capacity will arise. A comparable situation exists for the transport routes over the Pyrenees to Spain and Portugal.

3. Changes in Demography

The average age of the Western European population is steadily rising. Also the average spending capacity of this growing group of elderly people is increasing. Already nowadays we have in the EC more than 100 million people of 50 years and older. People belonging to this
group will be accustomed to travelling and it is plausible that they will continue this habit over time (cf. Grevsmühl, 1989). Most likely their travel activities will partly exist of short day-trips, but also longer trips to a further destination will become common practice, witness the emergence of retirement villages in the Mediterranean countries occupied by pensioners from Western and Northern Europe during wintertime. A consequence of this development will be that an increasing demand for convenient transport at both short, medium and long range distances will emerge. In the Netherlands, for instance, car ownership amongst these people has increased substantially over the last 10 years. One may expect however, that the majority of this transport demand lies outside the rush hours.

The percentage of people owning a car is steadily increasing in all countries. When one does not take into account the probability of restrictive measures of the government, the penetration degree of car ownership, among people older than 15 years, will in the Netherlands for instance amount to 62% in 2010, a growth of over 60% (see van den Broecke/Social Research, 1987). This would mean an increase in absolute numbers of cars in the Netherlands from 4.4 mln in 1985 to 7.9 mln in 2010. Car ownership in the EC is expected to rise from 116.5 mln vehicles in 1987 to 134.4 mln vehicles in 1994. It is clear that the 'silver generation' will increase its share in car ownership, at least in case of an unrestrictive policy towards automobile ownership. In the Netherlands plans are now made - through effective government policy measures - to diminish this growth to 50% (the government expects a growth of 70% without restrictive measures). This indicates how trifling the government itself expects its possibilities to steer the automobility (see also Rietveld, 1990).

Since pre- and post-transportation to and from public transport terminals is usually troublesome, it is expected that most journeys will continue to be made by car. Although the majority of trips of elderly people will be made outside the rush hour, still this growing use of the car for social purposes will create various problems. For example, in most cities there is simply not enough parking space for all these vehicles. Another aspect is the negative effect on the environment. Current policies try to restrict the growth of automobile use, but in order to accomplish this intra-urban and short-distance travelling, transportation to and from the public transport nodes has to be improved, also with an eye on the aging society (implying convenient pre- and post-transport systems). Another aspect of the demand concerns the need for comfort and shorter travel times, especially when longer journeys are concerned. The TGV in France and the ICE in Germany are developments that respond to this demand. The TGV Sud-Est, between Paris and Lyon, is in operation since 1983. The 417 km long route has appeared to be a great success. A European network of fast trains might be capable of fulfilling the long distance travel demands of an aging society. In any case, a European transport and communication network should fulfil also the needs of an aging population.
There are two megatrends influencing nowadays the economic and political map of Europe and hence also the transport scene in Europe. A first main aspect influencing the transport network is the gradual southward shift of the economic gravity point of Europe. The economic growth in southern countries (Spain, Italy, Portugal) is larger than in the North Western countries (see NEA, 1989). Additionally the completion of the Channel Tunnel could stimulate economic relations in the corridor London - Paris - Stuttgart - Munich. These developments induce changes in the network of most important transport routes. If this southward shift continues, it might mean that northern countries like the Netherlands or Denmark will have to offer very efficient transport possibilities in order to keep up with the economic developments elsewhere. The second megatrend concerns the recent shifts in the East European system which will also lead to an eastward focus. Here railway networks have to be drastically improved, whilst road infrastructure is still in its infancy stage.

In any case in an integrated European society efficient transport systems require fast, frequent and reliable transport for both passengers and goods. These necessary qualities of transport systems cannot be realized when important infrastructures are situated outside the main transport corridors. Because of the current southward shift of the European economic gravity point, the possibility of an incongruent development is rising. The consequence of such a development will be the necessity of at least one transshipment of goods, when the destination or origin falls inside one of the new transport corridors. This factor will be an enormous challenge for the competitiveness of the train with other transport modes. From this point of view it may be stressed that it is of utmost importance to investigate thoroughly the possible future scenarios when a new infrastructure is planned. This is especially important since infrastructure has normally a lifecycle of at least 50 years. Clearly, nowadays one may question whether the current southward shift may not be accompanied by a more eastward shift because of the developments in Eastern Europe which opens up an enormous potential market. But it is also evident that this new market will not exert an effective impact before the turn of the century. Provided that economic relations intensify throughout the European continent, long distance transport (> 1000 km) gets more important. Thereby opening up new market opportunities in rail and air. Clearly, liberalisation and harmonisation are important prerequisites to open up these markets for rail and air.

5. Technological Developments

In considering future options one has to consider also the possible technological developments that may be of importance to the developments in the transport sector. Basically there are two...
kinds of technological developments to be distinguished. At the one side we have the direct technological developments; these developments influence immediately the technologically feasible aspects of transport systems. At the other side there are developments which influence in particular the demand side of the transport system, the indirect technological developments.

Direct technological developments have a straightforward impact on the structure and form of transport systems. The construction of extensive motorway networks in most EC member countries constituted substantially to the paramount position occupied by truck and passenger car nowadays. Probably a more striking example is the development of the high speed trains in France and Germany. This development started in the sixties when the National Japanese Railways (JNR) introduced their bullet-train, the Tokaido Shinkansen. This fast train provided a very frequent service between the cities of Tokyo and Osaka. The Shinkansen was in all respects a new transport system. In contrast to the existing railway system, which used the narrow gauge, the Shinkansen utilized the standard gauge. An evident consequence of the decision to use standard gauge was that the two systems became incompatible. In this sense the Shinkansen is a completely new development. Also the purpose of the system differs from the existing railway system. The Shinkansen is developed to transport as many passengers as possible in as short a time as possible. The Shinkansen is based on person transport only. The design proved to be a great success; consequently the Japanese government and JNR decided to build a complete Shinkansen network in Japan, connecting all major cities. The network should be used for person transport over longer distances. In this case the existing narrow gauge could be used more effectively for shorter trips and for the slower goods transport.

New developments are also taking place in (Western) Europe with the development of the TGV and the ICE. Both systems have become feasible because of the application of modern technologies, notably in the control systems. Apart from the high speed, the TGV and the ICE differ less from the existing railway system than the Shinkansen differs from the existing system in Japan. Both the TGV and the ICE are compatible with existing systems, although it is not possible to fully utilize all potentials of the new trains on the existing tracks. Some other noteworthy examples of new transport structures are completely automated subway systems (e.g. in Lille), new light rail systems and the Maglev systems. Other new systems under construction that are not (yet) operational but may become technically feasible are for instance the electric car, the guided car system, the underground vacuum tube system, etc. Within the framework of the Prometheus project, the European car industry together with electronics industries are making important advances concerning guidance, safety, materials and new engines (Jeffery, 1990; Calandrino, 1990; Klijnhout, 1990).

Current developments taking place in the informatics and logistics field are of great importance to the transport sector. Besides the possibility to construct advanced control systems for the high
speed trains, these developments also have a more indirect effect on the transport stem. Planning techniques like Material Requirements Planning (MRP) and Just-In-Time (JIT) are becoming more and more common. The objective of these techniques is to limit the stock of both raw materials and products. Due to the computerization of production equipment combined with the opportunities of telematics, original batch-processing production is gradually transforming into an almost continuous flow production process. This is for instance very evident in the car industry. By producing on order instead of on stock, not only intermediate stocks, but also the final stocks may virtually vanish. The next step in integrated logistics is to establish direct and consequently reliable links between the inflow of material and the flows in the production process, thereby eliminating stocks of input resources. In doing so the production process and the shipments of materials and products have to form an integrated system. In order to ensure strategic stability in their supplies, large manufacturers try to establish associations with their suppliers. The establishment of all kinds of associations often includes screening procedures, apparently favouring suppliers in the proximity of the plant. This in turn may have interesting impacts on the regional economic structure of the area in which the plant is located. Yet, for light manufacturers and services spatial limits seem to be less strict. On the contrary, if up to date business information becomes ubiquitous - like in the airline industry and banking - the operation space becomes genuinely global, in which actual business relations may change rapidly (Gillespie and Williams, 1990).

One very important aspect of this system is that the volume of shipments will become smaller, but at the same time transport will take place more frequently while the value of commodities will rise (cf. Seidenfus, 1989). A higher frequency of smaller shipments demands a different quality of transport systems. The current trend towards small volume high value transportation of goods places a heavy burden on the already congested road infrastructure. Another aspect is the increasing need for reliability of transport. Because the stock is kept to a minimum an almost continuous inflow of materials is required to keep the production process going. In most cases it is primarily a matter of highly reliable arrival times of shipments. This should not be confused with a need for short transportation times (i.e. fast transport). Only in case of emergency (e.g. parcels), perishable goods (e.g. flowers) or very high value goods, fast transport may pay off; otherwise even (container) barges may be a valid alternative. Clearly, this need for reliability brings us to the next problem, viz. congestion.

6. Congestion

Reliability is a very important aspect of new logistic management systems. In fact the entire production process depends on the reliability of the shipment of materials. The stock of raw materials is kept down to an absolute minimum in order to reduce the costs. A consequence of
this policy is that a serious delay in the delivery may force the production process to a complete stop. Of course the picture drawn here is a bit extreme, but basically this kind of situation may be created when JIT systems are in extremis carried out.

The reliability of transport is strongly affected in a negative sense by the increasing congestion problems. Almost every transport mode is affected by this phenomenon. Probably the least affected transport mode is inland navigation, but road and air traffic face severe congestion. The congestion on the road network is mainly caused by the simultaneous use of the same parts of the road infrastructure during the peak hours by the majority of the working force (as far as they use car transport). The consequence is an intensive, though geographically and temporally limited congestion pattern. Congestion in the air is caused partly also by limited infrastructure capacity of the airports, but at least as important is the slow integration of modern technologies in the air traffic control. A major bottleneck in European air line systems is the dispersed character of the European air traffic control, where 44 control centres exist, using 22 different national control systems, whereas in the US a total of 20 air traffic control centres exist. According to various studies the air congestion in Europe costs $5 bln per year. The number of flights delayed over 15 minutes has doubled to 1 out of every 4 in the last four years. An expansion of the ground infrastructure is clearly necessary, but this will be futile if the air traffic control in Europe is not reorganized. In view of the foreseeable growth of transport, it is expected that the capacity of the current air transport infrastructure will reach its limits by 2010 (see Marchetti, 1988). In a Prognos report (1988) it is predicted that cross border transport will grow 40% and that road haulage will increase its share in subterranean modal split to between 52.7% and 55.3%, dependent on the policy trends. A policy in favour of rail transport will increase the share of rail from 18.5% in 1984 to 19.8% in 2000. As far as road traffic is concerned, the roads in and around industrial areas - at least in Western Europe - are jammed with traffic nearly every day during the peak hours in the morning and afternoon/evening. Severe congestion also appears on the rail and road infrastructure in the Alps. Moreover, environmental concerns and annoyance of the local inhabitants press the Austrian and Swiss authorities to limit transit road traffic, e.g. by night closures, weight limits and by stimulating combined rail-road transport. Because there are only a limited number of possibilities to cross the mountains, almost all traffic is caught in these bottlenecks.

It is generally accepted that the economic development is to a considerable extent dependent on good infrastructural connections. When the infrastructure is not capable of absorbing the increasing transport volume after the European integration of 1992, this will form a strictly limiting factor for the otherwise feasible and promising economic development in Europe. From this point of view it is clearly an overall European interest - more than a national interest - to promote and initiate infrastructural and transportation improvements in order to support the economic growth potential.
As mentioned earlier the solution should not (alone) be sought in an expansion of the physical infrastructure of the networks, but most of all in an improvement of the orgware and software of the transport networks. Examples are the communication and information systems of the railways, notably HERMES and INTIS. INTIS is a communication system to improve the communication between the participants in a transport chain. The management of transportation demand can also contribute to a better utilization of the infrastructure. An example is the recent decision of the Dutch National Railways to change the working hours of personnel at their headquarters in Utrecht, thereby changing the transport demand of some 6500 people to outside the rush hours. These are but two examples to indicate that a solution to the congestion problem does not always have to include extensive and costly innovations of the hardware of transport systems.

7. Environmental Preservation

As mentioned before environmental protection is becoming a very important aspect of management of transport and infrastructure and transport and infrastructure planning. In the last decade there has emerged an awareness that we cannot continue on the path we have been following since the Industrial Revolution.

Transport is - besides industrial production - a major polluter. Several aspects of pollution, with regard to transport, can be distinguished. Firstly, and most importantly, there is the actual pollution of the environment. In the Netherlands, for instance, road traffic was in 1987 responsible for approximately half of the photochemical smog. On the other hand, traffic hardly contributes to acid-rain, which is a result of the industrial emission of sulphur dioxide and ammonia. Air traffic also places a burden on the environment, while inland navigation and railways are relatively much less polluting. Several ways of dealing with this pollution problem can be distinguished. Again a division can be made between hardware measures at the one hand and orgware measures at the other hand. Hardware oriented measures may comprise restrictions placed on the maximum allowable emitted fumes (e.g. catalytic converters), the development of cleaner and energy efficient engines, the design of electric engines, the use of recyclable materials and components, etc. Measurements that relate to the orgware encompass the institutional aspects like the promotion of combined transport, a relatively cheaper public transport, special taxes for the use of road infrastructure, pollution taxes and deposit levies to encourage recycling, etc.

A second aspect is the land use of the various transport infrastructures. Both road and railway infrastructure are material networks that physically split up the land. Of course waterways also have the same effect but since their density is much lower it has a less serious effect.
infrastructures are of a rather permanent and irreversible nature. The long life cycle of transport infrastructure thus creates a kind of grid which puts strict constraints on further land use and on the ecological functions of the area concerned. Possibilities to restrict the land use of the different transport systems can be subdivided into hardware and orgware aspects as well. An increase in the physical capacity of the infrastructure can be reached by expanding the infrastructure. One four lane highway places a lower burden on the land than two separate two lane highways. Another hardware oriented solution is to move a part of the infrastructure underground, as is the case with urban metro systems and future vacuum pipelines. An orgware option is to better utilize the existing infrastructure by means of traffic flow management (e.g. tidal flow management) and traffic demand management (e.g. by means of time of day tolls).

A third aspect to be mentioned here is the disturbance of the environment as a consequence of vibration and the emission of noise. Vibration is particularly caused by the railways while noise emission is caused by both road-traffic, railways and around airports. Especially in more densely populated areas this causes a problem: in densely populated areas a good transport system is necessary but at the same time less space is available for the transport infrastructure. The result is often a hardly adequate transport infrastructure - causing congestion and inefficient transport - to the detriment of the living space. With respect to airports this problem is growing as well, since the increasing volume of air transport induces an expansion of airports and a more intensive use of the runways. With the expansion of the airports an increasing number of people are affected by it and at the same time the growing number of planes landing and taking off increases the disturbance level. A solution to this third problem should probably be sought in either a removal of these transport systems from the areas where people live, or a new design of sophisticated infrastructure in which underground network systems may play an important role. Another approach is an technological innovation of the existing transport vehicles to reduce the noise of their engines (e.g., electric engines). Today road surfaces do already exist that dampen the sound of the rubber wheels on the surface, but a satisfactory solution has not yet been found.

8. New Transport Systems

The previous observations on constraints and potentials of the European transport systems lead to the following question: which are the critical success factors of transport systems in a European network economy? It may be interesting to use here a critical success prism, in the form of a 'pentagon' model, which encompasses the five most important key factors for a successful design, introduction and management of transport systems (see Figure 1).
Figure 1. A prism model for transport systems evaluation.

Figure 1 takes for granted that the quality of transport system planning depends on five critical success factors for the design and operation of such systems:

- hardware (e.g., efficient technological standardisation);
- software (e.g., use of compatible information systems);
- orgware (e.g., existence of effective management structures);
- finware (e.g., presence of private or public financial institutions);
- ecoware (e.g., environment-friendly or regulated systems).

This prism model may be particularly useful in evaluating new transport policies. Today several projects concerning transport infrastructure or transport systems are being executed. An example in the field of transport infrastructure is the Channel Tunnel (Chunnel), linking the transport infrastructure of Western Europe with that of England. The quality of the latter link, when finished, can be evaluated in the light of the five critical success factors mentioned above. With respect to the hardware, the value of the Channel Tunnel would be greatly reduced when through trains from the continent to e.g. London would be impossible. Partly, this reduced value might become reality when the French TGV is not allowed to attain its high speed on the English railways due to the lack of sufficient infrastructure on the English side of the Channel. As the Channel Tunnel will be used by through trains and by shuttle services, orgware is a very important factor too. The time tables must be organised in accordance with the time tables of
the French and the English railways, while the shuttle services must be performed with a frequency high enough to ensure its efficiency, which depends largely on the advantage of a strongly reduced travel time.

Projects that touch upon both the field of transport infrastructure and of transport systems are the TGV and the ICE. Both projects consist of fast train services partly on new and partly on existing tracks. This characteristic of both projects automatically includes the first three quality factors of the prism model in Figure 1, i.e., hardware, software and orgware. Another example concerns the Netherlands where a study is carried out concerning the feasibility of a new transport system, viz. Integral Transport System (ITS). This system consists of a subterranean network of vacuum tunnels in Western Europe, enabling shuttles to travel between, for instance, Amsterdam and Paris in approximately one hour. The ecoware of the system, in comparison with other systems, promises to be a strongly favourable factor. The entire system, except for part of the stations, will be underground, and therefore the direct land use will be close to zero. Since the tunnels are vacuum, there will be no air resistance which will allow a drastic decrease of energy consumption while still an extremely high speed can be reached. As the system is powered electrically, the overall emission rates can be very low. An additional advantage in this respect is, that a substantial increase of shuttle movements has a relatively small impact on the energy demand of the system.


With respect to the integration of transport infrastructures and transport systems into the existing infrastructures and systems, two different aspects of integration can be distinguished. In the first place there is the aspect of the compatibility of the new system with the existing ones. This is an important aspect considering the importance of the network effect. Secondly, one should distinguish the competitive aspect of integration. Since several transport systems already exist, new systems will be more or less competitive.

Given the need for compatibility with existing transport infrastructures, the hardware, software and orgware factors of new infrastructures are of great importance. An example of a new transport infrastructure that is not compatible with the existing infrastructure on the hardware level is the Japanese Shinkansen, as was already mentioned in Section 5. To ensure that the new system does not become in fact a stand alone system, software and orgware factors had to be emphasized. The time tables of the Shinkansen and the traditional Japanese railway had to be fully synchronized. This means that the departure times of the trains have to be based on the arrival times of connecting trains. When a slight delay in the arrival of a train occurs, this information must be used to delay the departure of connecting trains accordingly. The TGV and
the ICE are both compatible with the existing railway infrastructure. The new trains use even partly the existing infrastructure. This can only be made possible when the time tables of the TGV and the ICE are completely integrated in the time tables of the existing railway systems. If, in the future, a European railway network has to be developed, the national projects must be coordinated at a European level, to ensure the compatibility of at least the hardware, software and orgware of these projects. The compatibility problem is even more evident for the Maglev-system. Thanks to its high speed and its excellent comfort it is potentially an important competitor for the high-speed trains. However, the lack of integration of the system largely reduces the advantages compared to rail. Consequently the benefits of the system become debatable, hence the difficulties to establish a real commercial line.

Although the objective of a new transport system will not be to compete with existing systems, it is hardly possible to avoid this completely. Usually the objective will implicitly encompass some aspects of competitiveness. For instance, when a new transport system is introduced with the objective to diminish the use of the private car, this new system has to be competitive with the car, and hence it will be a (indirect) competitor with the automobile and gasoline industry. Two examples can be found in the introduction of the Shinkansen and the TGV line between Paris and Lyon. In both cases the use of air transport diminished considerably in favour of the new railway systems. The Channel Tunnel also will be competitive with the ferry services, even though the primary objective is to create a fixed link between the European main land and England.
In order to provide some further reflection on the strength and weaknesses of different new systems, a general survey table has been made which gives a summary of the previous observations and of some interesting features of the Shinkansen, the TGV, the ICE and the Channel Tunnel (see table 1).

<table>
<thead>
<tr>
<th>Project Aspect</th>
<th>Tokaido Shinkansen</th>
<th>TGV Sud Est(^1)</th>
<th>ICE(^2)</th>
<th>Chunnel</th>
</tr>
</thead>
<tbody>
<tr>
<td>starting date of operation</td>
<td>1964</td>
<td>1981/83(^3)</td>
<td>1991(^4)</td>
<td>1993</td>
</tr>
<tr>
<td>connection</td>
<td>Tokyo - Osaka</td>
<td>Paris - Lyon</td>
<td>Hannover - Würzburg</td>
<td>Cheriton - Frethun</td>
</tr>
<tr>
<td>length in km</td>
<td>515</td>
<td>417</td>
<td>328</td>
<td>50</td>
</tr>
<tr>
<td>goods/pass. transport</td>
<td>passengers</td>
<td>passengers</td>
<td>passengers</td>
<td>passengers</td>
</tr>
<tr>
<td>velocity max. km/h</td>
<td>210</td>
<td>270(^5)</td>
<td>250</td>
<td>160</td>
</tr>
<tr>
<td>velocity av. km/h</td>
<td>160</td>
<td>210</td>
<td>230</td>
<td>160</td>
</tr>
<tr>
<td>person cap. per train</td>
<td>1342(^6)</td>
<td>386(^7)</td>
<td>300/400(^8)</td>
<td>12.000/hour</td>
</tr>
<tr>
<td>person cap. per day</td>
<td>± 375.000</td>
<td>&gt; 70.000</td>
<td>-</td>
<td>12.000/hour</td>
</tr>
<tr>
<td>cost(^10)</td>
<td>380 bln Y</td>
<td>FF 11 bln(^{11})</td>
<td>DM 11 bln</td>
<td>£ 8.5 bln(^{12})</td>
</tr>
</tbody>
</table>

Table 1. A survey table of features of four new transport systems.

Legend:

1. TGV = Train à Grande Vitesse
2. ICE = During the test phase this means InterCity Experimental and afterwards InterCity Express
3. The TGV lines between Paris and Lyon have been taken in use in two phases. In 1981 the southern part between Saint Florentin and Sathonay became operational, while in 1983 the new part between Combs-la-ville and Saint Florentin completed the railway connection.
4. The data in the table concerns the tracks between Hannover and Würzburg only, since these consists entirely of new tracks (NBS, NeuBauStrecken).
5. The more recent TGV Atlantique has a maximum speed of 300 km/h.
6. The JNR (Japanese National Railways) utilizes two different trains. The Hikari has a capacity of 1342 persons, while the Kodama has a capacity 1483 persons. The Hikari is mainly utilized on the through-going connection from Tokyo via Osaka to Okayama, Hiroshima, Kitakyushu and Fukuoka.
7. The capacity of the TGV Atlantique is raised to 505 persons and may during peak hours be doubled.
8. The capacity is dependent on the degree of comfort. Each wagon of the ICE may be flexibly subdivided into a first and second class department.
9. The trains may consist of different configurations of carriages.
10. This concerns the construction costs unless stated otherwise.
11. From this amount 4.5 bln concerns costs for the rolling stock.
12. From this amount 1.5 bln concerns costs for the rolling stock.
10. Implications for Infrastructure Planning

Infrastructure is a prerequisite for a further economic development and integration of the European network economy. An effective (and official) recognition of the basic role of infrastructure for economic growth would allow new strategic exploration, inter alia concerning the necessary upgrading of the current service level of transport systems or the design of new infrastructure systems. Quality is apparently nowadays of more strategic relevance than quantity, and therefore infrastructure and transport systems planning ought to take prespecified performance and service quality levels as a strategic print.

A choice for operational performance levels would need coherent European - rather than a sectorial nationalistic - view. Only in this context sound financing and environmental approach to infrastructure can be reached. Such a European view is also necessary to cope with the phenomenon of missing networks in a pluriform European society.

In the same vein the problem of technological standardisation may be seen. Standardisation does not only pertain to hardware (like voltage systems in railways), but also to software (e.g., information systems for international customs procedures) and orgware (e.g., common carriage on European rails).

Finally, of strategic importance for commodity transport is also a further development of multi-modal transport solutions (such as piggy-bag systems and containerisation). But especially in this field a fine tuning in terms of hardware, software and orgware is necessary.
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