Access and capacity of European infrastructure networks

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ACCESS AND CAPACITY OF EUROPEAN INFRASTRUCTURE NETWORKS

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1. Preamble

It is increasingly recognized that our Western economies move gradually toward an international network economy. This phenomenon has a demand aspect - related to international trade patterns, international service deliveries, international exchange of information, international tourism etc. -, but also a decisive supply aspect - related to large scale international physical infrastructure, the emergence of the new information technology and the rise of sophisticated telecommunication systems. Political developments such as the move toward Europe 1992, have acted as a catalyst for this irreversible and far reaching process.

Seen from the above perspective, international network infrastructure will play a key role in the internationalisation processes of our economies. Such network infrastructures would have to serve the need of a mobile society in which mobility/interaction of goods, persons and information are the clear exponents of a modern network economy (see CEMT, 1986; Nijkamp et al., 1990).

In the past decades new infrastructure expansions and investments have indeed by and large followed the demand requirements; transport policy was mainly demand driven and investments in transport infrastructure followed mainly the demand trends. Only the 'jumps' in the system (e.g., airplanes, high speed trains etc.) were also caused by technology push motives.

However, the question we are facing nowadays is more complicated: if we take for granted the politically advocated and largely accepted objective of <u>ecologically sustainable economic development</u>, are then the needs of an extremely mobile network society for a drastic expansion of infrastructure compatible with the constraints imposed by environmental concerns, safety considerations and socio-economic equity objectives?

The answer to this question has far reaching consequences. The conflicting nature of a demand driven transport system evokes immediately the question as to the role of supply in terms of managing and expanding infrastructure. Here the fundamental question is: are ecological, safety and equity considerations prohibitive regarding network expansion? If so, then the question of <u>capacity use</u> of the existing material infrastructure in Europe has to be given due attention. If not, the question remains nevertheless whether a <u>better use of existing capacity</u> may not be an economically more viable option than an uncritical investment effort in conventional physical infrastructure.

Furthermore, the problem of capacity constraints should not only be considered from the viewpoint of separate bottlenecks in a given infrastructure component, but also - and even more important - from the viewpoint of the functioning of a network as a whole. Thus also the relationship between infrastructure development and its use on the one hand and the modal split on the other hand is at stake here. This question also leads to complex trade-offs between investments and disinvestments at the same time in the transport sector. Transport policy should - in this context - serve to enhance efficiency and sustainability from the viewpoint of network operations (see also ERT, 1991). Thus an important related question is: what kind of network policy can be feasibly developed so as to serve simultaneously the needs of a mobile society, the ecological paradigm and the socio-economic needs of the new mobility-deprived?

The previous questions make it evident that the notion of capacity and the idea of network management are critical parameters for a policy analysis of new infrastructures in Europe. In this report we will in particular call attention for the need for effective, efficient and creative capacity management of existing material infrastructure (including the need for a high-tech upgrading of and a more market-oriented view on such networks).

The paper is organized as follows. In Section 2 some empirical evidence regarding the discrepancy between supply and demand and the conflicts vis-à-vis environment and safety will be given. Section 3 will provide some background notions and conceptual reflections on network capacity which are necessary to provide the proper scene for the remaining part of this paper. Next, Section 4 will make the substantive point that management and upgrading of existing infrastructure networks is the heart of modern transport policy, as compatibility between transport, the environment and physical planning is of primordial importance. This will be followed (in Section 5) by a reflection on the interest and potential of current transport policy to achieve a better performance of transport systems at both the metropolitan and the European level. Finally, also the European dimension will be given due attention, where again the point will be made that coordination and sophistication are critical success factors for an appropriate European transport policy.

2. Some Observations on Social Costs of Transport

Transport seems to have a double face nowadays. On the one hand, it is increasingly recognized that transport plays a vital role in building up an integrated European network economy and on the other hand there is a growing awareness of the high - sometimes unacceptable - social costs of transport (notably in the area of land use and the environment). Transport has become a focal point of research and policy interest because of the conflicting roles it plays in our modern society.

The previous observations indicate the transport field is fraught with conflicts. Transport policy makers in most European countries find themselves in extremely complicated choice situations. A large number of interest groups, ranging from multi-national companies to local environmentalists, urges them to take action, however often in quite different directions. Current discussions on the creation of mainports or the construction of high speed rail links are illustrative in this respect. On the one hand it has become obvious that the environment poses its limits on the volume, the character and the pace of the extension of the transport infrastructure. On the other hand most business firms in (Western) Europe are concerned about their competitiveness in a global context due to inadequate network infrastructure in Europe.

Transport forms thus the heart of our European network economy and the transport scene has shown significant changes. Mobility has drastically increased and as a consequence congestion has also increased in almost all transport modes, especially on motor roads and in the air. At the same time the environmental burden of the transport sector far exceeds the carrying capacity of our environment and threatens ecological sustainability as advocated amongst others in the Brundtland Report.

The field of transport and communication is in full motion, not only at the local or regional level, but even more so at the (inter)national level. International commodity transport - in terms of both volume and value - is increasing, international passenger transport is rapidly rising, and also international telecommunication is increasingly gaining importance. From an international (i.e. cross European) perspective the following developments at the European level may inter alia be observed:

- Despite many institutional frictions, there is an increasing tendency towards an integrated and open European market, which by 1992 will have become the largest trade block of the world (with 320 mln consumers). A further association with EFTA-countries and East-European countries will increase its scope.
- At a European scale, many initiatives are being taken to improve and expand the current infrastructure (e.g. the Channel Tunnel, the extension of the French TGV, the construction of the Trans European Motorway, the design of an advanced European telecommunications system, etc.), so that all European countries will be linked to each other via a common and accessible network (see CEMT, 1989; Community of European Railways, 1989)
- Internationally, the heartland of Europe seems to shift towards the south (see e.g. Boeckhout and Romkema, 1989) - and more recently also the east - which has enormous economic and social implications

for transport and mobility. Furthermore, many different kinds of border problems still have to be solved in Europe's unification policy.

- Many countries have officially adopted a 'basic right' principle towards peripheral or less accessible areas, which means that a certain level of accessibility is ensured on the basis of this equity paradigm. However, in the case of severe budget stress such principles tend to be easily neglected, particularly when it is accompanied by privatisation of (parts of) the infrastructure networks, public transport services, telecommunications, etc. This may lead to severe imbalances at the European level, especially for non-central areas.
- Concentration tendencies in physical planning of facilities (schools, medical health care centres, high tech centres, etc.) have decreased the local level of services, thus causing a forced mobility in order to have access to these services. Here the relationship between an equity oriented physical planning and an efficiency oriented transportation and infrastructure planning is at stake. In addition, new forms of spatial organisation seem to arise at a European scale, viz a tendency towards the development of large metropolitan areas. Europe seems to become the home of metropolitan regions rather than of individual states.
- The European trend toward more deregulation and decentralisa-tion may seduce policy makers to wonder whether there is a case for planning at all; more particularly, the seemingly higher efficiency gains of a market oriented planning system need to be traded off against the social welfare gains of public interventions. This is especially important since a demand driven transport system is increasingly advocated, even though the final results of such a market orientation are not always desirable (as is witnessed by the monopoly tendencies in the American airline sector).
- International spatial interactions in the form of physical movements of persons or commodities are increasingly influenced by modern developments in the field of communication and information technologies (e.g., JIT systems, MRP systems etc.).
- The area of commodity transport is going through a rapid trans-sition phase, especially due to the emergence of modern logistic systems. The transport sector is not only a 'shipper' of physical transport, but increasingly an 'organizer' of such transport. For both national and European freight transport this development has far reaching consequences, not only in efficiency terms but also in terms of social consequences.

The previous observations demonstrate that transport has manifested itself as an extremely dynamic sector, at both the supply and the demand side. It is also clear that this sector is facing major bottlenecks caused by its pervasive nature. Everybody in society is - direct or indirect - an interest party, as far as it concerns transport and mobility.

The factual development of both commodity transport and passenger transport (measured in terms of tonkilometers and personkilometers, respectively) has shown a continuous rise in the past 20 years. In both cases road transport has exhibited the strongest growth, as can be seen from Figures 1-3 concerning CEMT countries.

For commodity transport, we observe a slight decline for rail transport and inland waterways, but this is largely compensated by the high growth rates of road transport (and pipeline transport).

In passenger transport, private transport modes (i.e., the car) have become the dominant vehicle, while public transport has shown a much less high growth rate (although this situation seems to improve recently in most countries).

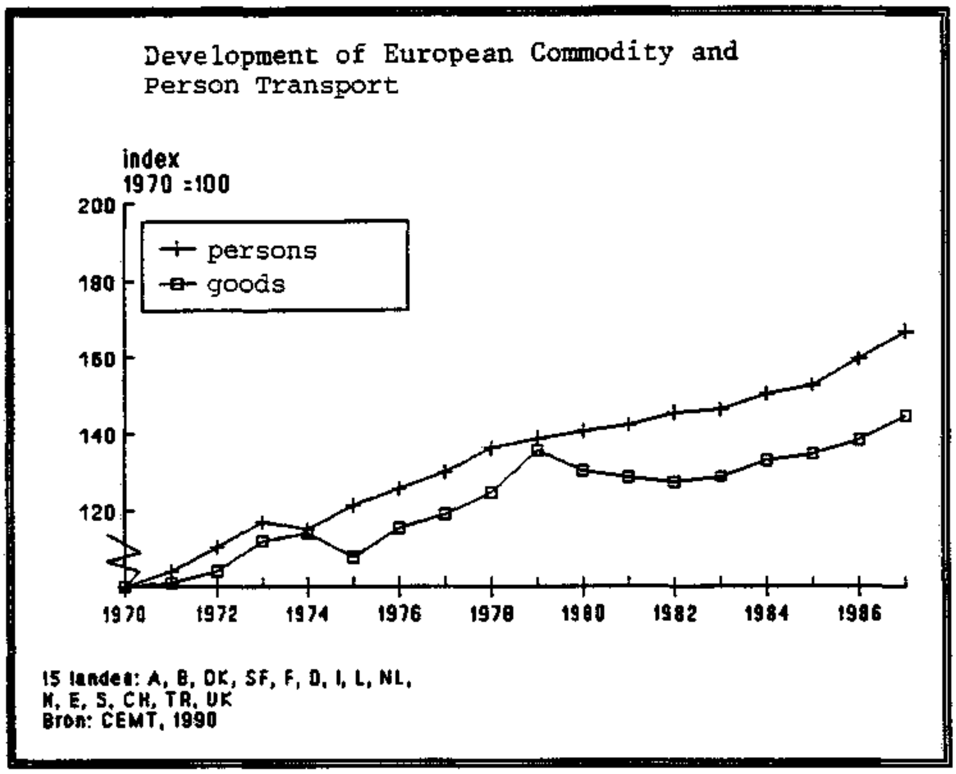
It may now be interesting to confront the rapid rise at the demand side with the investments made at the supply side (see Figure 4). It turns out that in most European countries there has been a steady decrease in transport infrastructure investments in the past 15 years (except in railways which has shown a relatively stable investment patterns). Thus supply has certainly not kept pace with the rise in demand. The combination of these two factors has led to various externalities (i.e., social costs):

- congestion costs

- environmental costs

- safety costs

Various attempts have been made to assess the order of magnitude of these costs (cf. also Himanen et al., 1991; McKinsey, 1986; Vleugel and Van Gent, 1991). Congestion costs appear to be significant in all countries, but their order of magnitude varies drastically, depending on how a reference situation (without congestion) is defined and how time is valued by different road users. In a recent OECD report (1989) various estimates of environmental and safety costs of land transport can be found:


Development of European Commodity and Person Transport
index
1970 =100
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160
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120
persons
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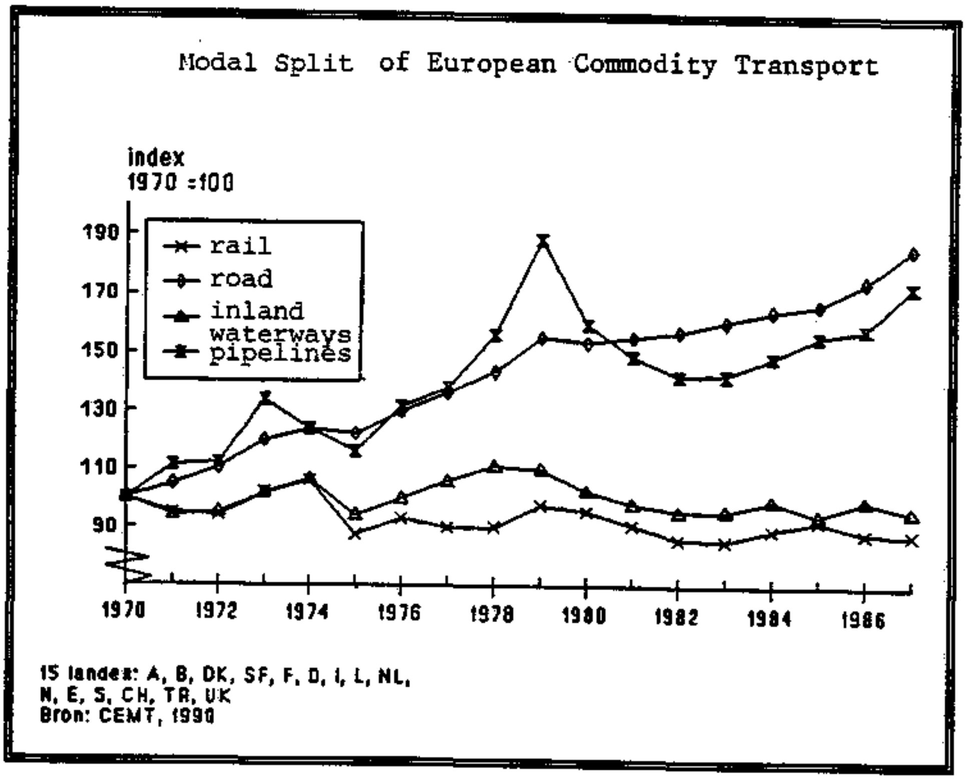
15 landen: A, B, DK, SF, F, D, I, L, NL,
N, E, S, CH, TR, UK
Bron: CEMT, 1990


Modal Split of European Commodity Transport
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1970 =100
190
170
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110
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rail
road
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pipelines
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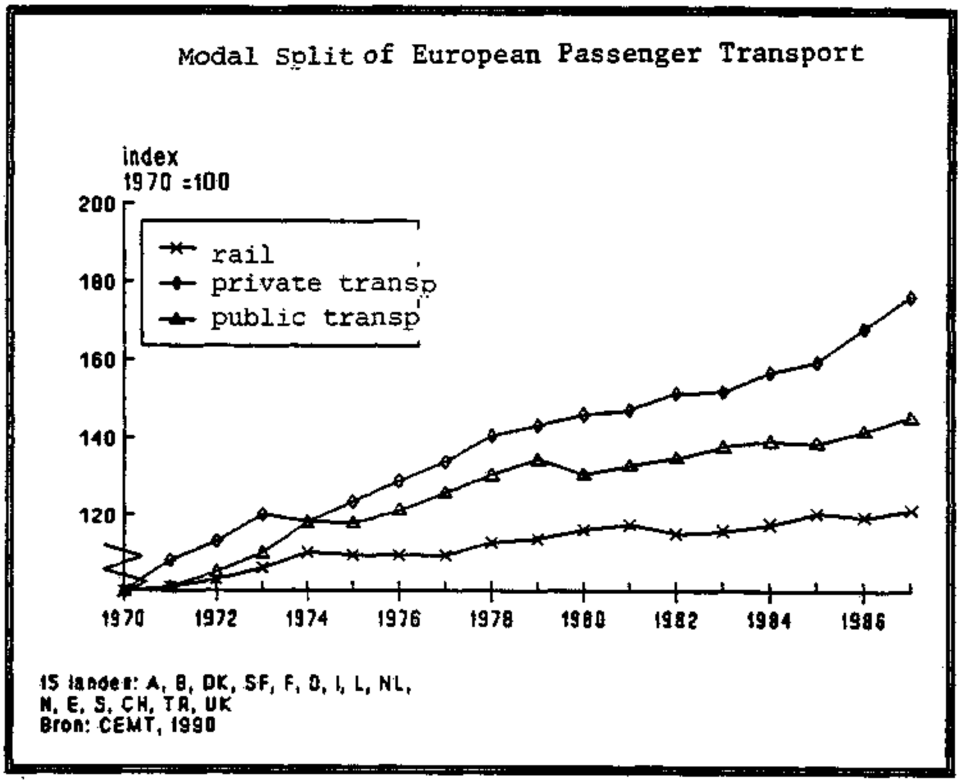
Modal Split of European Passenger Transport
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1970 =100
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N, E, S, CH, TR, UK
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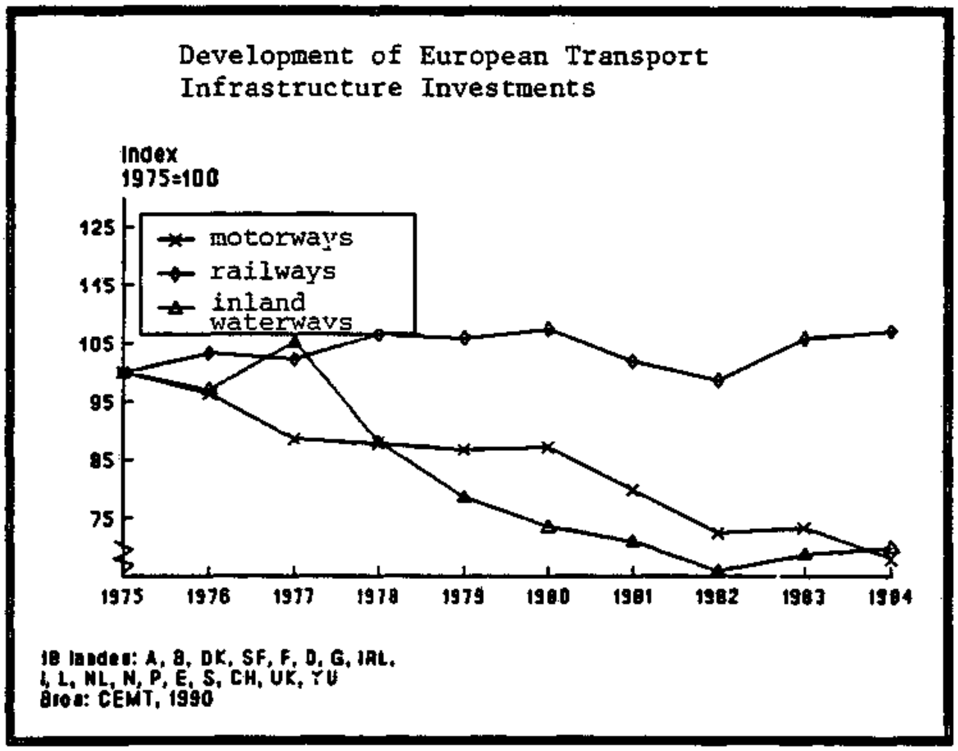
Development of European Transport
Infrastructure Investments
index
1975=100
125
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105
95
85
75
motorways
railways
inland
waterways
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
18 landen: A, B, DK, SF, F, D, G, IRL,
I, L, NL, N, P, E, S, CH, UK, YU
Bron: CEMT, 1990

- **noise annoyance**, both damage costs (e.g. productivity losses, health care costs, decline in property values and loss of psychological well-being) and abatement costs (e.g., adjusted vehicle technology, anti-noise screens, double glazing etc.). Studies in various countries show a relatively high level of social costs of traffic noise.

Social costs of traffic noise

Country	**Percentage of GDP**
France	0.08
Netherlands	0.10
Norway	0.06
USA	0.06 - 0.12

Source: OECD (1989)

- **air pollution**, both damage costs (e.g., damage to health, buildings or forests) and environmental protection costs (e.g., air pollution control, new vehicle technology, catalytic converters etc). Numerical estimates of air pollution costs caused by transport show some variation, but point all in the same direction: social costs of transport are high.

Social costs of air pollution by traffic

Country	**Percentage of GDP**
France	0.21
Germany	0.4
Netherlands	0.2
USA	0.35

Source: OECD (1989)

- **(lack of) safety**, mainly resulting in accidents, leading to damage costs and recovery costs (including damage to vehicles, medical treatment, productivity losses, policy and emergency service expenditures etc.). Various costs estimates have been made which show high financial burdens.

Social costs of road transport accidents

Country	**Percentage of GDP**
Belgium	2.5
France	2.6
Germany	2.54
Luxembourg	1.85
Netherlands	1.67
UK	1.5
USA	2.4

Source: OECD (1989)

The estimated figures lead to the conclusion that on average the social costs of road transport in developed countries falls in the range of 2.5 - 3.0 percent of GDP. Recent estimates (see Himanen et al., 1989) suggest even much higher figures.

This relatively high figure has serious implications for transport and infrastructure policy. In order to make transport part of an ecologically sustainable economy, intensified efforts have to be developed to make the need for transport compatible with the need for a better environment in the European economies. This implies that market imperfections have to be removed by internalizing the external (environmental) costs, e.g. by means of use charge principles which are increasingly accepted in European countries. A decline in the social costs of transport requires also a more efficient operation of current networks and a better, i.e. more coherent, design of new infrastructures.

The conclusion from the previous observations is rather straight-forward: transport is increasingly facing severe constraints, in terms of both infrastructure capacity and environmental sustainability (reflected in external costs). Furthermore, it should be added that the social distribution of mobility is rather unequal; especially the trend towards large scale mainport developments (e.g., the hub and spokes system) means a relative mobility deprivation for less central areas. Despite these observations, it is in the light of the relatively strategic position of the transport sector in a European network economy difficult to claim that this sector should be phased out. But serious concern is warranted: the question of the right to mobility at all cost is at stake here.

In conclusion, the previous observations suggest in any case three important fields of research: (a) the development and use of (new) infrastructures; (b) the application of various types of user charge principles; (c) the selective sustainability by means of modal split changes. These elements, which are also of a political nature will be further discussed in Section 3.

3. Mobility and Sustainability: A View on Capacity and Networks

Mobility and transport are not an aim per se, but serve the goal of economic growth and welfare increase. However, there is not a linear correlation between mobility and transport on the one hand and economic development on the other. As shown in the previous Section, as a result of external costs various negative feedback effects may occur. Thus there is essentially a conflict between three major policy orientations:

- economic development (ED)
- environmental sustainability (ES)
- network access (NA)

Depending on the size of transport flows, the specific modal split in a network, the vehicle technology used and the type of regulations, this conflict is more or less present in actual situations.

It is evident, that the above conflicts are becoming more serious, as more traditional infrastructure investments - in combination with more traditional mobility processes - are allowed and realized. In this sense, a straightforward linear expansion of traditional transport systems is incompatible with sustainability and socio-economic/spatial equity considerations (see also Himanen et al., 1991). Whether or not this is politically unacceptable, is a different question which apparently is given different answers in European countries.

In order to come to grips with the above mentioned conflictual issues, it seems plausible to investigate the critical success factors for the planning and implementation of transport systems. In this context reference can be made to the so-called pentagon model which has been used elsewhere to analyze and evaluate new European transport plans (see inter alia Maggi and Nijkamp, 1991, and Vleugel and Nijkamp, 1991). The edges of the pentagon (see Figure 5) represent five critical success factors for designing and operating transport systems.

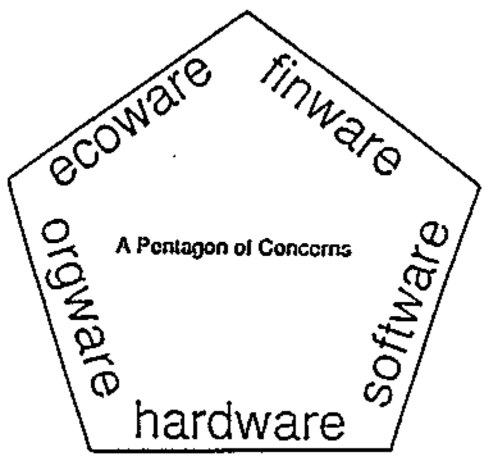

Figure 5. The pentagon with critical success factors

These five factors have the following meaning:

- 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 large scale and transnational transport infrastructure is the Channel Tunnel (Chunnel), linking the transport infrastructure of the mainland 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 tracks due to the lack of sufficient infrastructure on the English side of the Chunnel. 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 that is sufficiently high to ensure its efficiency, which depends largely on the advantage of a strongly reduced travel time. Similar observations can be made regarding the finware (where the private financing of this project has caused major concerns), the ecoware (in terms of protection of vulnerable areas crossed by new tracks) and software (in terms of sophisticated information systems).

The previous notions may also be helpful in investigating policy alternatives regarding infrastructure capacity. Capacity is not only a technologically determined given stock (measured in terms of hardware), but may also be determined by route guidance systems (software) or smart traffic regulations (orgware), especially from the viewpoint of a network system's operation.

In the light of all these remarks however, it makes sense to pay more thorough attention to the notion of capacity of infrastructure, not only on line segments but also - and particularly - in multi-modal networks. Infrastructure expansion is usually advocated on the basis of lack of capacity of existing infrastructure. And normally the claim is made that new infrastructure investment would lead to a rise in capacity (even though we know that - according to Say's law 'supply generates its own demand' - after some time any new infrastructure will again manifest congestion phenomena). Therefore, the question is opportune: what is essentially capacity? And is it conceivable that capacity management, technologically upgraded capacity and intermodal flexibility contribute more significantly to the solution of capacity problems than straightforward expansion? And last but not least: are we able to assess - and charge to the user - the right price of capacity use?

A closer analysis of the concept of capacity brings to light that capacity is essentially a multi-faceted phenomenon which cannot easily be characterized by means of a single indicator, but needs to be investigated from multiple dimensions. Therefore, the above mentioned pentagon may also be helpful in identifying a proper definition of capacity (see also Kreutzberger and Vleugel, 1991).

In the context of searching for a new concept of capacity the following reflection seems plausible. Capacity of infrastructure refers to the maximum volume of persons, goods, vehicles or messages that can use a given (part of) infrastructure in a given time period. The main question however is: what is maximum? This is not easy to answer, as for instance a road segment may already have reached its environmentally sustainable maximum, before it has reached its technical maximum. Consequently, the notion of capacity as a maximum use can only be delineated, if the criteria determining a maximum are specified. Following the pentagon approach, the following indicators are possible:

- technomax: the maximum volume that is possible, given the technical constraints on infrastructure.
- enviromax: the maximum volume that is allowable, given the sustainability constraints.
- orgmax: the maximum volume that is possible, given the regulatory system for the infrastructure at hand.
- economax: the maximum volume that may be expected, given the economic efficiency and financial criteria.
- infomax: the maximum volume that can be digested by the infrastructure, given the available information (road conditions, congestion etc.).

These notions clarify the point that capacity has to be viewed as a multi-dimensional constraint, not only in a traditional technical sense, but much more in a broad sense in which policy intervention and human behaviour play a critical role. This leads to the important conclusion that capacity problems are not necessarily and predominantly solved by physical (hardware) expansion, but by a smart combination of different constituents that altogether make up a series of constraints on the use of infrastructure.

The previous considerations have been studied and tested for various transport fields in the Netherlands (e.g., railways, commodity transport, inland waterways, airlines). These concepts appeared to be extremely helpful in identifying the preponderant bottlenecks in existing infrastructures without leading immediately to a plea for physical expansion. In many cases, the limitations caused by technical or environmental barriers might even be overcome by a better organization of the transport system in a broad sense (e.g., better route guidance systems). Thus the focus on the multidimensionality of the capacity concept prevents us from thinking - exclusively or mainly - in terms of physical technical capacity. Even if expansion of infrastructure would be necessary, the question would arise: which type of infrastructure should be expanded and which type reduced, looking also into economic efficiency or performance indicators of infrastructure.

It is clear from the above strategic considerations that Europe should increase its efforts and selective investments in improving the quality and performance of transport and communication infrastructure in order to increase its competitive power. Despite the urgency in some areas the extra efforts should be allocated with care for both economic and environmental reasons. This raises an extra difficulty, as sufficient care is usually incompatible with swift action. Short term solutions, as advocated by some - mostly business-oriented - interest groups, will heavily rely on a further massive extension of the European motorway system. This option may make some sense for Southern and Eastern Europe, but for Western Europe this option does not seem viable in the long run. Time and again, Say's Law has proven its validity concerning the motorway system. Therefore, any extension beyond the level of relieving some unfortunate bottlenecks will only create a next era of congestion on a higher level. Such scenarios will likely become reality, even if additional measures such as road pricing would be introduced. Furthermore, it will be detrimental to the spatial organisation of most urban areas as well to the ecology in Western Europe.

There is another element which deserves full scale attention in this context. Capacity should not only be considered in relation to a separate infrastructure segment, but as a feature of a multi-layer and multi-modal network. Thus the interface between different spatial interaction modes becomes increasingly important, so that the attention has to be focused on nodes (or centres) and connections (edges) in both physical and non-physical networks. Also the hierarchical structure of infrastructure connections (e.g., motorways, provincial roads, local roads etc.) deserves attention here. Multi-modality of a network is an important way of coping with capacity problems (e.g., peak hour congestion) in some modes, as this allows for inter-modal substitution and complementarity, through which both the economic efficiency and the environmental sustainability as well as socio-economic equity may be increased (see Van den Hanenberg, 1990). Here also the potential of telecommunication (including telematics) has to be mentioned (see Giaoutzi and Nijkamp, 1989). The identification of the optimal mix of necessary infrastructure modes in view of reaching given objectives (the so-called packaging problem) is a major issue in this context.

The network configuration (including its links to all other modes) is decisive for network access, the efficiency of the network, and its load structure. The main problem is that in the past network planning has mainly taken place on the basis of segmented infrastructure planning rather than system-wide optimization. Such piece-meal approaches have mainly led to second-best solutions, in which none of the prevailing interests were fully accounted for.

From the viewpoint of system-wide network optimization, it makes sense to pay particular attention to specific bottlenecks, such as transit points, variety in interaction/communication speed, intermodal connections, information systems regarding network operation, peak load and peak use, flexible working hours, new logistic systems, the position of mainports, standardisation in transport systems technology, hierarchical functional divisions in networks etc. Combined transport may often be regarded as an efficient way of overcoming current limits, by improving intermodal transit potential, rather than physically expanding the whole infrastructure. This allows also a much better use of existing capacity, so that through chain connections the above mentioned socio-economic equity problem of limited network access can be relaxed.

Finally, also the transport aspects of non-transport policies (e.g., urban policy, industrialisation policy, recreation policy, retail policy etc.) have to be mentioned. Since transport is a derived demand, significant consequences of non-transport policies for the mobility of people and goods may sometimes be expected which are hard to control (see also Louw et al., 1991). Consequently, the notion of instrument systems (i.e., packages of direct and indirect control measures) is relevant here.

4. Management and Upgrading of Existing Networks

The previous Section has emphasized the need for an alternative view on network capacity (and hence network expansion). Rather than seeing capacity problems as a technical hardware problem (which might only be solved by means of material extension of existing infrastructure types), it has been argued that capacity has to be viewed from the multidimensional potential of a multi-modal network, with a focus on organization/management, financing, ecological sustainability, and information systems access.

The present Section will take up this point a little further and will also call attention for ways of improving the economic efficiency of networks without doing harm to the other aspects summarized in our pentagon. It is important to do so, as the transport sector is exhibiting a strange paradox. It is on the one hand a cost factor (incorporating both private and social costs), so that its use would have to be minimized. On the other hand, transport is an important economic sector which in most countries provides a significant contribution to national income (up to 5-7 percent in many countries), so that it would be tempting to maximize its use. However, recent statistical evidence also demonstrates that the profitability of the transport sector is relatively low (see Roschar et al., 1991), so that the transport sector tends to become a (sub-) marginal sector, which is only a necessary evil in view of its strategic role in a competitive European situation.

The only way to improve this situation is not a straightforward expansion of conventional physical infrastructure, but to develop new transport systems which would increase the economic position of the transport sector without violating the constraints incorporated in our pentagon model. The main strategies to be pursued here are:

- avoidance of any unnecessary physical transport, by improving the transport systems efficiency through more appropriate information systems, telematics, new logistic and management concepts for fleet guidance and management etc.
- operation of necessary physical transport systems against lowest social costs, by using the best available technology (route guidance systems, better vehicle technology etc.), or by developing and using more environment-friendly means of transport.

Unfortunately, most existing infrastructures are so strongly embedded in our production and mobility patterns that the shift toward new systems (e.g., Maglev, underground vacuum tunnels etc.) is extremely difficult due to almost prohibitive transition costs. Furthermore, new transport systems need to be linked to existing ones, in order to ensure a minimum critical mass of operation (the 'connectivity' problem).

With respect to the integration of new 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 (e.g., in terms of technological standardisation). This is an important aspect considering the importance of the network effect. Secondly, one should recognize the competitive aspect of integration: since several transport systems exist already with a given market share, new systems will in general 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 in itself was not compatible with the existing infrastructure on the hardware level is the Japanese Shinkansen. To ensure that the new system did not become in fact a stand alone system, software and orgware factors 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, so that the benefits of the system become debatable, and 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 competitive behaviour 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 its production will be a (indirect) competitor with the automobile and gasoline industry. Two interesting 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.

Thus the construction of new advanced infrastructure networks is fraught with many difficulties, which may only be overcome if all conditions implied by the pentagon are satisfied. A straightforward expansion of existing infrastructure (more of the same) does not seem to be a logical or plausible strategy in many countries. Upgrading of existing infrastructure using modern information and telecommunication technology - in combination with a selective transport volume policy - seems to be the best viable policy. Thus, it has to be recognized that 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 explorations, 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 point of departure.

A choice for operational performance levels would need coherent multisectoral European - rather than a sectoral 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 (see ERT, 1991).

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-back systems and containerisation). But especially in this field a fine tuning in terms of hardware, software and orgware is necessary.

The conclusion from the above observations is that there is a need for strategic and anticipatory research, by taking long-run sustainability criteria as a point of departure and linking design and operation of networks to these criteria. This would also bring to light the (potential) success and failure of transport policy in different regions and nations in Europe.

5. The Interest and Potential of European Transport Policy

Transport policy in European countries, regions and cities cannot boost a high success rate, as transport policy is also trapped between a variety of mutually conflicting social goals.

The rapid dynamics of the transport sector in the context of the emerging European network economy has also clearly brought about in the political arena the awareness of the limits to growth: the European transport map is featuring various problematic developments and both local/regional and national/international scales. Despite the increasing popularity of Just-in-Time (JIT) systems and related concepts, the actual practice of both commodity and passenger transport is disappointing and often frustrating. Severe traffic congestion phenomena at the urban or metropolitan level (e.g., Athens, Rome, Paris), unacceptable delays in medium and long distance transport during peak hours, unsatisfactory service levels of European railway systems (and public transport in general), unreliable airline connec-tions due to limited airport capacity and slow technical and institutional renewal of air traffic control in Europe; all these phenomena illustrate the difficult position of the European transport sector. And there is no clear perspective for a drastic improvement of this situation.

On the contrary, it is increasingly claimed that a free European market (beyond the year 1992) and a further deregulation of the European transport may lead to unacceptable accessibility conditions in major regions in Europe. The development of the American airline sector into a monopolistic or oligopolistic market structure is illustrative in this respect.

Another important complicating factor will be environmental policy. In contrast to the deregulation with respect to the pure transport market phenomena, environmental policy is critically dependent on a great deal of regulations. In particular more technical restrictions are likely to be imposed, e.g., limited emission levels of motorcars or even a prohibition of the use of certain transport modes.

Altogether, governments are facing a complexity of questions which may briefly be indicated as follows (see also Louw et al, 1991):

- The role of the government in a deregulated market with respect to access, competition, financing/subsidising, safety and risks is an important issue. The effects of deregulation deserve a thorough analysis in order to remove monopolistic tendencies and to ensure a competitive market. This is particularly relevant for railway companies. They have the potential to operate in a more commercial way in combination with a high quality offer in terms of speed, reliability and comfort.

- As far as commodity transport is concerned, deregulation of freight transport (e.g. scope and impacts on modes) deserve also full scale attention in the near future.
- In view of he international importance of transport infrastructure and freight transport, possibilities of developing coastal transport and roro (roll on roll off) transport in Europe as a partial solution to infrastructure shortcomings, have to be explored more intensively.
- The consequences of the massive (auto)mobility growth are evident: on a European scale we have to face the problem of endless traffic jams and inaccessibility in and around urban areas. A main side effect is the serious environmental impact. Two different kinds of policy measures deserve analytical attention here:

(1) Variabilisation of costs of car use as a compensation for environmental costs. In many countries the idea has emerged that the user should be charged for all (direct and external) costs. But since actors with different economic interests and aims use the same infrastructure, the question is: which user has to be charged for which use of scarce infrastructure? This question is at the heart of current debates on transport policy, as it reflects potential conflicts between business traffic, private traffic and public transport (including substitution possibilities between different modes). This issue has also been a focal point of recent policy interest in the Netherlands, especially because of the strong dominance of the commodity transport sector in the Netherlands, which is one of the strongest in Europe. Although several experiments have been done with navigation systems and dashboard mounted video display screens (especially in Japan), a practical European cross frontier programme of electronic traffic aids on congested trunk roads is still missing.

(2) Improvement of public transport. It is plausible - in the light of actual choices made regarding modal split - to assume that for short- and medium-distance transport (notably railways and private cars) most likely the environmental decay will not count as an argument in the choice between these two different modes, unless public transport will improve substantially its quality (in terms of fares, punctuality, comfort,etc.). Some important necessary conditions are: liberalisation of the European transport market, a reduction of the monopoly positions of (notably) railway companies which

implies a separation between infrastructure holding companies from transport operations; and (ex ante) evaluations of new transport projects in the light of their environmental effects.

- Design of management information and planning systems, and satellite control of trains and vehicles under the condition of integration of national and international databases is urgent.
- In view of the 'magical year' 1992, the analysis of possibilities for reducing border formalities and customs delay in both passenger and freight transport is also an important item on the list of planning research priorities. Harmonisation of combined transport technologies in personal transport and in freight distribution seems in this respect to be the main precondition which has to be studied in order to find practical solutions. Of course, telematics plays a crucial role (as also the COST programme illustrates).

The foregoing observations have shown that there is a wide variety of transport policy options in coping with capacity and network access issues without expanding immediately conventional material infrastructure. The types for policy can be systematically distinguished into metropolitan-urban policies focusing on transport systems in main nodes (e.g., mainports) of a network, and cross-border policies focusing on European transport corridors.

As far as metropolitan-urban policies are concerned, three categories can be distinguished, viz. demand-oriented, supply-oriented and indirect transport policies.

(1) Demand-oriented transport measures are mainly concerned with short-and medium-term ways of influencing (urban) transport behaviour in order to ensure a more efficient transport system or to reduce environmental or other external costs. Examples are:
    - optimizing urban transport network flows (e.g., coordinated traffic lights, electronic route guidance systems etc.).
    - road pricing - or user charge measures (e.g., the Singapore model, or the recent experiences in Oslo or Stockholm)
    - auto restraint measures (e.g., closing of inner city areas, such as in Milano)
    - car- or vanpooling and/or special lanes on motorways for carpoolers
    - information and communication campaigns.
    - integration of fare systems in an urban area in order to enhance inter-system connections and thereby improving the accessibility and usefulness of public transport (e.g., the

national 'strip-card' for public transport in the Netherlands).

In various cases a combination of such management options is chosen. All these examples do not require a 'hardware' solution, but originate from orgware, ecoware, finware or software type of policies.

(2) Urban supply-oriented transport strategies refer to medium- and long-term measures which have a structural impact on the mobility pattern in urban areas from the provision of infrastructure. Examples are:
- improvement of public transport (e.g., in combination with deregulation, e.g. in Manchester)
- more efficient management and organisation of transport systems technology
- design of sophisticated new infrastructures (e.g., light rail, subterranean solutions)
- incentives for using telematics in transport systems
- parking policy (in terms of volume, location and opening hours)

Also in this context the focus is more on management and organisation than on technomax expansion.

3. Indirect policies refer to measures which outside the direct realm of the transport system have a preponderant impact on the functioning of transport systems. Examples of such indirect policies are:
- alternative work schedules to avoid transport peak problems (analogous to electricity load management) (see also Tacken en Boer, 1990)
- further introduction of telecommunication to favour telework, teleshopping, etc.
- urban design, urban land use and urban street design (e.g., building permits for offices near terminals of public transport in the Netherlands).

We may conclude here with the observation that the strategic evaluation of the efficiency and the reduction in social costs of transportation as a result of new urban transport policy measures is an underdeveloped field, which nevertheless is of great importance for urban planners. Some illustrative examples of potential success measures may be given here for the city of Zurich (see Sommer, 1990):

	1995	2000	
Promotion of public transport/parking	- 300	- 350	tNOx/year
Fiscal measures	- 150	- 150	"
Speed limits	- 500	- 400	"
Heavy vehicles	- 200	- 300	"
Total	-1150	-1200	tNOx/year

As said above, next to metropolitan- urban policies there is a need for an effective cross-border policy initiative in order to pave the road to a unified European market. Without adequate infrastructure investments the European economy will not be able to reap fully the fruits of the market integration. The need to develop a strategy network plan for Europe was recently advocated in a study by the Group Transport 2000 plus (1990).

The report was produced by the Group Transport 2000 Plus, an advisory policy group of the Transport Commissioner of the European Commission. This group was given the task of compiling medium and long term definitions of the European Community's internal and external transport problems, as part of a wider outlook taking into account the upcoming Single Market, environmental protection, technological education, and extension of present networks to Central and Eastern Europe.

In the necessary development of European transport system, four issues deserve special attention:

- integration of ecology in transportation planning
- energy efficiency of vehicles
- spatial implications of transport infrastructure
- social dimensions of spatial mobility

The study makes a plea for fair competition in the transport sector by charging all infrastructure and external costs to the user, by making the cost structure more transparent, by avoiding manifest and indirect subsidies, by favouring market harmonization and by stimulating logistics and telematics.

The negative externalities have to be coped with by abatement at the source with the best available technology regarding emission reduction, noise abatement energy savings and safety.

Intermodal transport for commodities has a good potential and has to be strongly favoured. Temporary subsidy - based on the 'infant industry' argument - may be allowed to ensure viability in a competitive multi-modal transport market.

The quality of decisions in the transport sector has to be improved by favouring more active and efficient institutional procedures at all levels of decision-making; in a European setting the subsidiary principle is a valid policy paradigm.

Also the financing aspects of European transport systems deserve due attention. Variabilisation of transport costs and road pricing are regarded as appropriate instruments. Furthermore, it is suggested to create a European Infrastructure Fund in order to finance missing links or missing networks in Europe's infrastructure.

It is interesting to observe that most bottlenecks facing the European network system can apparently be described by means of the considerations/indicators incorporated by the pentagon concept. European transport problems are not in the first place a matter of lack of technical capacity, but are related to management and organi-
sation.

The latter message is also reflected in a Community document on trans-European networks (see EC, 1990).

This community document contains a European action programme in the transport sector. The argument is put forward that the emergence of Trans-European networks is a necessity and deserves high priority, especially because current infrastructures in Europe are suffering from many insufficiencies. Furthermore, new transport systems developments have to be compatible with ecological constraints.

At present, many barriers to the emergence of Trans-European networks can be observed, notably:

- difficulties of transfrontier interoperability
- inadequate legislative environment
- constraints linked to competition
- lack of an overall view at the European level regarding the expected increase in demand and the resulting necessary infrastructures.
- shortage of statistical data collected on common bases.

This community report then continues by concisely reviewing some problem situations in air transport, road transport, railway transport, inland waterways, sea shipping, coastal transport, telecommunications and telematics. The report recommends to draw up comprehensive schemes for developing Trans-European networks, to introduce rapidly rules needed for the realization of Trans-European networks, to reinforce standardization programmes (both technologically and institutionally) and to grant a declaration of European interest in such new infrastructure concepts.

The previous observations on the need for an intensive interest in the non-hardware aspects of European infrastructure networks also imply that the current trends of declining infrastructure budgets is detrimental to a sound and sustainable development of the European economy. the creation of a sophisticated infrastructure requires a maximum attention for the orgware, software, ecoware and finware aspects for transport in Europe.

6. The Need for European Cooperation

A successful international spatial and transport policy requires also an effective infrastructive policy. The role of infrastructure as a catalyst for economic development has since long been recognized by the European Communities, witness the huge subsidies for infrastructure projects in European countries. Clearly, it is not an easy task to establish priorities regarding infrastructure projects, but the limited financial resources force governments to find a compromise between efficiency and equity, a dilemma which is often reinforced by the predominance of national interests in European infrastructure planning.

The interest in a real European transport policy does not only rest with governments, but also with the industry in Europe (see ERT, 1988). In the context it is worth calling attention for a recent study on missing networks in Europe, commissioned by the ERT (1991). This study has been carried out by NECTAR (Network on European Communications and Transport Activity Research), a research group which acts as a liaison of the European Science Foundation (ESF) in Strassbourg. Based on the above mentioned pentagon of critical success factors, NECTAR (1991) has analyzed various European-oriented transport systems (including multi-modal options).

The field of international transport and communications is characterized by ad hoc and partial policy strategies and measures. Government actions tend sometimes to be taken more in response to crisis situations, rather than as part of a coordinated and pro-active policy programme, which is strategic, holistic and anticipatory in nature (see Vleugel and Nijkamp, 1991).

A major reason for the emergence of missing networks is thus the inevitable tendency for national governments to protect their own manufacturing industries and to maintain their own transport enterprises. Only when a mutual benefit can be derived by all parties, different countries come together to tackle problems at the international front. The importance of international policy forums such as EC, Economic Commission for Europe of the United Nations, ECMT, Benelux, OECD (the Organization for Economic Cooperation and Development), etc. is worth mentioning in this respect. Even here however, agreements are often difficult to reach. While part of the problem often lies in a disagreement on the nature of common actions (e.g. resolving 'the customs problem' or agreements on joint standards for electronic data interchange ('harmonization') etc.). it also stems from fundamental differences in national attitudes to transport policy. The problems of finding satisfactory forms of transport policy coordination at the international level are often even more severe for those countries which have significant regional variations or where the administrative system is of a federal nature (e.g., Austria, Switzerland).

In the sequel of this study a summary of 6 case studies based on the above mentioned NECTAR (1991) study on various transport fields will be given, each giving a sketch of bottlenecks in a given network followed by an outline of a new strategy which is not necessarily oriented towards technomax solutions. These policy fields are:

- freight transport on roads and rails
- airline systems
- high speed rail networks
- European common carriage
- coastal transport and inland waterways
- telecommunication networks

In subsections 6.1 - 6.6 these fields will briefly be described.

6.1 Freight transport and roads and rails

a. A sketch of bottlenecks.

The current bias towards passenger transport (e.g., the planning of high speed trains, maglev systems and electrocars) may prove to be fatal if it reduces awareness of the forthcoming problems in the domain of goods transport. A continuation of the vast growth of freight transportation (especially by road vehicles) must be expected. This increase will be amplified by the liberalization of trade in Europe. Because of this, urgent attention must be given to this area in the light of the existing bottlenecks in freight transportation in Europe.

Bottlenecks in European freight transport can be identified at all layers of our pentagon of concerns. They relate to the capacity of road and rail networks and goods terminals. An important number of problems have been identified on the org ware level which relate to the inefficient use of the existing networks. The national orientation of the planning and operation of railways in Europe, the lack of separation between network and operation, the absence of a clear, Europe-wide tariff structure, the insufficient planning of the spatial structure of thefreight transport network in terms of hubs and spokes for multi-modal solutions are together responsiblefor the under-use of the existing transport infrastructure in Europe. Concerning soft ware, the absence of logistics strategies as well as all instruments of combined transport to control the European wagon and truck fleet on road and rail are the most important shortcomings. In the fin ware domain problems arise with the funding of infrastructure projects which have a European impact while being planned by national companies. A European approach to the integrated treatment of funding on the one hand and the equalization of economic and environmental benefits and costs is urgently needed.

b. New networks

A solution for many of the current problems is the realization of a multi-layer network which combines transport on road and rail. The first layer would consist of a combined **transport network**, where the nodes would be central European freight terminals near the big European agglomerations and the links would be used by block trains running according to a strict timetable between these terminals using standardized container technology.

A second layer will have to be installed, based on what might be called soft technologies in combined transport. The nodes of this network will be the existing freight stations in Europe. These stations can be used for combined transport due to the use of transhipment techniques which allow drivers to change their loads. The links will consist of piggy back trains. This network links smaller centres all over Europe.

This two layer system requires an advanced logistic system. A future integrated European Electronic Data Interchange (EDI) system for combined transport is urgently required, which deals with the movement of freight on road and rail at the same time. Logistic centres placed at the terminals should provide services on a commercial basis to any haulier who wants to operate combined transport.

Another solution concerns road haulage. Given important capacity limits on the European road network, measures must be found which allow for a more efficient use of existing roads. A solution might be a satellite based network of mobile telecommunication for the European truck fleet (orbital truck fleet management). The installation of such a system would lead to a considerable reduction of the movement of empty trucks in Europe, increase the efficiency of road transport and thus increase the capacity of the existing network enormously. In the case of trucks, this network solution could be combined with the electronic customs facilities mentioned in the telecommunications case study.

A great deal can be realized through the reorganization of the transport and logistics divisions of large European companies. The case of the mergers of various large-scale retail companies in Switzerland shows that there is an enormous transport cost savings potential in merging the goods distribution of several companies. A new network might be created if the transnational companies combined their logistic efforts and founded a European clearing house to make the most efficient use of their fleets.

6.2 Airline systems

a. A sketch of bottlenecks

The European airline system consists of a series of overlapping networks. These are the product of bilateral intergovernmental agreements on route authorities, (ambiguous) fare structures, etc. infrastructure (hard ware) networks with airports and airport access facilities normally under the national authority, the software of air control and communication systems. This complicated network is likely to change after the European integration, with various mergers, strategic coalitions etc., which may improve the efficiency of the European airline sector. Financing is in general typically a question of national public investment or public subsidies to the national airlines. Finally air traffic results in important social costs from noise and air pollution.

There are various forms of air transport networks, but none of them are complete. The key organizational network required to co-ordinate the overall system is entirely absent and aviation is overseen by a variety of agencies. Where networks exist, they are characterized both by the total absence of some facets (such as a common technology for air traffic control) and the lack of networks of sufficiently high quality provision (such as the adequacy of access to airports on the ground).

The European air traffic control is a patchwork of 22 systems operated out of 44 en route control centres. Some limited coordination exists in the framework of EUROCONTROL. The control system itself involves verbal contacts between ground control and pilots. This presents no problem in the US but leads to serious difficulties in air traffic control in Europe because of the multiplicity of languages used. Automated systems are available but the necessary network of computerized infrastructure is missing. Another bottleneck is the shortage of experienced air traffic controllers.

b. New networks

The solution which would be compatible with a new network look at European air traffic control is the reduction of the number of air control centres. These will have to be equipped with powerful standardized main-frame computer (like in the US) and the installation of a Central Flow Management Unit (CFMU). The main focus in the case of air traffic is thus on air traffic control and organizational and logistic solutions which will bring about a new European network.

Another weak element in air transport is the extremely unfavourable time-loss because of pre-and post-transport (by buses, taxis or trains). Rapid railway links from airport to major cities and the eventual interlinking with the new rapid train network might bring improvements.

6.3 High speed rail networks

a. A sketch of bottlenecks

High-speed travel on rail is an excellent solution for many of the passenger transport problems in Europe because the distances between the major cities range from 200 to 1000 km, distances for which the rapid train is very competitive. Conscious of this challenge, the Community of European Railway Companies of the twelve EC members plus Austria and Switzerland presented in 1989 a project for a European high speed network (Community of European Railways, 1989). This project redraws the European railway network map.

Such a project, in principle, introduces a network which has so far been missing. However, taking a multi-layer- multi-national perspective some problems become immediately obvious. At the hard ware level most technical problems have been solved, but the existing solutions are national ones. The only regularly running rapid train network - the French TGV - is running on tracks built exclusively for rapid passenger transport, while the German ICE is planned for both passenger and freight transport. Hence the effort of putting the national plans for improvement of rail transport in Europe onto a map does not in itself guarantee the achievement of a European network solution. To reach such a solution, important problems have to be solved on the org ware level and the ecoware level. It is doubtful whether a European rapid train system will ever come into being if its planing is left in the hand of the national railway companies and their related segmented ministries.

b. New networks

A coordinating body to operate the services and/or distribute operations between companies according to competitive principles should be foreseen at a very early stage. The planning of the infrastructure, which is not independent of the chosen system, must also be undertaken by a centralized body, unless the national railway companies can agree on a common standard.

In the short term the realization of the Northern TGV could serve as a test bed for the multilateral coordination of rapid train planning involving several states. In the medium term, an integrated approach is required and the European Community has a clear responsibility if this network is to come into being. The basic problem in this field is to find a compromise between national and Community interests mainly on the level of org ware and fin ware. A coordinating European infrastructure bank might be used to finance these high-speed projects.

Before the funding problems can be solved a solution to the incompatibility of the different national systems must be found. Otherwise the new train will experience the same difficulties as the traditional trains with all the problems which arise at border crossings.

6.4 European common carriage

a. A sketch of bottlenecks

From an economic point of view the idea of separating carriage and infrastructure in high-speed rail transport is based on the idea that networks have many of the characteristics of a natural monopoly. Consequently, if competition within a given mode is to be favoured, they should be separated from the use of the infrastructure, thereby realizing a European concept of common carriage. Solving org ware and fin ware problems is essential for the realization of such a strategy.

The development of the concept of common carriage must take account of many of the problems cited in the context of rail freight transport and the future rapid train system. In the process, many standardization questions have to be solved.

b. New networks

The concept of common carriage on European rail can only be realized for transport between high ranking central places in Europe. Regional and national transport will be organized at the appropriate levels. At the European level **a European Common Carriage Organization** will be necessary.

This organization will set standards and distribute slots on the rail system. Common carriage implies an integrative view to additions to the European train network, the closing of gaps, the retooling of certain tracks, especially with a view to the Eastern European countries. Authority should be given to the European Common Carriage Organization with free entry to (private and public) parties meeting certain standards. Priority rules need to be set with respect to freight and passenger transport, feeder systems and regional traffic, and rules for concessions are needed which define bidding systems for routes and time schedules. However, overregulation should be avoided by limiting the power of this body.

6.5 Coastal transport and inland waterways

a. A sketch of bottlenecks

Changes in the international division of labour are concomitant with a new pattern of international trade flows, especially by sea and waterways.

Existing natural barriers though seem to impede the development of a European unitarian vision of the latter mode (inland waterways), while issues of strong competition between harbours within the European region have failed to develop the idea that they are part of a European network. In view of the above problems, the European Community has been recently engaged in an effort to develop the inland waterways network.

In the context of our analysis we deal with three different types of networks: inland waterways, coastal transport, and mediterranean transport.

From the large number of bottlenecks in this field we may mention - inter alia - lack of standardization and network integration (e.g., lack of standardized vessels in transit areas); lack of harmonization of regulations (cabotage) - also because national regulation is used to support national firms -; lack of investment and planning of new networks or upgrading existing ones; lack of investments in fleet modernization (also because of environmental reasons); lack of compatibility between barges, cargo specifications, train terminals and port facilities (necessary for multi-modal transport).

And if new infrastructure is eventually being built - as is currently the case with the Rhine-Main-Danube Canal - both planning and investment periods are very long.

b. New networks

To solve missing networks, policy makers should especially concentrate on (transnational) plans for main transport axes connecting at least Europe's major industrial areas with each other. Firms in each industrial area should be able to choose between road, rail and water as means of transport. Integration and harmonization of national policies and regulation (cabotage, labour, etc.), and standardization of hard ware and soft ware should also be favoured. Informatization is also called for to ensure Just-in-Time transportation.

6.6 Telecommunication networks

a. A sketch of bottlenecks

The main problems in this field are the following:

At the hard ware level there is an extreme kind of diversification between EC-members. This is particularly evident in the differences in developing infrastructure (ISDN) and differences in transmission capacity etc.; incompatibility and lack of interconnection.

At the org ware level the main problems lie in the lack of standardization between national norms and standards for equipment, approvals etc., and - most important - in the way and pace in which European standardization is eventually achieved. Given the non-existence of a common European market in telecommunications, national priorities will then determine the kind of response to market needs. Another problem lies in the asymmetric way of price setting in telecommunication, determined by national considerations. For instance, high international telecom prices are often used to subsidize national users. Consequently, prices and costs are then more or less unrelated.

At the soft ware level a major problem lies in the absence of demand for sophisticated services using the telecom network. As long as this situation continues, suppliers of such services will not develop new applications.

Fin ware bottlenecks are also very important, since large investments are needed to develop a basic European telecommunications network.

Because of these problems, there is a real danger of a Europe 'a deux vitesses', with a clear division between those countries and/or regions having access to recent technology and those that have not. The socio-economic impacts of such developments are considerable, since existing differences in wealth and business opportunities will be accentuated.

b. New networks

The introduction of a base European telecom network including standard facilities, uniform rules and tariffs, and services is necessary. Local networks should be at least hard ware compatible with this base network. Management and ownership should be take the form of a public-private partnership in which governments, operators and users participate. Developing such a network will be very expensive, but will have positive economic impacts both for the users as well as for the industry, the use of EC (development) funding is needed.

A separation of responsibility between regulators (government; policy) and operators (implementation) is needed. Beside, avoidable barriers to entry should be minimized; the existence of monopolies should be avoided.

Since delivery technologies are changing too fast, a sustainable basis for regulation is missing. Improving competition should then be the keyword. Telecom prices should be cost-related. Furthermore, it would be necessary to use

the outcome of current ENS-applications (e.g., the European NERVOUS-system) in transportation (EDI, ATMOS, FTM, Single Document etc.), banking, environmental protection, health care, education in order to develop European-wide applications.

Possible solutions include:

a) the use of new teleports as a operational planning tool for connecting telecommunications with physical goods transport or passenger movements (cf. the Amsterdam teleport success story).
b) the introduction of new networks:

1) substitution of postal services by more efficient and faster express mail:
   Express mail services are booming, but the lack of a true network and thereby inefficient competition leads to very high prices;
2) the combined use of deregulation of national PTT services and the introduction of new standardized telecom services. The French Minitel might be used as a basis for such an European network (soft ware, org ware). Experimentation with Telecom Zones in rural areas between two or three countries (org ware) is also an option in line with deregulation;
3) where substitution is impossible in goods transportation, options include the use of orbital fleet management in relation to electronic customs (replacement of physical border controls by standardized electronic vehicle identification at the big European freight terminals, ports and airports).

It is interesting to observe from the above case studies that the real heart of modern transport systems policy lies essentially in the coordination of multi-modal systems, seen from the multi-dimensional viewpoint of five critical success factors. Expansion as a first logical choice is not plausible and does not solve the essential problems inherent in our modern network economies. Based on the previous case studies three messages can be extracted for European policy-makers.

The first message from the report concerns the predominance of national perspectives in transportation planning. Missing networks in Europe exist because transportation systems have been developed in a segmented way, each country and each transport mode seeking for its own solution without considering the synergetic effects of coordinated design and the use of advanced infrastructure. Because all economic development in space involves interacting networks, missing networks will sooner or later translate into missing economic development. Because of segmented national planning, there are European failures at the same time as national successes. New networks are created at the nations level - the national rapid train systems are an excellent example - but the corresponding European network exists only as a fanciful map.

The second message of the report is the importance of a European perspective in the analysis and resolution of transport and communication problems in European countries. This is not only a question of formulating a coordinated standardization. Lack of standardization creates bottlenecks on all transport models with the exception of air transport. These problems range from a lack of technical standardization of cargo in combined transport on road and rail to problems with the width of canals and sluices on inland waterways. The greatest potential for standardization is in rail transport (differences in gauges, voltages, frequencies and supply type, signalling systems and norms for using foreign traction on domestic rails as well as in free profiles and other things) and in telecommunications where the policies of the national PTT companies and developments in the NIT industries have led to the presence of an enormous variety of standards.

The third important message of this report is the need for multi-modal solutions. Although there are many success stories concerning uni-modal solutions at the national level, multi-modal approaches are rarely found and, if present, are only of minor importance in terms of market shares. Nevertheless, it can be argued that the huge demand for additional transport capacity in Europe can only be met if multi modal solutions are also pursued. This holds for passenger transport (e.g. rapid trains for medium distances combined with air traffic for long distances) as well as for goods transport (e.g., rapid trains for medium distances combined with air traffic for long distances). A third message of this report therefore is that in looking for new network solutions, a multimodal view is essential.

The previous caveats suggest that infrastructure be declared as of a basic economic interest for Europe, so that a strategic priority plan from a European viewpoint has to be designed. Some necessary conditions for an efficient and effective European transport policy are a European institute for Standardization, a European Infrastructure Bank, but also more strategic and coordinated transport research on a European level. Finally technological progress should be stimulated in order to fully benefit from qualitatively advanced transport infrastructure.

7. Concluding Remarks

The previous observations have called attention for the development of European infrastructure in a highly dynamic political, economic, social and technological context. Many uncertainties seem to prevail in the area of transport and infrastructure planning, such as the expected impacts of the completion of the internal market in Europe, the consequences for transport systems of deregulation and privatisation, the effects of stringent policies in favour of ecological sustainability, the potential of new infrastructure technologies, the flexibility (or rigidity) in human responses to transport policy measures, etc.

This also leaves us with an enormous research task regarding the design, use and access of European networks. Important research directions would have to be explored, such as:

- financing modes of new (transnational) infrastructure networks.
- international coordination, harmonisation and standardisation of transport and communication systems.
- assessment and charging of social costs (and benefits) to various user categories and modes of transport.
- the development of co-evolutionary planning principles between efficiency, equity and sustainability.
- cost-effectiveness analysis of network expansion vis-à-vis improved capacity use of existing networks.
- feasibility analysis of various types of user charge and road pricing measures.
- the substitution possibilities between different transport modes in the light of their (realized or expected) performance, in terms of financial-economic, structural-economic and environmental consequences (e.g., intermodal transport).
- the need for large-scale subsidization of various types of transport (both public and private).

- experimental studies on separating property rights on infrastructure from operation and management of such networks.
- the resilience of users of transport systems against changes and control measures impacting on human behaviour.

In terms of policy initiatives, the following strategy for the various planning levels (regional, national and European) regarding all transport and communication modes may be considered:

- declaration of infrastructure (development) as of basic economic interest for Europe; such a status should, for instance, include access to the various fiscal and financial instruments of the EC for R&D and pilot projects in this field;
- definition of a priority plan of base European networks (road, rail, air, waterways and telecom) in terms of network quality and performance (e.g., maximum travel time, reliability of transportation etc.). Such a network would need of course sound links with lower level national and regional networks;
- strategic policy analysis of how to implement such a European network; for instance, coupling existing national networks is only a first step in this process, since nationalistic planning failures and thinking have strongly prevented the European network vision from emerging;
- creation of efficient decision making procedures for European infrastructure (e.g., a coordination via a European Institute for Standardization), since current procedures are far from ideal. Growing constraints on infrastructure (e.g., financial, environmental, technical, etc.) have helped to create a climate in Europe which seriously affects its competitive position;
- a clear strategy on prioritization of European infrastructure projects, including a sound transnational financing (e.g., on the basis of a European Infrastructure Bank associated with a coordinating body for European transport policy).

Such initiatives are not in the first plan addressed to the planning of infrastructure in the short term, but are focussed on medium and long term projects, and form thereby a contrast with the well-known short term demand-oriented planning failures of the past. The emerging European network economy is faced with a large number of transportation bottlenecks, of which an important number may be ascribed to the absence or inefficient operation of vital physical and non-physical networks. From this study the fundamental causes of missing networks have become more clear. One of the most important causes appear to be the nationalistic and/or uni-modal way of organizing and planning of infrastructure networks. A necessary condition for a competitive European network economy is a multi-modal European view on infrastructure, taken into consideration the five critical success factors discussed in this study. Europe's transport policy should thus be more strategic in nature.

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