THE TRANSPORTATION INFRASTRUCTURE - A KEY PROBLEM FOR EUROPEAN INTEGRATION PRINCIPLE CONSIDERATIONS FOR THE LAYOUT OF THE PROSPECTIVE GERMAN RAILROAD NETWORK IN THE EUROPEAN CONTEXT

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1. EXISTING SITUATION AND PROSPECTIVE MARKET REQUIREMENTS

The progress of European integration, the implementation of the western European home market, the opening of the borders to the east European countries, and the German reunification lead to a development in the field of transportation that requests a diverse and highly quantitative as well as qualitative demand from the transportation infrastructure. There is no doubt about the key position of transportation for the integration and economic growth - this is true for the national area as well as for Europe in the whole.

Several different transportation modes with different technical features are involved in handling all of the traffic. These different technical features result in different capabilities for the performance in the diverse transportation tasks. On the one hand, the diverse transportation modes compete, but on the other hand cooperation and task sharing offer possibilities for the improvement of the quality of supply that are not used so far, neither in business economics nor in societal economics. In the same way, compared to the former reflection oriented towards different sectors, an integrated transportation policy gains more and more importance for the future. In other words: the problems of future transportation policy can only be solved with an overlapping examination of all transportation modes. The optimal use of the specific advantages of the diverse systems in economic as well as social terms also requires an adequate consideration of the different environmental impacts.

You have to take into consideration that the infrastructure of the railroad was almost completely built in the 19th century and neither has received any essential structural improvements nor any new constructions. Because of the long service life of the infrastructure, the long term effects of today's decisions for a railroad that lasts into the next century, and with the consideration of an increasing environmental awareness, it seems to be necessary not only to make short term observations but to think further into the future.

Where are the expectations and chances of the essential future uses of the railroad?

The major expectations from the railroad in the field of passenger transportation lay in the high speed transportation between the metropolitan and urban areas - especially with the use of the technological innovations.

Being supported from both politics and business, this is expressed through comments like: "The high speed rail network is a opportunity for Europe" or "The future for the railroad is high speed transportation". The Community of European Railways (UIC) bears this in mind with the concept of the European high speed rail

network. In this context several reasons lead to give importance to the cooperation between rail and air transportation.

In the field of freight transportation, the stagnation in bulk goods traffic and the decrease in volume of the classical single unit traffic face potential large scale growth for the transportation of high time value goods, the part-load traffic, the multi-modal traffic, and complete logistic concepts. It is remarkable that with the especially expansive potential of the cross-border traffic, the transportation distances also increase (a fact that makes it easier to use the specific advantages of rail transportation).

Therefore which market demands can be derived for the future railroad?

2. INFRASTRUCTURAL AND OPERATIONAL REQUIREMENTS

2.1. General Considerations

Consequently, this means for planning the infrastructure: the future development of the railroad should not be based on developmental concepts that are as old as the railroad itself. The key for the future is the increased use of the opportunities of innovation, containing the - improvement of the single components of guideways and vehicles and their integration, - improvement of the railroad as a whole in hard - and software, organization, operation control, communication and computer technology, as well as - intelligent planning in the use of the infrastructure, the thinking not only in discrete lines but in corridors in which the use of several lines together can be improved with the result of a significant increase of the capacity of the whole corridor. Hence, it seems to be necessary to think about the possibilities and limits of a future oriented rail system. For the future we need lines for high speed passenger trains as well as for fast freight trains carrying goods of high value. These lines must build up a complete national and European high speed rail network.

There is also a demand for an efficient freight rail network and this demand does not depend on the diverse national or relation based decision criteria for the use of high speed rail. This freight rail network can, but need not to be identical in all parts with the high speed network. Especially for routes with high passenger as well as freight traffic loads, it can be useful for economic as well as operational reasons to discriminate the trains in the corridor because of their speed and to dispatch a significant part of the freight trains over other than the high speed lines (and if necessary place higher improvement investments there). There, the freight traffic could also get a higher priority in scheduling and real operation during the day time than on mixed operation lines with high quality, phased passenger traffic, a fact that becomes more and more important.

High speed rail lines and the whole new network have a very long service life. A prognosis over such a long time period of how diverse technical and operational parameters will develop is only possible in a kind of rough projection. Hence, with the use of scenarios it seems to be useful to show the possible developments of the diverse options - aside from the demand development - and to examine the complex, future general rail system:

- Using scenarios for showing the development from the technical as well as operational point of view,
- alignment related to dynamics for new high speed lines from the technical and operational point of view depending on these scenarios,

- business and societal economical evaluation approaches following from these technical and operational examinations.

The expected developments in technology and organization are to be included in the scenarios with the goal to reach a high quality and quantity performance and to improve the use of the infrastructure and the rail system as a whole. And if I just mention some key points regarding technology potential obviously having a strong impact on the market opportunities, then it means with regard to the track superstructure, signal control technology, propulsion technique and operation:

- starting from the existing conditions with the crushed stone track superstructure, traditional train control with line leaders between the rails, classical engines and mixed operation of all kinds of trains.
- to the already foreseen possibilities that get their practical approval in the near future like tracks without ballast, radio train control, high engine power with GTO- and super conductor technology, MUs with powered single axles, tilting, demixing of train types regarding speed, and computer aided, integrated train operation and control, for example.

In accordance with a mid-term but absolutely realistic "vision" the future perspectives of possibilities being in development right now have to be shown, too. This includes for example the use of the linear induction motor for the rail system in the sections with acceleration/deceleration or steep gradients, single wheel suspension and powering; for the operational sector it includes the computer integrated train operation and control with the use of the innovations of the communication and computer technology as well as the flexible operation planning and the short range disposition, not only route but also corridor related.

2.2. Suggestions for the Planning of Future New Lines or Line Improvements.

2.2.1. Complete High Speed Rail Network

In previous plans of the new lines the attention was focused on the routes but not on the junctions. With continuous plans of new lines which inevitably have to pass big junctions the junctions have to become equal to the routes for the achievement of a connected high speed rail network in the heart of Europe. This consideration does of course not exclude the possibility of using existing or low standard infrastructure in sections for the high speed traffic for the short or middle term. When new lines are combined with improved existing lines, it should always be checked if the strategic aspect of the long term perspectives of the option to close the gap is guaranteed.

If not, a low speed section would be integrated in the high speed network that could never been corrected. It is necessary to examine with operational studies, the capacity of the (mostly complex and sensitive) areas of big junctions - especially in metropolitan areas. Also it has to be checked to the extent the existing infrastructure can fulfill the sophisticated future requirements in terms of quality. The early initiation of these studies seems to make sense since its results can have an important impact on the future planning of the new line, as it is shown by several examples.

2.2.2. Location of High Speed Line Stations in Metropolitan Areas

In the context of the possible capacity problems in the junction areas of large cities - especially where terminus stations exist - transportation engineers, urban and regional planners discuss the possibility of high speed trains passing the city business districts with a stop in the out skirts. It is obvious that the settlement and economic

structure is very important for these considerations. In Germany the settlement and economic structure is a partly different margin for the transportation service than in France, for example. High speed train stops being an alternative to the big existing junctions stations (the main stations located in the city business district) have in principle the same problems as airports: its realization would mean to combine the disadvantages of the railroad with the disadvantages of the aircraft. The chances of the railroad for long distance travels lie especially on the fast connection between the high density urban areas - for German domestic relations as well as for the connection with the adjacent countries. The direct access to the system (like the advertisement "Riding directly into the heart of the cities") as well as the network effect are also very important. This is true for both transfers in between long distance trains and regional and local trains (especially in metropolitan areas with rail rapid transit, light rail and bus). Therefore it is necessary to use this network effect in the interest of regional planning and transportation policy as well as the management of the railroad itself. The discussion of systematic stops of the high speed trains in the outskirts is only worthy if these stops are additional and if a considerable demand potential is developed. In this situation it is often possible to facilitate an easy access for the automobiles (freeway proximity), but it is almost impossible to find an adequate solution for public transportation. The main stations are for the most part the established main transfer stations of the whole public transportation system, where all long-distance and regional rail lines, the rail rapid transit lines, most of the light rail lines , and a multitude of bus lines are connected.

Considerations about this problem in several German cities show that high speed train stops in the outskirts would result in a significant worsening of the service and connection quality compared to the central main stations.

Also for Stuttgart as an example the regional center of a metropolitan area with a population of 2.5 million, only 10 - 20 % of the direct transfer possibilities would be preserved, for 80-90 % of the passengers several transfers would become necessary. This loss of attractiveness would be a disastrous misdevelopment of the urbanization and at the same time it would be a perversion of the high investments in the transit networks of rail rapid transit and light rail. Therefore it seems to be worthwhile to look for better solutions for this problem. One better solution for example can be the construction of a through station for the high speed traffic in the basement of the existing main station. A stop in the outskirts with freeway access can be considered in this situation as an addition but not as an alternative.

2.2.3. Addition of an Airport Stop to the High Speed Network

There are several reasons why politicians stress the importance of the future cooperation between the transportation modes rail and aviation. The integrated examination of rail and air transportation becomes more and more important, as the mobility in the medium-range air traffic grows, the airside capacity problems of the airports increase, and an appropriate task share between the airports takes place. An appropriate, attractive rail offer as an alternative to short-distance feeder flights is also desirable with regard to the environment. Therefore it seems to be reasonable to examine the rail connection of major airports - as a direct link or a special branch - in the view of the local conditions, while planning a new rail line and where ever possible at least to secure the option for a future connection. Over and above that, airport stations offer an additional access to the high speed rail network for the area (often with a good automobile access, too). (see paragraph 2.2.2)

2.2.4. Multitrack Line Expansion through Populated Areas or new Alignments for High Speed Lines far from Populated Areas

The possibility of a multitrack expansion and improvement of an existing line for high speed traffic depends as well on the geometric design standards of the existing line (these standards are in most cases limited by the topography and adapted to the ideas of speed of the 19th century) as on the adjacent land use. Housing and industrial developments often reach the tracks over long sections with the consequence that the adequate land necessary for the improvement is not available (especially if the increase of the maximal speed through higher geometric design standards is planned at the same time). Significant interferences with the existing development would be the consequence.

However, even if this is accepted, the achievable speed improvements obviously will have lower limits than a new line. There are complex problems for the affected cities and places regarding the regional policy, land development, urban development, and conservation. Which advantages do these place in a high density populated and industrialized area get from the multitrack line expansion? The only decisive fact for the population and economy of an area is its transportation development with local and regional trains as well as its connection with the major junctions of the long-distance traffic, but not the number of long-distance trains going straight through without any service tasks in this area.

Extensive noise protection measures become an inevitable consequence with regard to the environment. It must be emphasized that it is true that standard noise barriers decrease the noise level in these cases, but the demanded threshold cannot nearly be reached. Furthermore, there is the problem what it means with regard to the urban development, to increase the number of tracks from two to four with high noise barriers running through the places for many kilometers and the involved significant optical separation.

It has to be a trade-off between these considerations and the impacts of a new line far from populated areas. Here the attention is focused on problems of nature conservancy, land separation, etc. If you can manage to minimize the impacts on the environment by a combination with other transportation facilities for example with a freeway to a large degree (like it is planned or already realized for the new high speed line Cologne/Frankfurt and several TGV sections in France), then this seems to be an extremely interesting alternative. Though this has consequences for the geometric design standards: I will go into this in paragraph 2.2.5.

2.2.5. Demixing of Trains with different Speed Levels instead of mixed Operation - positive or negative for the Freight Traffic?

The combination of a new high speed rail line with a freeway automatically brings up the question about the maximum gradient. It is much more easier to fit with the alignment of the freeway if aside from the minimum horizontal radii this design parameter is also almost similar for both facilities. This is not compatible with the demand for all classes of heavy freight trains being able to use the new lines in low mountain ranges. In this case, the use of steeper gradients becomes appropriate. Gradients of 2.5 % up to 3.5 %, if necessary up to 4.0 %, instead of the limit for absolute mixed operation of 1.25 % seem to be useful.

Though, it is required for the use of these standards that other routes in the relevant traffic relation (corridor) are available. For these cases, the possibility to

dispatch different types of trains over the different corridor routes - including the discussed new line - have to be evaluated through adequate operational studies.

It is evident, that the highest line capacity is achieved, if all trains using this line have an almost similar speed level. The higher the speed differences (freight trains with 80 or 100 km/h compared to an ICE/TGV with 250 to 300 km/h for example), the less platoons of trains of the same class can be formed, the lower is the line output. The increasing phasing of the high quality long-distance traffic - and over and above the possible overlying of other phased traffic on the line - aggravate this situation. The consequence is that already slight deviations from the scheduled operation result in an inevitable fast increase of the delays of lower category trains.

At this point the question about the optimum freight train operation geared to market requirements becomes particularly important. The quality of the offered transportation output will play an important part for the future freight traffic in the competition between the different modes. Under consideration that the market is particularly growing for goods of high value, the part-load traffic, and the inter-modal traffic, and that the market researcher talk about a rail potential in the growing market that is to 2/3 cross border traffic, then the following expectations and conclusions can be derived:

- the distances for the freight transportation will grow, especially for high value products (a fact that makes it easier to use the specific rail advantages),
- higher freight transportation output must be produced for the longer distances (especially for cross-border traffic as a result of the European opening) during the daytime, - therefore it becomes more than ever important to offer enough slots for the freight traffic also during the operation time of the passenger traffic and to guarantee them with a high degree of punctuality.

But this demand often cannot be met for mixed operation lines working closely to capacity on which all classes of trains should operate. Because even if special freight trains got a significant higher priority in the schedule than today and therefore received slots geared to market requirements, already in the case of slight schedule deviations it would become necessary under real operation conditions to give delayed high quality passenger trains priority, because otherwise their level of quality would rapidly fall and they would not be competitive anymore. The more phased schedules are overlaid and the higher the speed differences between the types of trains, the more critical this situation becomes. As a consequence, it is to be checked and also weighed up under future aspects to what extent the demixing of the different types of trains in the respective corridor has significant advantages under the existing conditions and with the use - of the new high speed line for fast long-distance passenger traffic and high value, fast light freight traffic, - of the existing lines for the lower category long-distance passenger traffic (as far as it has service tasks on these lines), regional and local traffic, as well as the remaining freight traffic (also compare with preceding paragraph 2.1)

2.3. Consequences for Infrastructure Plans within the Framework of the German Transportation Union

From these considerations the following recommendations can be deduced for All-German plans in particular, as well as for Central Europe in general.

The planning of high speed lines must be based on a conclusive, complete network concept. It is then useful to look at whole corridors from the very beginning. These examinations should check the possibility and usefulness of demixing trains of

different categories regarding several available lines of the corridor relation. A view on the geographic map of the All-German major rail lines in the context of a European rail network almost forces to such considerations in some areas: In a lot of relations where a new line is being planned, several old lines are available that - after some, but also possibly major investments - probably offer much more flexibility and quality for the freight traffic than new lines with mixed operation.

The development and service of large cities with high speed traffic should consider in an adequate way as well the central location of the main stations in the central business districts as their importance as a comprehensive junction.

The direct connection of airports with the high speed network is a very important and interesting challenge. It is important because of the connection of the airports with each other as well as more and more cooperation between rail and aviation.

For the freight transportation, the attention for the planning is to be focused especially on the multi-modal traffic and the logistic concepts. Freight distribution centers that will be new constructed should have, wherever possible, good access to the rail as well as to the road network. The construction of freight distribution centers that have only road access should be avoided, if possible.

In the sense of an economically useful task share between the transportation modes it is to be checked where these facilities also can be built as a combination of road - rail - waterway.

3. FINAL CONSIDERATION

Only a rail infrastructure conforming with the quality demands of the European competition can in the long term fulfill the expectations people have from the European unification. Because of the central location of our country, the German network in this case has a high significance for the north-west-traffic as well as for the east-west-traffic, while the "bridge - function" to our Easteuropean neighbors has to get a special position.

Also in transportation, the importance of socioeconomic tasks becomes clear against the background of changing moral concepts of the population. Aside from the individual desire for increasing prosperity resulting in increasing mobility requirements, the concern of the protection and conservation of a natural environment becomes more and more important.

The advantages of the railroad; low air and noise pollution, low energy consumption with an appropriate capacity utilization, low land use, and a high safety standard correspondingly have to be utilized to a higher degree while sharing the tasks of transportation. Accordingly, they also have to be included into socioeconomic evaluations.

Though independent from the above, it will be more than necessary to fit the operation of the railroad in passenger and freight transportation to the structural changed market requirements. This is a continuous process since the obligation for innovation will further raise in the field of technology as well as operation/organisation. This is a big challenge but also a big opportunity for the system "railroad".