PROJECT OUTLINE FOR A FAMILY OF "INTELLIGENT" RAILCARS
A RENAISSANCE OF THE RAILROAD IN NORTH AMERICA?

Will Uncle Sam travel by train again?

What do the passenger trains of "Old Europe" have to do with the United States of America, the country of car drivers and air passengers, of the mobile individualists? Almost nothing at first glance, at second glance quite a lot. All the more so if one thinks of the enormous opportunities for the USA hidden in the railroads to be the "railroad country of tomorrow". After all

– *the US railroads sum up to approx. 230,000 network kilometers, this is by far the vastest railroad infrastructure of one single state worldwide; the USA offers about one running kilometer of railroad network per 1,300 inhabitants; for comparison - in Germany one running kilometer has to suffice for about 2,300 inhabitants*

– *the US freight trains yield a major part of the worldwide railroad traffic output; each of the "Big Six" (including the two Canadian companies that also operate in the USA, these are Burlington Northern Santa Fé, Canadian National, Canadian Pacific, CSX System, Norfolk Sothern and Union Pacific) reaches the magnitude order of DB AG or SNCF with reard to network length and turnover;*

– *public transport in Manhattan (which is in itself a big city) achieves a modal share that many European metropolises can only dream of;*

– *the newly constructed railroad public transport systems in many American cities enjoy great popularity and increasing numbers of passengers;*

– *the German model for local passenger traffic on railroads, the "Karlsruher Modell" (integration of the suburban trains and the innerurban tramways in one technical operative system) has been adopted from the "Redliners" in San Diego;*

– *Vice-President Joe Biden is a self-confessed train passenger and holds a protective hand over Amtrak – a model for many US citizens who desire a "change"?*

In fact America is a railroad country already today. However, qualified passenger transport on railroads has been developed only in certain areas and halfheartedly up to now. This might change.

Where America is the most similar to Europe and Japan

Also in future people will obviously travel from New York to Los Angeles by aircraft. Long-distance trains such as the "California Zephyr" (Chicago – Oakland) will in future be important only for traveling individualists.

However, there is a region in the USA whose settlement structure is comparable to France, Germany or Japan (homes of TGV, ICE resp. Shinkansen), i.e. the four-city area of Boston – Washington – St. Louis – Milwaukee (BWLM):

– *The four-city area BWLM corresponds to the four-city area of Hamburg – Munich – Barcelona – Bordeaux; the relation Boston – St. Louis corresponds to the entire Shinkansen route Sapporo – Kagoshima.*

- *The Amtrak northeast corridor Boston – New York – Philadelphia – Baltimore – Washington – corresponds to the stretch Hamburg – Rhine/Ruhr area – Rhine/Main area – Rhine/Neckar area – Stuttgart and Tokyo – Nagoya – Kyoto – Osaka/Kobe – Hiroshima.*

- *The relations Chicago – Detroit or Cleveland – Pittsburgh – Washington/Baltimore correspond to the Eurostar route London – Paris, the ICE route Cologne – Berlin and the Shinkansen trunk route Tokyo – Osaka.*

- *The tri-city area of Indianapolis – Louisville – Cincinnati approximates the tri-city area of Stuttgart – Munich – Nuremberg.*

- *The relation Buffalo – Cleveland approximates the routes Hamburg – Berlin, Frankfurt/Main – Munich and Tokyo – Nagoya.*

- *The relation Indianapolis – Dayton corresponds to the routes Cologne – Frankfurt/Main and Nagoya – Osaka/Kobe.*

- *The relation Dayton – Columbus approximates the routes Hamburg – Hannover and Nagoya – Kyoto.*

If one includes the Canadian "corridor" (Detroit-) Windsor – London – Toronto – Ottawa – Montreal – Quebec, about 120 million people live on a surface the size of France, the Benelux and Germany combined, just as many as in Japan.

Following the European and Japanese example, a major part of long-distance passenger traffic can be transferred from the roads and the air onto the railroads in the BWLM area, the more so as air traffic reached its limits there long ago. This requires long-distance passenger transport on railroads which complies with the TGV, ICE or Shinkansen standard. Double as fast as the car, half as fast as the aircraft, many distances can then be covered within a few hours, many big cities then are less than one hour apart. For the long-distance route New York – Chicago it is possible to crack the eight-hour limit.

For this purpose the single routes discussed up to now, such as Chicago – Milwaukee / – St. Louis / – Detroit are insufficient, since they only constitute connections from point to point and do not exhaust the passenger potentials which could be attained in the BWLM area. In fact it is necessary to construct a dense high-speed railroad network.

The northeast corridor which is to be included in the high-speed network has to be further expanded. The Acela railcar train-sets, that derive from the TGV and travel at approx. 110 km/h schedule speed on the Boston – New York route and at approx. 130 km/h on the New York – Washington route remain far below the high-speed standard, although their top speed is 240 km/h. Since the old New York Central route via Albany and Buffalo is too circuitous for being an attractive connection between the northeast corridor and the western centers, especially around the Ohio, it might be convenient to consider crossing the Appalaches in the axis of Cleveland/ Columbus – Pittsburgh – Washington/Baltimore.

The high-speed network in the BWLM area comprises a length of about 6,000 – 7,000 km, including the Canadian "corridor" it is 8,000 to 9,000 km long. This equates the TGV and the ICE network combined and is three times as long as the Shinkansen network.

When it is about high-speed railroad traffic, the USA knows best

TGV? ICE? Shinkansen? Transrapid? Maglev? These European and Japanese models are not really useful for the USA, since all of them are too expensive which is due to their expensive track systems.

A newly built ICE track gobbles up 20 – 25 million € / running km (in case of assumed €/$ purchasing power parity therefore 20 – 25 million $ / running km), approximately the same amount as a Shinkansen track. A TGV track still costs 10 – 15 million $ / running km. Transrapid and Maglev tracks are even more expensive, as a part of the traction motors is located in the route. For European and Japanese railroad systems, the track systems account for 80 – 90 % of the invested capital, the trains only for 10 – 20 %.

So America should avoid the errors committed by Europe and Japan and develop its own solution for its high-speed system. For this purpose it can recollect the best traditions of its rail freight companies, the only railroad traffic model in the world operating without subsidies. In contrast thereto all European and Japanese railroad companies are highly subsidized, for example the DB AG by 20 – 25 billion $ /year. What are the reasons thereof?

On the one hand, the USA has ever had "state-owned railroad companies", except for Amtrak, the Conrail episode and special regulations during the World Wars. Instead private companies have always competed with each other that each had their own railroad infrastructures. For US railroad companies, the cost expenditure for the track system has been and is a competitive factor that necessitates continual increase of efficiency. For European railroad companies, the cost expenditure for infrastructure only plays a minor role, since they can rely on subsidies from the governments. There has never been a pressure to increase efficiency.

On the other hand the major traffic axes of the US railroad companies came up against a topographical obstacle, i. e. the Appalaches, at an early stage. For financial reasons, expensive line routing mit long tunnels, high viaducts, deep cuttings and high dams was out of the question. In fact the routes had to be adapted to the Appalachian topography in an optimal way.

This required "intelligent" rolling stock permitting narrow curve ratings, big longitudinal inclinations and thus "flexible" line routing parameters. As many driving axles as possible with optimum mobility were required. Right from the start, America was the first country where pivoted bogies, pneumatic brakes and pivoted steam engines were implemented. The final breakthrough occurred at the end of the 1930s, when the former GM affiliate EMD offered multi-part diesel-electric engines that had exclusively driving axles in their pivoted bogies. Four-part units had 16 driving axles compared to 8 maximum for the biggest pivot joint steam engines.

<u>A family of "intelligent" railcars for cost-effective track systems</u>

If the USA does not want to be content with very heavy, slow freight traffic, the "intelligent" conception of the infrastructure, operation and rolling stock of its freight trains has to be transferred to the long-distance, regional and local passenger railroad traffic. In practice this means:

– *Also in future operation with diesel-electric drives in order to avoid expensive overhead contact lines, but considerably higher specific outputs, i.e. for railcar train-sets at least 20, better 25 HP per gross ton of train (about ICE 3 standard), for traction engines at least 50, better 60 HP per gross ton of locomotive;*

  Both means a world record – although diesel-hydraulic engines with comparable power density had been engineered and constructed in France in the mid-sixties and in Germany at the beginning of the eighties; with highly supercharged diesel engines, the latest AC traction technology and consistent lightweight construction it should be possible to outperform which was possible already more than 25 years ago;

  Such specific outputs ensure top speeds of 300 – 350 km/h and high balancing speeds at drags; these help to reaccelerate quickly after intermediate stops, thus limiting extended travel times;

– *Active tilting technology for railcar trains-sets, especially for those in the high-speed segment, that way curve ratings can be minimized for new resp. upgraded lines, which helps to adapt such routes more flexibly to the existing topography or to converge them better with the existing traffic routes.*

– *All-axle resp. mluti-axle drives for railcar train-sets, thus big ascending and downward slopes can be managed (for adhesion railroads up to 7 % is technically feasible); the biggest longitudinal inclinations possible as well as the smallest curve ratings possible are prerequisites for route linings adapted to the topography in an optimal way;*

– *Wireless, i.e. radio- or satellite-based signaling and control; so expensive line installations for railroad traffic safety and override can be dispensed with; this technology has been operating in Canada since the 1970s and is meanwhile used all over North America.*

Such “intelligent” railcars permit reducing the cost for track systems considerably. A new high-speed route which only consists of railroad ballast, crossties, rails and nothing else, which hardly deflects from the natural terrain, is available for 4 – 6 million $ / running kim. Compared to a ICE or Shinkansen route, this saves up to 80 % of the building cost, compared to a TGV route it still saves up to 60 %.

But neither in Europe nor in Japan there is such “intelligent” rolling stock available – an excellent opportunity fro the USA to develop these itself. For North American manufacturers are world leaders on the market for big diesel engines already today. So these manufacturers as well as supliers all over the world have the chance to move beyond the narrow segment of “freight diesel engines” and to configurate a much bigger family of “intelligent” railcars, consisting of

– *a high-speed railcar train-set with tilting technology for 300 – 350 km/h top speed,*

– *trainsets for local and regional passenger traffic of various overall lengths with and without tilting technology and for at least 160 km/h top speed,*

– *a multi-purpose diesel engine with 7,000 – 7,500 HP gross from a total service weight of 120 – 130 tons and more and for at least 160 km/h top speed.*

In contrast to America, mixed service is dominating globally, comprising local, regional and long-distance passenger traffic and freight traffic; therefore high-speed trains become more and more important. If this family of railcars includes freight diesel engines of North American origin, it can comply with any railroad traffic challenges in the USA and the whole world.

Zero CO2 emission and diesel engines do not exclude each other

The whole world wants climate protection and requests electric vehicles. Is the diesel engine still suitable for this brave new CO2-free era?

Counterquestion: What does electric traction have to do with CO2 prevention – if nobody knows where the electricity is coming from?

Diesel engines may also operated with biodiesel. Obviously fuel must not generated in the form of ethanol from corn as is currently usual in the USA. Since the use of plants which serve for food production is not ethically justifiable. Moreover the energy density of ethanol is too low in comparison with biodiesel.

Therefore it is more intelligent to generate biodiesel from waste materials produced in agriculture and forestry. Interesting model experiments are being carried out worldwide for this purpose. So the USA should transfer these promising beginnings to the big industry scale, thereby organizing a totally new added value chain, creating a lot of new jobs in its own country and maybe even becoming an important exporter of biodiesel.

In the medium to long term, the price of biodiesel will become competitive to the price of mineral oil diesel. Moreover diesel engines can be adapted "continuously" from conventional fuel to fuel generated without emission of CO2. In any case climate protection does not require a new traction technology with its own expensive background infrastructure.

Amtrak will become a big railroad company

Currently the state-owned US railroad company for long-distance passenger traffic transports about 25 million passengers per year, this equates approx. a fifth of the DB Reise & Touristik AG figures. If Amtrak operates a high-speed railroad network comprising several thousand km (possibly in cooperation with the Canadian VIA Rail) and each BWLM inhabitant uses the super fast trains only six times a year (three round trips each), Amtrak will come up to 600 millon passengers, in cooperation with VIA Rail to 700 – 800 million passengers. Even for this defensive estimate this is five or six times the figures of DB Reise & Touristik AG, corresponding to a third of the total volume of DB AG passenger traffic and will in the best case only be exceeded by one of the big Shinkansen companies.

By using "intelligent" railcars the high-speed railroad network can be realized cost-effectively for 5 million $ / running km on average; so this requires an investment of 30 – 35 billion $ (40 – 45 billion $ including the Canadian corridor) distributed over several years. Crossing the Appalaches is the most expensive and challenging section with regard to line routing technology. But 150 – 200 km through the Appalaches are hardly an issue with regard to several thousand km of overall length. Moreover the design speed can be adaorro 250 km/h does have a considerable impact on the construction cost, but affects the travel times only in the range of 15 minutes.

A first pilot survey of some Appalachian express highways showed that a high-speed railraod route can be converged with regard to line routing quite well with these, which would permit top speeds for tilting trains in the range of 150 km/h after all. That way a non-stop journey time of two and a half hours can be attained for the route Washinton/Baltimore – Pittsburgh.

In all likelihood the high-speed railroad network outlined in this manner does not even require subsidiaries by the US government on a continuing basis. A kind of stimulus funding might be sufficient. Since in case of a reasonable tariff for route usage per km covered by train, already a capacity utilization in one-hour intervals will bring in the depreciations on replacement and maintenance. With every additional train run the high-speed railroad network will really make money.

In case of ICE line routing usage, however, the estimate would have to be 120 – 140 billion $ only for the Amtrak network, including the supplementary VIA Rail network this would be 160 – 180 billion $. With due respect of Keynesiansm which with regard to the current economic crisis is also running rampant in the USA, these amounts would not be affordable.

The promotion of Amtrak to a "big" railroad company that does not own only a few hundred km, but several thousand of cost-effectively built routes would create the prerequisites for full privatization. The "New Amtrak" could become negotiable like the US or Canadian rail freight companies. With a high-speed railroad network like TGV, ICE or Shinkansen, Amtrak and VIA Rail would never become negotiable, but would permanently depend on the government.

The "New Amtrak" can help to revive the downtown of many American cities. It boosts the "New Urbanism" movement. Also the USA has discovered the convenience of the city with its short distances (sidewalks and bikeways). The Union Station and its surroundings are becoming "good addresses" again. New (relief) cities could develop at intermediate stops in the high-speed railroad network – obviously also in the spirit of "New Urbanism".

The US railroad model becomes a global export success

Viewed globally, the golden era of the railroad is yet to come. Like no other means of ground transport the railraod achieves maximum transport capacity on minimal track system cross sections with minimal energy consumption even at maximum speeds. In the era of global urbanization and climate change the railroad is the ideal solution for traffic problems.

It would not be surprising, if in the next 30 years as many railroad lines were built as in the past 170 years up to today. This requires a lot of rolling stock. However, all this will only become reality, if railroad traffic is available at low cost. Which model will come out on top globally in the long term:

– *De-facto state-owned railroad companies like in Europe, which depend on government subsidies, are deep in debt, marginal on the market and vertically separated?*

– *Or commercially independent, private railroad companies like in the USA with cost-effective track systems, which dominate the market and are vertically integrated?*

The appointed manufacturer of the family of "intelligent" railcars and Amtrak as operator of the complementary high-speed railroad network can market their concept internationally as soon as success will have been proven in the BWLM area. The first should have an interest to see that for new railroad projects the capital is not invested in concrete, tunnels or bridges, but in rolling stock. Amtrak becomes "Amtrak International" – is it allowed to say "PanAmTrak"?

The global railroad market is enormous, annual turnover in the range of three-figure billion $ figures is realistic, since the waves of first investments and replacement overlap in the medium and long term. Initially continuos increase of demand ist to expected over several decades.

To this, only three small examples from "Old Europe":

– *For years the new development of a high-speed railroad route from London to Scotland has been deliberated in Great Britain. This project can be built and operated economically with the railroad model outlined here. The journey times London – Glasgow/Edinburgh are reduced from 4 ½ hours today to less than three hours*

– *For the same duration of time a transalpine basis tunnel has been discussed on the Brenner axis from Austria to Italy. This giant project has not gone beyond some geological probings. Following the example of the crossing of the Appalaches, a new high-speed summit level railroad route can be built for a fraction of the cost for building a tunnel. Parallely the existing Brenner railroad can be used for local and regional passenger traffic and in particular for European heavy-cargo traffic. On this, the US rail freight companies could serve as examples.*

– *The Baltic States request (train) connections to Central Europe. Indeed Estonia, Latvia and Lithuania are in the EU. But with regard to railroad technology they are still being dominated by their Russian neighbor – for instance in view of track width (1524 mm compared to 1435 mm in Central Europe and North America). Insofar the Baltic States are certainly interested in an efficient and simultaneously affordable new railroad system.*

But the really big railroads are realized in other places, such as China and India. If both countries wanted to offer their inhabitants only rudimentally the same high-speed railroad network standard as Europe does with the TGV and ICE and Japan with the Shinkansen or as the USA maybe intend to do in the BWLM area, high-speed railroad networks of at least 20,000 km each would have to be constructed in both countries. The demand for "normal" new and upgraded railroad lines for mixed service is even much bigger. All in all a giant market for the "intelligent" railcar family.

If the supplier of “intelligent” railcars and Amtrak cooperate and present themselves offensively on these markets, their European resp. Japanese competitors will be in a difficult situation. Since the winner of the race will be the supplier of the most cost-effective collective railroad system. And this can be America – why not? It may still sound exotic:

– *The USA can become global leaders in all fields of railroad systems.*

– *The USA can create the world market for railroads themselves.*

– *The USA can develop railroads to become its new cash cow, bringing in foreign currency.*

They only have to want this.

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