

1 THE RAIL IN EUROPE AT PRESENT

When taking a look at the European panorama it is easy to realise in how far the state railways were national. Country and railway borders are the same except where neighbour countries share an agreement and technical compatibility. The ghost of the old national railways is still present in all countries [1], and just some of them hold private enterprises attempting to take part in the game. On the other hand, the need for international connections was soon answered with the standardisation of important elements like buffers or wagon dimensions, and the cooperation between railways; certainly a way full of obstacles. As a result it is possible to travel and send freight across Europe today and there will be more trains crossing borders at high speed soon.

Unfortunately, the decades of uncompetitive operation and insufficient investments led to the loss of transport shares, allowing inefficient and more polluting alternative modes to become the leaders of the transport sector, whilst tax payers keep on financing the construction and operation of infrastructures that they rarely can afford to use.

1.1 Systems and operation

Today's technical systems in use are different from country to country. The possible combinations of power supplies, gauges, control and signalling systems care for it. Furthermore, the different rolling stocks and the organisational and operational schemes add more obstacles to an already complex scenario.

1.1.1 Gauge

The variety of possible uses of rail gave birth to a wide number of different gauges in Europe, most of them for mining or local services, especially in mountainous areas. Concerning national nets (see figure 1-1) the influence of countries like the UK, at that time technically more advanced than the rest, on building the first lines in many other countries and the "Technical Unity" was decisive in spreading the use of the 1435 mm standard gauge. Nevertheless, as a result of technical ambition and national politics, Russia and Spain decided to build wider gauges. Portugal did not have any other chance than meeting its neighbour's gauge to avoid isolation.

The consequences showed up in the fact that vehicles could not cross certain frontiers. But the need for international connections demanded a solution where two different gauges met. The answer given for passenger services was, until the arrival of the multi-gauge Talgos, transferring from train to train. The solution for freight trains was transferring the load or, after developing the necessary vehicles, changing axles of all wagons. In both cases the measures adopted have proven inefficient, time wasting and annoying. The overall result until the present day is a loss of reliability and capacity, an increase in costs and a lower average speed.

Nowadays, the implementation of solutions turns into a political decision and has considerable costs. Such is the case of the automatic gauge change system, for there is population depending on the transfer points and the price of the pool of multi-gauge wagons needed is very high. Reconstructing the network to international gauge is out of the question for the advantages would hardly pay the costs.

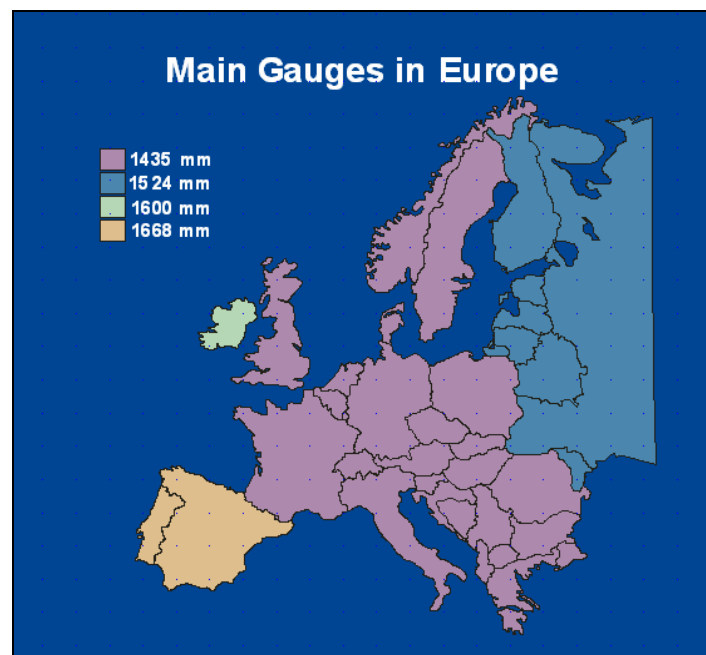


Figure 1-1: Main gauges in Europe. Source: DB AG

Regarding the circulation of the trains there are also differences. In Netherlands, Denmark, Germany, Poland, Czech Republic, Austria (80%) and Russia among others, trains advance over the right track whereas in UK, Belgium, France, Sweden, Switzerland, Austria (20%) and Italy they do it on the left one. This fact is of no further importance since trains can be easily driven to the other track, but it also reflects the lack of consensus between operators.

1.1.2 Power supply

As electrical locomotives were introduced, available engines worked with direct current only. Consequently, the first rail power networks supplied DC. But owing to lower loss rates in transport of electricity, national distribution nets preferred supplying alternating current at 50 Hz. The technical knowledge at the time was not able to dominate the conversion from this frequency to direct current, but it could be done from 16.2/3 Hz, which is exactly one third of 50. Therefore, a simple transformer between distribution net and rail net was necessary and so the first of today's main AC systems were established.

Other countries were later interested in using alternate electrical power supply too, but at that time conversion from 50 Hz to direct current was not a problem anymore. Therefore, initial technical circumstances, among others, led to the use of different electrical systems. At present the most common ones are:

- DC: 1,5 kV and 3 kV
- AC: 15 kV at 16.2/3 Hz and 25 kV at 50 Hz

Some countries decided to electrify their networks according to their neighbour's already established system, as to avoid incompatibilities (Sweden-Norway, Germany-Switzerland-Austria, etc.). On the other hand, Denmark decided to electrify its rail network in the nineteen eighties using 25 kV / 50 Hz when all its neighbours were using 15 kV / 16.2/3 Hz, thus isolating himself whilst contradictorily funding the construction of the Oresund bridge to make freight transport faster and easier [2]. Figure 1-2 shows the actual situation regarding the main electrical systems in use. High-speed lines are usually fed with AC, since the power requirements are higher. Therefore, in Spain, the South of France and Italy for example, the power networks are not entirely DC.

The configuration of networks and the increasing need for international traffic demanded the development of electrical multi-system locomotives, for both high-speed trains and conventional trains, to make the traffic faster, easier and more reliable. Modifying the electrical system of certain countries to a unique standard one was studied, but turned out to be a far more expensive solution. Today, using a fully compatible locomotive is just a matter of costs: a locomotive compatible with both alternating current systems costs as much as one built for a single AC-system, whereas one compatible also with direct current is a 20% more expensive [3]. The price difference restricts the availability of multi-system locomotives, sets additional difficulties to the planning of the operations and has final consequences on the market prices.

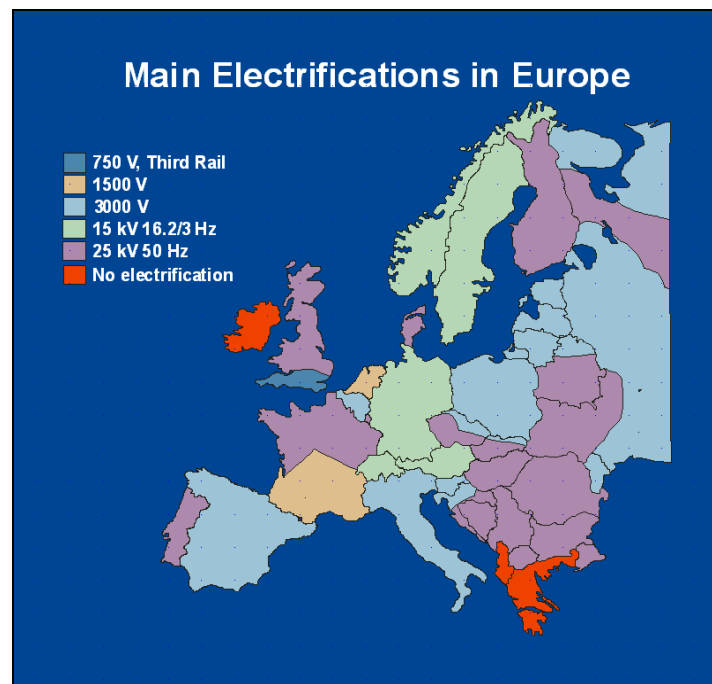


Figure 1-2: Main electrifications in Europe. Source: [4]

But for the use of the efficient non-polluting electrical locomotives, tracks must be electrified. As listed in annex 1, the degree of electrification reaches a high level (70 to 80%) only in small and densely populated countries like Luxembourg or the Netherlands or in those with high environmental sensitiveness like Sweden. In total, almost half the lines in the western European countries are electrified.

1.1.3 Control systems

Signalling, control and protection systems are a case similar to the previous one. State railways developed or imported solutions investing on each of them great amounts of public funds, but not taking into account the international traffic. The variety of national signals and rules make it impossible for a driver to work across Europe, whereas the different signal or position transmission devices restrict the utilization of locomotives (figure 1-3). This situation frequently forces the operators to change drivers and locomotives at borders. For the services where travel time is more important, namely for passenger trains, installing the different control equipments on those locomotives and self-powered trains travelling abroad or equipping tracks with different control systems, are more interesting options. In all cases, the result of the present complexity is a multiplication of investment, training and maintenance costs. The limitation of traffic capacity and

reliability, especially on the routes where locomotives or drivers must be changed more than once, is also to be considered.

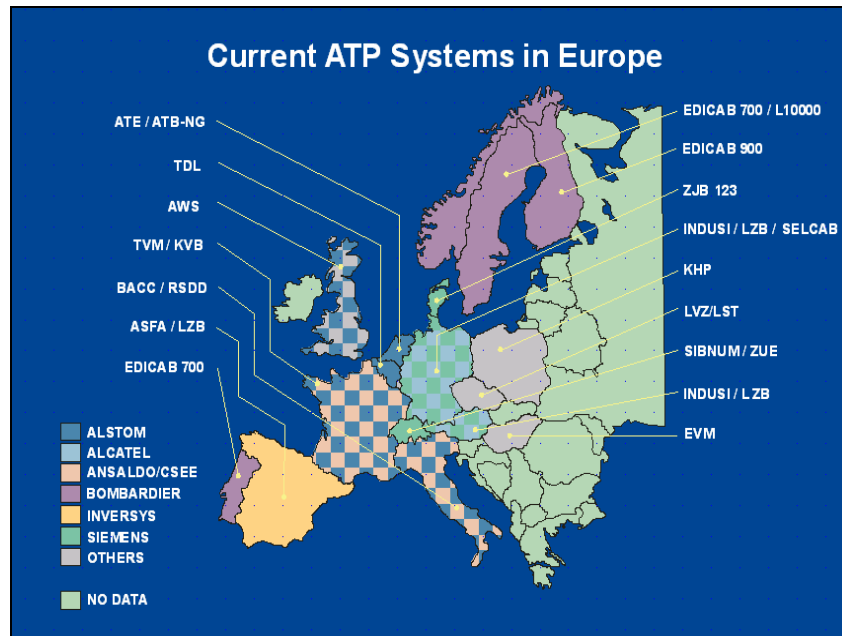


Figure 1-3: Current ATP systems in Europe. Source: ERTMS & [4]

The ideal solution, a unique combination of signalling, protection and control systems, collides with the interests of railways and operators. The opposition to gradually change expensive but already good working systems for new ones, with all the difficulties involved is comprehensible, and changing the procedures that staffs have been carrying out for years is, besides expensive, difficult.

1.1.4 Rolling stock

Another consequence of independent development is the variety of rolling stock. Particularly in the case of passenger transport, major railways designed their coaches and private enterprises built them (except the successful coach designed by the UIC that was used by many railways on their main lines). A change to this working pattern arrived with the newest high speed trains, designed and built by private enterprises (Talga 350, ICE 3), but this alternative has not solved the main problem: resources are being invested in parallel expensive designs that have a reduced market, which translates into hardly profitable investments and higher production and maintenance costs.

On the other hand, not few railway companies hold vehicle pools characterised by diversity that augment maintenance costs and planning complexity.

Although the UIC publishes standards to avoid incompatibilities, every country has its own norms. In the end different rolling stock fulfils different requirements and this becomes an obstacle when permission to roll must be granted to foreign material and, at the same time, raises its cost. Furthermore, network operators take advantage of this obstacle to favour national railways, thus preventing competence and better quality rail services. Unique European guidelines for certification and testing would be very useful to promote multilateral acceptance of material certificates.

Regarding the performances of the rolling stock many aspects need to be improved, especially in the case of freight wagons for they are generally obsolete [5]. Major items to work on are noise reduction, maintenance (cost and time), interoperability and new designs of containers to suite even better the requirements of the market.

1.1.5 Use of networks

Although private investors were the promoters of the first rail lines, the logistic importance these infrastructures acquired for military purposes turned them into a subject of national interest and states continued then expanding the networks. In this context, the increasing need for public passenger transport developed urban tramways and underground, regional and main-line services. Railway companies and infrastructure operators grew as two faces of a single state enterprise enjoying a monopoly with a clear national orientation. A relation of the different companies and their main features is shown in annex 1.

Until the present day operators have protected the national railways by giving priority to own trains and by setting initial difficulties for foreign trains to roll (as mentioned in 1.1.4.), to get a slot in a route and to use the best available tracks, etc. Furthermore, the owner of the train does not have any influence on the operation but he is responsible for the whole service towards his client. These obstacles relegate foreign companies to a secondary position and reduce the attractiveness of their products and its competitiveness.

In spite of this behaviour, favourable for state railways, there are also national private companies in the scene. Their overall presence in the market is small at the moment owing to conditions being very restrictive [6], although in a country like Germany, which is the leader in the liberalization of the market, their number is already noticeable. But, even though most of the private trains just run regionally or within state borders, some of the private

freight trains do cross frontiers. And there are even plans in development for international passenger high-speed services [7]. So far, their products already prove interesting and innovative.

To provide the rail system with the degree of competition needed, network operation and train services must be separated [8]. Punctuality and reliability, as they are the cornerstones of logistics, must be set as a standard and the offer has to be completed with a logistic service around the rail that optimises the transport and focuses on the clients needs.

1.1.6 Other difficulties

There are other important factors affecting international connections; one of them is information among railways. Particularly in the case of freight transport information systems are underdeveloped and so, telling a client where his shipment is, turns out to be almost impossible. For the railway company it is also difficult to know where its abroad-deployed wagons are, owing to the lack of communication and cooperation. Despite the advantages of modern GPS position transmitting systems on board of wagons, they are so far little used and number plate based research is the standard procedure [3]. Standardisation of data structure, exchange and use is needed.

Also in passenger services is information important. Fully informed staff at all times (connections, times, delays and other abnormal situations) able to communicate in different languages and multi-language signalling are demanded.

Another obstacle perceived by clients is tariffs. Different prices for the same services as well as different discounts and conditions result in a complicated purchase with lack of transparency when travelling abroad or ordering a shipment. Also information about prices of services in foreign countries is often disappointing. Therefore a unitary price system where users do not get lost and a European catalogue for prices would be very helpful to avoid clients choosing other ways of transport. And at the same time, one-face-to-the-customer selling would attract clients.

Regarding railways, serving passengers or freight, part of their problems is caused by the differences among the infrastructure operators. Their different management and the organisational and administrative schemes, culture and resources complicate their necessary coordination and communication. The various safety rules and procedures require the consequent formation of the personnel travelling.

1.2 INTERNATIONAL ROUTES

In the difficult context that the previous sections have described, international routes were established. State railways generally offered links with conventional material, changing locomotives where necessary, with a low performance regarding speed. Such slow long-distance services can hardly compete with airlines and coaches; therefore high-tech was put on service to improve some of the lines. The main international passenger services on duty with a high performance are products of one or more state railways:

- Thalys: France – Belgium – Holland / Germany (high-speed).
- Eurostar: London– Paris / Brussels (high-speed).
- Cisalpino: Stuttgart – Milano – Florence, Geneva / Basel – Milano – Venice.
- ICE International: Germany – Holland / Belgium (high-speed).
- TEE Rail Alliance: Germany – Switzerland – Austria (alliance of state railways to offer better prices on across-border journeys).
- Linx: Stockholm – Oslo – Göteborg – Malmö – Kobenhavn (high-speed).
- Berlin-Warsaw-Express.

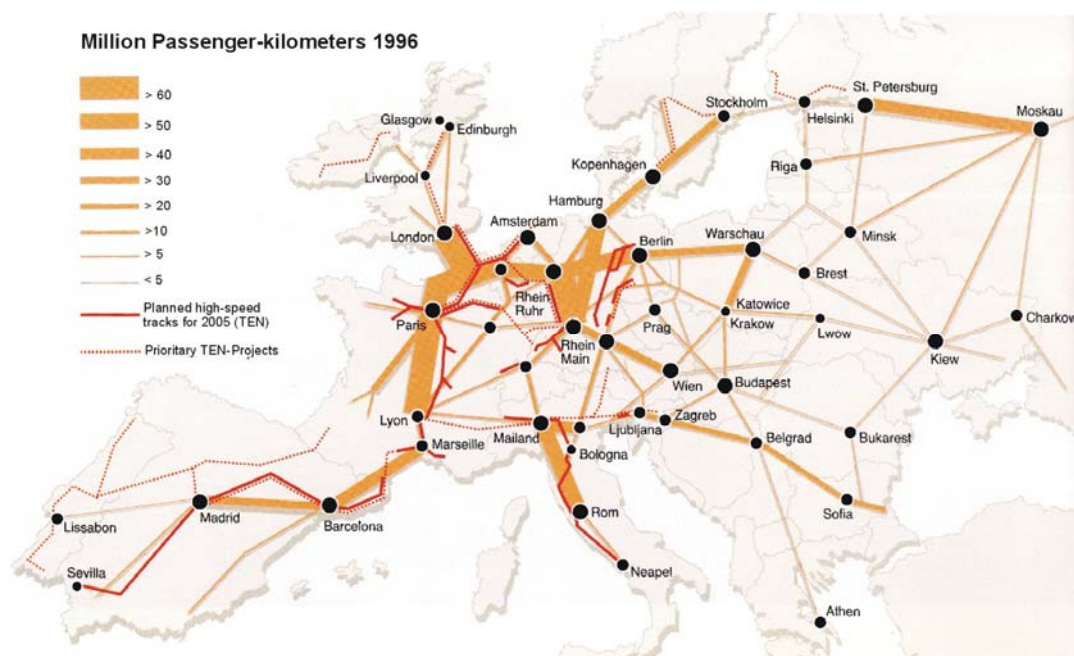


Figure 1-4: Passenger-kilometre flows in Europe 1996.
Source: UIC and EU DG VII in [9].

The main corridors for passengers crossing borders can be obtained from the overall performance of the existing lines, as shown in figure 1-4. However, more similar services and the completion of high-speed lines are required in Europe to link the still isolated areas to the high-speed network and to take the most possible advantage of the lines.

Rail freight transport finds in international routes its best performance for it is very suitable for large volumes over long distances [10]. Since European external trade is carried out mainly by sea, around 71% [11], the main routes cross the continent from big harbours like Rotterdam and Hamburg to Austria and the north of Italy. But bottlenecks, insufficient capacity of the infrastructure, costs and bad coordination and communication between operators among other reasons set limits to the freight transport. To overcome these, priority ways with specific standards must be set with low cost and high efficiency, during all day. But since the cost of infrastructure is always high, the focus must be, initially at least, at optimising rather than at building lines.

With the opening of the European market to eastern countries, the need for transport capacity will be greater and the main corridors will slide to the east. Therefore an improvement of the western and eastern infrastructures and operations is a “*conditio sine qua non*” for a sustainable future transport in Europe.

1.3 FIGURES

So as to have an objective point of view of the situation and the evolution of railways in Europe it is necessary to take figures into account. They reveal that the frame has changed. In the period from 1990 to 1999 the length of tracks has decreased in the European Union from 160.000 km to 153.600 km and in the eastern European countries from 69.000 to 65.000 [12]. During this time only the length of high-speed lines has grown.

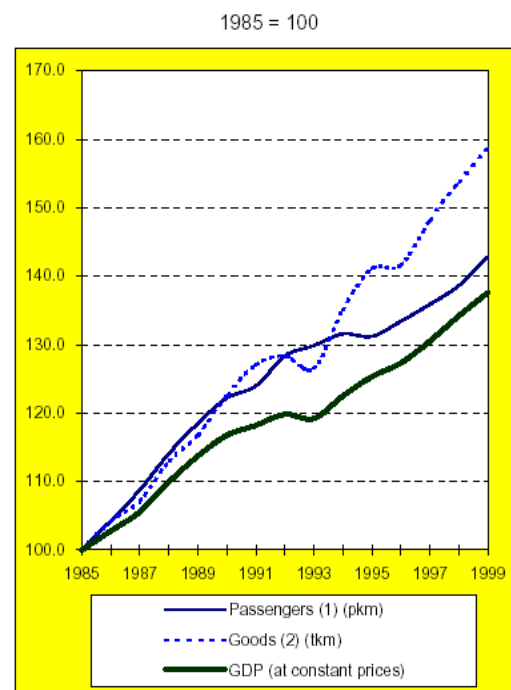
At the same time the number of locomotives and powered wagons has decreased to 35.454 (30% less) and the number of freight wagons to 523.400 (65% less) [12].

The railways performance on the passenger sector was of 217 billion pkm in 1970 and 290 billion pkm in 1998 [12], but despite the growth its share fell from 10,1% to 5,8% [11]. Nevertheless, the passenger use of high-speed rail transport in Europe has increased a 10 % per annum on average in the recent years and represents a fifth of the total railway passenger-mileage in Europe (including suburban traffic) [13].

Concerning rail freight traffic, the result in 1970 was of 282,8 billion tkm transported whereas by 2000 it had sunk to 237,2 billion tkm, thus its share diminishing from 32,6% to 13,4% [6] (not including short-sea shipping). Considering other sources ([12]) these shares would be 21,1% and 8,4% respectively.

These changes have taken place in a context of undeniable growth of the overall transport in Europe, both for passengers and for freight (see figure 1-5), and consequently, the railway's productivity on both markets (except on high-speed services) has been a fiasco during the last thirty years instead of taking advantage of the growth.

Germany also saw the rail freight figures diminish. From 113 billion tkm in 1970 to 71,4 billion tkm in 1999 despite the overall growth of market. The share decreased from 40,1 to 14,5% [6].



Notes :

(1) : passenger cars, buses & coaches, tram+metro, railways, air
 (2) : road, rail, inland waterways, pipelines, sea (intra-EU)

Figure 1-5: Transport growth in the EU of 15. Source: [11].

Over the years, in an attempt to improve efficiency, the old model of railway company was abandoned and staffs were gradually reduced, as can be seen in table 1-1.

Main railways							Infrastructure companies						
Company	staff in 1000						Company	staff in 1000					
	1970	1980	1990	1995	1998	1999		1995	1998	1999			
B SNCB	56.7	65.7	45.2	41.9	40.0	40.6	DK Banestyrelsen	founded 1.1.97	-	n.a.	n.a.		
DK DSB	24.0	22.1	20.4	15.7	10.9	10.5	E GIF	founded 1997	n.a.	n.a.	n.a.		
D-W DB AG	392.7	329.0	236.0	294.9	209.6	194.9	F RFF	founded 1997	-	0.1	0.1		
D-E DR	252.6	237.9	246.3	(DB)	(DB)	(DB)	NL Rallinfrabeheer	founded 1.1.95	n.a.	n.a.	n.a.		
EL CH	12.6	12.1	13.3	12.5	11.8	10.5	P REFER	founded 1.7.97	-	2.5	6.5		
E RENFE	85.1	71.5	49.7	39.0	35.0	34.5	FIN RHK	founded 1.1.95	0.1	0.1	0.1		
F SNCF	303.0	254.4	202.1	181.1	175.0	174.3	S Banverket	founded 1.1.88	7.4	7.4	7.4		
IRL CIE	22.3	18.1	11.8	11.1	10.7	5.2	UK Railtrack	founded 1.4.94	11.5	10.7	10.7		
I FS	197.6	220.7	200.4	129.8	118.3	114.2	Other railway companies						
L CFL	4.4	4.2	3.5	3.2	3.1	3.1	staff in 1000						
NL NS	26.8	26.9	26.2	26.6	25.8	24.0	Company						
A ÖBB	73.9	72.5	66.9	61.3	53.5	51.8	D German non-federal railways	14.0	13.0	13.0			
P CP	25.6	24.7	22.1	13.1	10.6	6.3	E FEVE	2.0	2.0	2.0			
FIN VR	27.7	28.7	20.2	15.2	13.8	13.5	E FGC	1.3	1.2	1.2			
S SJ+MTAB	45.3	37.5	20.8	14.2	11.1	10.5	I Ferrovie in concessione	15.7	n.a.	n.a.			
UK BR	274.3	241.9	135.3	90.2	n.a.	n.a.	UK EWS	-	n.a.	n.a.			
Total	1824.6	1667.9	1320.2	949.8	729.2	693.9	UK/F Eurotunnel	n.a.	3.2	3.4			
							UK NIR	0.8	0.7	0.7			
							USA AAR (freight)	566.3	459.0	216.4	188.2	178	177.6
							J JR	459.7	413.6	193.8	192.5	181.8	172.2
							CEC (11 railways)	1001	1048	1086	723.2	668.2	602.6

D: 1994 creation of DB AG out of former DB and DR

Source : Union Internationale des Chemins de Fer, national statistics

Table 1-1: Employment in European railways. Source: UIC in [11].

In eastern countries though, freight rail transport still enjoys a 30% share [6]. It will be necessary to avoid the history repeating in these countries if the transport need is to be satisfactorily fulfilled and, at the same time, the environment saved from unnecessary pollution.

The causes for the negative evolution of freight rail transport are [6]:

- Decentralization and spatial distribution of production: more routes with fewer quantities.
- Structure of goods: less bulk and miniaturization of shipments.
- The requirement for extended delivery intervals and permanent monitoring of freight.
- Liberalization of road sector since 1985 and consequent drop of its prices.
- Slow reorganization of railway companies and inadequate degree of internationalisation (an exception to this last cause is Germany's DB Cargo, now Railion, with 50% of its traffic being international and a forecast of up to 60% for 2010).

The evolution of the composition of all goods transported in the last thirty years is shown in table 1-2. Minerals have lost importance but agrarian goods and aliments are clearly growing whilst its share in rail is still almost irrelevant. If this growth is to be attracted to the rail sector, modern wagons that substitute the obsolete pool have to be developed for cereal and refrigeration-needing goods.

%	Minerals, Solid Fuel	Steel, Iron Metals	Mineral Oils	Chemical Products	Industrial Goods	Agrarian Goods, Aliments
1970	46,5	7,5	20,5	7,5	6,5	11,5
1980	35,0	7,0	21,0	10,5	7,5	19,0
1990	27,5	6,0	18,5	12,0	15,5	20,5
2000	23,0	5,0	16,5	13,0	17,5	25,0

Share of each item in the railway transport in 2000:

43%	17%	8%	10%	18%	4%
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Table 1-2: Modal distribution of freight transport in the EU. Source: [5].