

INNOVATIVE FREIGHT WAGON CONCEPTS FOR EFFICIENT TRANS-EUROPEAN RAIL FREIGHT

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Changes in the competitive environment force railways both to improve rail freight's economies of scale in order to increase cost-efficiency and to introduce new production methods in order to enter into new market segments. The authors present conceptual outlines of new wagon designs to achieve this, a long intermodal wagon and a flat wagon for transport of semi-trailers. They apply a system perspective considering even adaptations of certain infrastructure parameters.

1. Background

During the last decade rail freight has in many European countries seen a renaissance. One driving factor is the liberalization of the European rail freight market, which opened up for intramodal competition, forcing railway companies to act more customer-oriented and improve cost-efficiency as well as quality.

While changes in the institutional and market-regulatory framework and – partly initiated by these changes – the process-improvements in rail freight operations have shown a positive impact on the development of the rail freight sector, the technical and infrastructural development of rail freight has severely lacked behind. Investments in the rail network have mostly been passenger traffic-oriented, while the conditions for rail freight have hardly improved at all. There are certainly a number of “good examples” for innovative and efficient rail freight in Europe, however, these examples are often the exception from the rule and are not implemented on a European-wide scale.

At the same time intermodal competition is increasing. Road transport may in a near future benefit from far more generous weight and size limits than today, enabling it to realize important economies of scale.

The freight railways need answers to these changes in their competitive environment. The fact that system changes in the rail freight system – due to

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the close interdependencies between different technical sub-systems and the high amount of capital bound in each of them – take much longer time to implement, a long-term system perspective is imperative for the rail freight sector. Such a system perspective must be pro-active and also include a discussion whether today's – often many decades old – technical norms and standards are adequate to secure the competitiveness of rail on the future freight transport market – or whether they will not cement a system, which will be less and less able to respond to market demands.

This paper focuses on rail freight wagons, a key resource for railway companies and an important determinant of the competitiveness of rail freight. In line with the system perspective postulated above – the authors also treat relevant infrastructure-related aspects as well.

2. Basic considerations for future freight wagon concepts

For the further development of the rail freight system, one can discern two principal strategies:

- 1) improving rail freight's economies of scale
- 2) introducing new production systems, especially new train operating principles

The main goal of the first strategy lies in reducing output-unit costs (e.g. cost per ton-kilometre or wagon-kilometre) in existing production systems for rail freight by moving more payload per wagon – either in tons, cubic-metres or number of loading units – and more wagons per train.

The second strategy can result in lower output-unit costs as well, however, the main goal is rather to penetrate new – or re-enter into lost – market-segments, i.e. to widen the market for rail. This could for example be achieved by liner-trains, which allow intermediate stops at small-scale low-cost terminals, giving a much higher geographical coverage of the rail freight system. Also the introduction of Train-Coupling and –Sharing operations (TCS) can contribute to this.

The best effect can be achieved by combining both approaches. Thus future freight wagon concepts should take into account both strategies.

Another key question is which infrastructure parameters future freight wagons should adapt to. Rolling stock and infrastructure form an interacting system. Thus when considering improvements of the rail freight system neither rolling stock nor infrastructure should be a priori considered as "fixed". A combined approach may present the best solution.

In this context even the time horizon plays an important role. A new wagon design can be implemented within a relatively short time frame – and thus give benefits in a near future –, while changes in the infrastructure

take longer time to implement. However, the system effects may be much bigger, which underlines the importance of a long-term perspective in the development of the rail freight infrastructure.

A third aspect, which has to be considered, is which traffic products new wagon concepts should address. The main products of the railways are today wagonload, trainload and intermodal services. For wagonload it is desirable to have multi-purpose wagons, which can carry a wide variety of commodities. For regular trainload services specialized wagons are often used in order to adapt optimally to a specific transport task and commodity. For intermodal services mainly wagons exclusively for moving intermodal loading units (containers, swap-bodies, semitrailers) are used. Thus there are today different wagon fleets and wagon designs for different traffic products – especially intermodal wagons form a group quite separated from the rest of the wagon fleet.

In order to achieve economies of scale in manufacture and maintenance and to increase the flexibility of the wagon fleet it is desirable to have a joint wagon design for different tasks and traffic products. This can best be achieved by a platform concept, from which different wagon types can be derived. It appears especially desirable to overcome the quite strict separation of intermodal and classic wagons. There is already today a trend in this direction, as shown in figures 1 and 2. In a longer term it is a realistic scenario that intermodal and wagonload/trainload transport may become more integrated even on the operational level.



Fig.1 and 2: Standard container-wagons equipped with stanchions for timber transport in Sweden. (left; photo: G.Troche). Detachable superstructure of a freight wagon. The structure is not intended for transport on public roads and thus can utilize the full loading gauge of the railway. Standard intermodal handling equipment can be used in terminals (right).

Based on these considerations the authors have developed an outline for a wagon concept, consisting of two basic designs. One design is intended for intermodal transport of containers and swap-bodies and can be equipped with – fixed or detachable – superstructures for wagonload and trainload

service as well. The other design is intended for intermodal transport of semitrailers with the ability to also take even semi-trailers not adapted to intermodal transport (today only about 5% of all semi-trailers in Europe can use intermodal transport).

3. Outline of wagon design A – long freight wagon

The most expensive parts of a freight wagon are normally the running gears (bogies). Thus the goal should be to minimize the number of running gears per amount of payload. In intermodal traffic the load capacity in tons of a freight wagon is seldom reached, partly due to the relatively lower density of typical intermodal commodities, partly due to the fact that intermodal loading units cannot make full use of the railway's loading gauge, reducing the volume of cargo, which can be carried on an intermodal wagon.

Today's standard intermodal 60'-bogie wagons carry three 20'-containers or two class C swap-bodies. Length utilization when loaded with swap-bodies is low. Articulated six-axle wagon designs reduce the problem when loaded with swap-bodies, require, however, a more complicated wagon and the number of axles per container increases!

The solution proposed by the authors is an intermodal four-axle single-frame bogie wagon with a loading length of ca. 25 m (80'). Such a wagon could carry four 20'-containers or three class C swap-bodies and in both cases give a good length utilization.

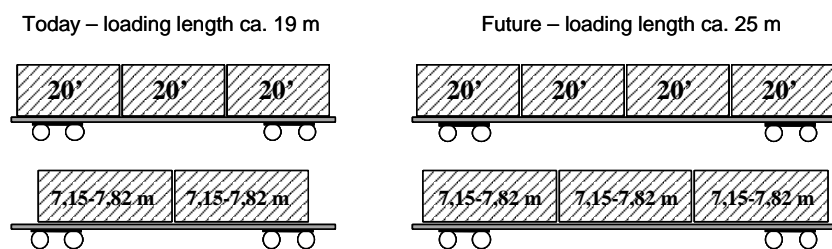


Fig.3. Conceptual illustration of today's and suggested future wagon for containers and swap-bodies.

Due to the greater distance between bogie-centers the frame would become heavier; however, at the same time the bogies move more far apart, with the result that the tare weight per meter of an 80'-wagon would still be less than of a 60'-wagon, as a careful weight analysis and calculation carried out by the authors revealed.

The 80'-wagon is today the standard length of (single-level) container wagons – and common even for other wagon types – in North America and other parts of the world. Even in Europe long freight wagons exist, e.g. the class Rbns 641/646 of DB Schenker Rail, which with a length over buffers of 26,35 m is even slightly longer than the wagon proposed by the authors.

The maximum possible payload per loading unit would be less, which in most cases is not a severe problem. This effect also could be counteracted by increasing axle-loads, e.g. to 25 tons, which likely will become a future standard in Europe.

With an increased axle-load it would even become increasingly interesting to equip the 80'-wagon with superstructures, so that can be used also in wagonload traffic.

4. Outline of wagon design B – semi-trailer flat wagon

This wagon design has a more limited traffic task. It addresses mainly the market for intermodal transport of semi-trailers. The basic idea is to adapt the Trailer-on-Flat-Car (TOFC) concept from North America to European conditions. This would allow the transport of non-cranable semi-trailers, multiplying the potential market for semi-trailer transport by rail, while at the same time – in contrast to other, highly complex and expensive wagon designs aiming to do the same – keeping to a relatively simple and cheap wagon design. Neither any advanced handling equipment in terminals is required.

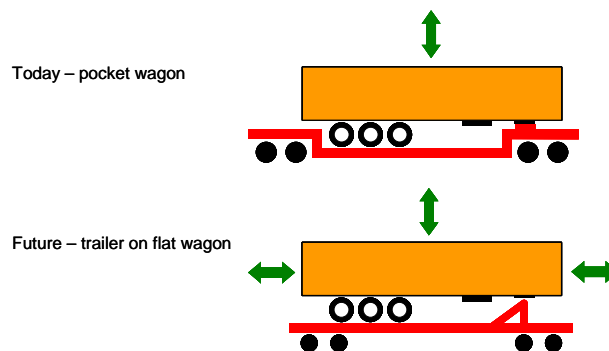


Fig.4. Conceptual illustration of today's and suggested future wagon concept for semitrailer transport

The standard height of a European semi-trailer is 4 meters. Thus within most European loading gauges it cannot be carried on a standard wagon

with a typical floor height of 1.155 mm. The approach advocated by the authors is to create the necessary clearance *partly* by lowering the floor height of the wagon, *partly* by slightly increasing the loading gauge on selected corridors.

The floor height envisaged is 800 mm. This floor height is only slightly below the floor height of certain container wagons already today already in use in Europe. In contrast to extreme low-floor Rolling Highway-wagons with very expensive running gears, an 800 mm floor height still allows a two-axle bogie design (fig. 5). Wheel diameter would be ca. 700 mm.

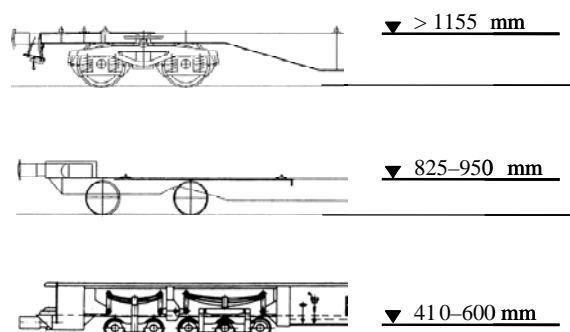


Fig.5. Typical floor heights of different wagon designs (G.Troche)

With an 800 mm floor height the loading gauge would need to be ca. 4.800 mm high to accommodate a 4 m high semi-trailer. This is ca. 150 mm more than the UIC GC-gauge, which normally is used for new and upgraded lines in Europe. The rationale behind the suggestion of a 4.800 mm high loading-gauge on selected corridors is that the implementation of the UIC GC-gauge in many countries in any case requires certain adaptations of the infrastructure; the *additional* cost of increasing the height ca. 150 mm *extra* should be in many cases relatively small, while the benefits would be very big. In the longer term the higher loading gauge could also be used for other wagon types.

Carrying semi-trailers on flat wagons, instead of pocket wagons, also gives a better length utilization of the train and reduced air drag due to less empty space between the trailers.

For loading and unloading standard terminal tow tractors would be used, identical to those used for trailer handling in ferry terminals. Even the road trucks for semi-trailers can be used. Loading and unloading can happen either via (fixed or movable) head-end ramps or via side ramps. The latter is recommended in bigger terminals, because it allows shorter handling times.

5. Other improvements

The wagon concepts presented above are expected to feature other improvements, either optional or as standard. Automatic Central Couplers for both tractive and compressive forces would in a longer term allow the removal of side buffers and open for further simplifications of the wagon frame structure, resulting in weight and cost reductions. The Transpac-coupler, compatible with today's screw couplers and thus allowing an incremental implementation, can be a possible solution.

The newly developed Compact Freight Car Brake (CFCB) also contributes to reduce the wagon tare weight and can result in better brake performance and lower operational costs.

There is also an increasing need to equip freight wagons with IT, in order to both improve internal planning and operations of the railway companies and to better integrate rail freight in transport customer's logistical IT-systems.

Finally, a wide range for further developments and innovative solutions exists for the fixed or detachable superstructures of the wagons, e.g. use of composite materials and sandwich constructions, etc.

6. Final remarks

This paper only gives a rough overview over new wagon concepts currently studied by the authors. The outlines of the wagon concepts will be elaborated and evaluated further by the authors as part of a project financed by FERRMED.

The authors want to underline that the wagon concepts presented above to a large extent are based on solutions, which already can be found on the railways today, sometimes in other parts of the world, but in most cases even in Europe. The concepts can therefore be characterized as a conceptual synthesis of different innovative, but proven solutions rather than a revolutionary design based on new untested ideas with still high technical development risks. The strength of the concepts lies first and foremost in the combination of several improvements, resulting in synergy effects. The total benefits are bigger than the sum of all individual improvements. The concepts are based on extensive research in the field of freight transport carried out at KTH and TUB [1-6].

7. Literature

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