

## THE TRENDS OF ROAD TRAILERS SYSTEMS FOR RAILWAYS

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*Summary: New trends how to replace at least part of the road transport, and if possible transfer it to rail or water transport were initially met with incomprehension or inability to technologically and financially provision to ensure the development and testing of the system. This paper describes a new system for road-to-rail vehicles (semi-trailers and semi-trailers for vertical transshipment) for railways. This is a description of new technologies in the transshipment of these vehicles on rail waggons and their consecutive transportation by rail.*

*Key words: road trailer, combined transport, railways*

### INTRODUCTION

New trends how to replace at least part of the road transport, and if possible transfer it to rail or water transport were initially met with incomprehension or inability to technologically and financially provision to ensure the development and testing of the system. Only a small percentage of the great number of those designed systems were applied. The American system of double (bimodal) semi-trailers and also European technology Ro-La (Rollende Landstrasse) can be mentioned as one of the first pioneering technology, but the Ro-La is accompanied intermodal transport.

Technologies that are now able to function as an alternative to road transport are gaining more and more better quality. There's no point to deal with systems that are at the beginning of development and also with systems which have little chance to succeed in the market and which is not able to overcome the high barriers to competition. Technologies CargoBeamer, Modalohr and Megaswing can be count among the most progressive systems in recent years. Those technologies are presented in the light of their components, capabilities, process technology and the possibilities for entering the Czech market of intermodal transport in the following sections of the paper.

The system of road transport to rail unit falls under the heading continental unaccompanied combined transport (CT) of road - rail. The technical base of the transport system are:

- transport units (semi-trailers),
- means of transport (rail waggon, truck - road kit),
- reloading mechanisms,
- infrastructure (transit, transport vehicle using the road).

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Basic segment of the system (the transport unit) is the semi-trailers. Compared to road transport of whole sets has this system several advantages. In terms of transportation on the railway car are mainly about saving the weight carried by truck or use a larger loading area. Road carriers using rail transportation can reduce the number of employees by shortening the distance transported by road.

This system can be divided into two specific groups. This is a specially prepared road transport unit called semi-trailers and cranable semi-trailers (for the vertical transshipment). Depending on the type used to adjust the semi-trailer and rail car and loading place. There are two types of the transshipment - vertical or horizontal manner.

## **1. ADVANTAGES AND DISADVANTAGES OF SEMI-TRAILERS ON RAIL**

The most important motivation for road hauliers, which leads to the use of combined transport lines as an alternative to direct shipments by road, is the fact that the offer of transportation must be of sufficient quality comparable to the carriage by road, but with lower costs. As the advantages of combined transport of semi-trailers are (3):

- reduction of road traffic volume (less congestion on roads),
- better use of existing rail capacity permitting, to a certain extent, limitation of investment in the road infrastructure,
- better sharing of volumes between the different transport modes,
- combination of the advantages of road (flexibility) and rail (more economical transport of large volumes over long distances),
- environmentally friendly alternative to rail transport,
- possibility of transfer regardless of bans trips (weekend, night, for a given commodity),
- acceleration of transport over long distances,
- lower transport costs,
- guarantee the accuracy of delivery with regularity and to avoid unpredictable situations on the road (congestion, accidents),
- state aid (grants, tax relief),
- adapt to future trends.

The last item mentions that the combined shipment will be the future trend of highly sought after, both from economic pressure, state authorities or the carriers. Therefore, the transition to this mode of today transportation bears the advantage of integration into the system, the orientation of issues and experiences with this type of transportation.

For the carriers are the advantages:

- lower manpower costs: savings on variable costs, reduced personnel (drivers, driving time, night work),
- gain in competitiveness,
- savings on fuel thanks to the section completed by rail,
- less wear on equipment (tyres, maintenance), longer life for trucks and reduced fleet of vehicles due to investment in transferable equipment,
- exemption from, reduction or reimbursement of road vehicle taxes,

- increased flexibility in the management of transport flows.

Of course, the system of transport of semi-trailers by rail has the few disadvantages:

- the need for prime non-recurring costs (road carriers - semi trailers, operators of combined transport - building of terminals and acquisition of reloading mechanisms),
- the possibility of transshipment only or transshipment terminal,
- consistent organization of logistics operations and planning,
- adapting to the time-table of railways and delivery dates road set before departure of the complete train.

There is a need introduce, that any system (semi-trailers or cranable semi-trailers) has its advantages and disadvantages. For the operation of the cranable semi-trailers is:

- need to approved for the cranable semi-trailers vertical transshipment by UIC and equipment to enable vertical elements of transshipment (with ties),
- more dead weight loaded of trailer,
- transshipment terminal has only reloading mechanism,
- independent of the starting and end points where the route meets the requirements of gauge,
- reloading faster and easier,
- established and proven method for known shippers and carriers,
- approximately the same financial burden for stakeholders (road and rail transport operators).

In compliance with road vehicle standards (13.60 m - maximum allowed on the road), semi-trailers are loaded onto wagons by means of gantries or mobile cranes equipped with pincers; this requires a handling zone on each side of the vehicle.

For the operation of the semi-trailers is:

- inexpensive road operators,
- can use any type of trailer permit adequate size,
- insufficient number of special wagons for cranable semi-trailers and mechanisms associated with them,
- attractive for road carriers.

According to EU Directive 92/106, road vehicles that are predominantly used in initial or final carriage in CT are to be completely or partially exempt from road taxes. This way, the imposition of excessive infrastructure taxes on such transport is avoided, as a user fee already has to be paid for the rail infrastructure in combined transport. Moreover, these vehicles usually cover short stretches of road and only carry out the road positioning legs: CT is released from any quotas and authorisation.

Rail transport can also take place at weekends and on national holidays without restriction, whereas road vehicles are subject to traffic prohibitions at these times. In order to use this advantage of rail transport, road vehicles that are only used in the relatively short

initial or final carriage sections connecting with rail transport are exempt from weekend and national holiday traffic prohibitions.

Because of the use of intermodal transport containers, the road vehicles used in Combined Transport are heavier than trucks with fixed structures. Therefore logistics companies need to have the same payload as for dedicated road haulage if they want to convey heavy goods.

Particularly because of its environmental advantages, the European Union has authorised its Member States to provide financial support for railway transport, and more especially for road-rail CT. However, these promotional measures have to be submitted to the Commission for approval. When Member States allocate subsidies to operational activities, the UIRR companies prefer to receive these directly in order to have their customers benefit fully from the amounts concerned, instead of this form of promotion being allocated to RUs, as the traction prices of several of them are often not transparent, which makes the choice of traction provider more difficult.

There is a trend currently in Europe towards the introduction of taxes on trucks (for example the “Maut” in Germany) calculated on the basis of the distance covered and the type of truck (EURO standards and number of axles). This applies above all to the motorways and major trunk roads.

## **2. THE NEW TECHNOLOGIES FOR ROAD-TO-RAIL VEHICLES FOR RAILWAYS**

The biggest obstacle to the maximum use of road transport trailers by rail is necessary, the adaptation of vehicles by road operators. For example, vertical transshipment is necessary that the trailer contained the additional fastener elements to the transshipment permit. For these reasons, efforts to develop technology for horizontal transshipment. During this operation, the transmission unit is much the specifics required for the road vehicle or trailer does not require any modifications.

In 2004, studies completed RoRoRail, whose aim was to explore the technical, operational and economic feasibility of the technology of semi-trailers without vertical transshipment. Therefore, systems with vertical transshipment as Flexiwaggon, CargoSpeed, Megaswing, Modalohr and CargoBeamer. For vertical transshipment, which is widespread in Europe, it is possible to use semi-trailers, the system Eurospine or project ISU. In another part of the paper will describe new transportation systems of semi-trailers on rail.

### **2.1 System CARGOSPEED**

System CargoSpeed is based on a single, simple idea and has the potential to revolutionise the road-to-rail freight industry. The system has been developed in conjunction with the industry and delivers significant benefits for the Environment, for the Economy and for Industry. System CargoSpeed utilises Roll-On / Roll-Off principles and no lifting is required. This means that electric traction is used in the terminals and there is no need for polluting diesel locomotives, works completely with electric traction. Therefore as electricity generation becomes greener, so does System CargoSpeed and is capable of economically

moving a significant proportion of existing road freight onto rail, thereby reducing road congestion. Terminals are cleaner, quieter and more energy efficient to operate than existing alternatives.

System CargoSpeed uses standard semi-trailers. It does not need the expensive specialist liftable trailers that existing road to rail solutions require. Not only does this reduce the initial investment for the carrier, it also increases their flexibility and operational efficiency. System CargoSpeed is fast for the road haulier. Loading and unloading trailers takes a fraction of the time required in a Lift-On / Lift-Off terminal. This ensures that driver's time is spent on the road and not waiting in a terminal.

System CargoSpeed gives terminal operators a choice. They can choose to either transfer the same volume of road to rail freight at 20% of cost of a typical Lift-On / Lift-Off terminal or transfer 7 times the volume for the same cost as a typical Lift-On / Lift-Off terminal. This makes the business more efficient and profitable. In a Maxi terminal an entire train of 40 rail wagons can be unloaded and re-loaded in only 8 minutes (20 minutes including time for the train to enter, and exit, the terminal). This compares with over 4 hours for existing Lift-On Lift-Off terminals. Time is money and System CargoSpeed saves time. Terminals are multi-directional—trains can arrive and depart the terminal from either direction. This significantly increases the operational flexibility of the terminal and reduces the construction costs. As the system is primarily a Roll-On / Roll-Off system, no lifting is necessary in terminals. This means that electric traction can be used in the terminal and the time wastage and environmental impact of switching to diesel when a train arrives is not necessary.

At the heart of System CargoSpeed are 3 main components: the Waggon, the Wellfloor and the Pop-Up. Each has been designed to be simple, robust and economical. Where possible, existing technology has been used and the system has been designed with as few moving parts as possible. System CargoSpeed has been designed with simplicity built-in.



Zdroj: [www.cargospeed.net](http://www.cargospeed.net)

Fig. 1 - The main components of system CargoSpeed



### Waggon

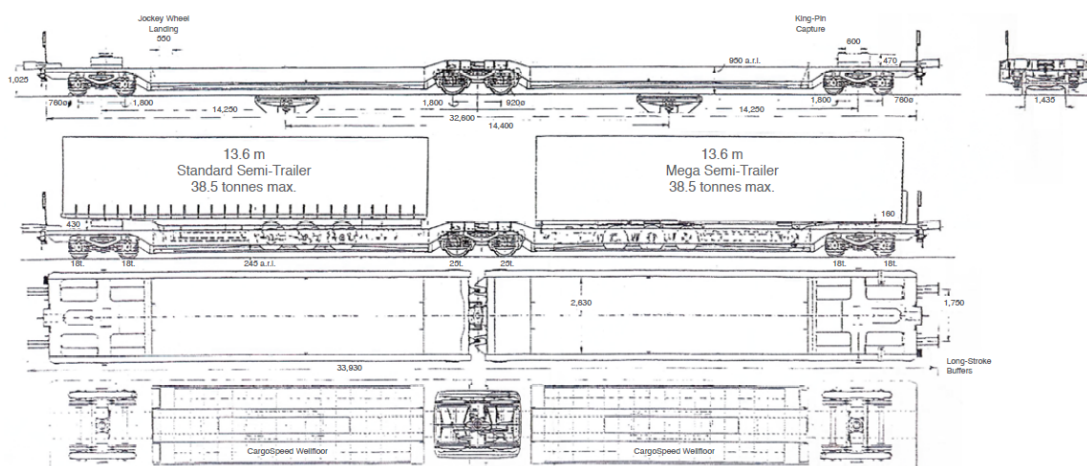
- the waggon has been designed in conjunction with one of the leading waggon manufacturers,
- it has been based upon a tried and tested existing design with as little modification as possible,
- large diameter wheel bogies are used to reduce maintenance costs and improve reliability,
- the waggons have been designed to be simple, robust and cost-effective.

### Wellfloor

- the Wellfloor sits in the Wagon and is removable,
- the Wellfloor has been engineered to fit within an existing wagon design,
- the Wellfloor is a simple welded steel fabrication and is both cheap to manufacture and extremely strong,
- the Wellfloor can be engineered to support both Pop-Up and liftable operation,
- the Wellfloor has been designed to work with a train stopping tolerance of +/- 35cms in relation to the Pop-Up mechanism.

### Pop-Up

- the Pop-Up mechanism is located in a pit between the railway tracks. It rises up and locks onto the Wellfloor. It then lifts and turns the Wellfloor before lowering it across the platform edges,
- each Pop-Up can operate independently from, or in conjunction with, the other Pop-Ups,
- the Pop-Up mechanism is mounted into a fixed socket between the railtracks and can be easily exchanged,
- each Pop-Up is powered by a single hydraulic motor which handles both the lift and turn operation. This reduces costs and improves reliability,
- if a Pop-Up fails, it can be quickly removed and replaced within minutes with a spare working unit. This allows the terminal to keep operating without the need for lengthy repairs.



Zdroj: [www.cargospeed.net](http://www.cargospeed.net)

Fig. 2 - Scheme of waggon for system CargoSpeed

## 2.2 System FLEXIWAGGON

Flexiwaggon is a new and unique solution for intermodal freight transports on the railway and the roads in Sweden, Europe and the rest of the world. Flexiwaggon enables more environmentally friendly, financially viable and rational transports.

Flexiwaggon offers great opportunities for intermodal transports since it can combine lorries, buses, cars, containers on one and the same waggon. The necessary equipment is integrated on each waggon. Flexiwaggon can travel at speeds up to 120 km p. h. To load or unload an entire train set takes 10-15 minutes. The driver will operate the loading or unloading of his truck. Loading and unloading is done horizontally which means no consideration is necessary for overhead contact lines. Loading and unloading can take place anywhere, in principle. The only requirement is a firm base, sufficiently hard to hold the weight of the vehicle to be loaded or unloaded. The cradle that the lorry stands on can be opened at both ends and turned to the left and the right. The lorry can drive on and off the waggon, no need for reversing.

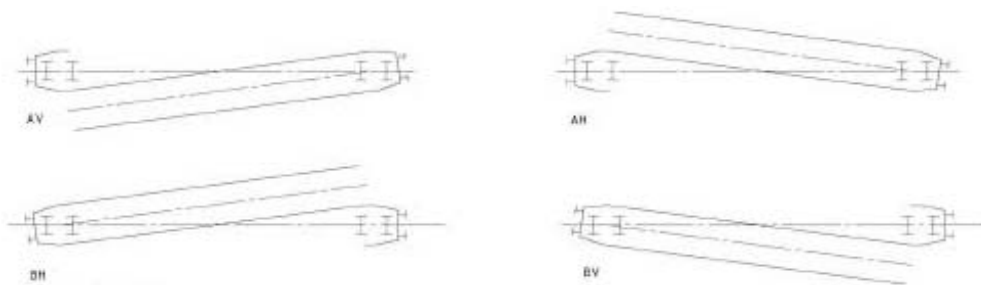
The weight of the waggon is the same as for existing waggons but Flexiwaggon can load 50 tonnes compared to 44 tonnes for similar solutions. The loading capacity in volume is also higher since Flexiwaggon is extremely low-bedded with the result of strongly improved passability along the rail.



Zdroj: [www.flexiwaggon.se](http://www.flexiwaggon.se)

Fig. 3 - Road-set in rail waggon of system Flexiwaggon

The environmental benefits of Flexiwaggon are many and important. The greatest benefits relate to reducing the emissions of carbon dioxide but there are many more. There is less wear on the roads, the emissions of exhaust and tyre particles are reduced and maybe the most important – the solution contributes to improving road safety.



Zdroj: [www.ettar.eu](http://www.ettar.eu)

Fig. 4 - Flexiwaggon launching modes

The waggon is divided into two parts and each part can be moved separately. The two parts are rotated parallel to one another an acute angle to the place running so as to be channeled to the appropriate place for loading. One of the loading platform and turn will reduce the loading valve fitted to the loading platform. So can a single vehicle driven directly to the rail waggon. Rotating equipment and engines are assembled on the rail car. Transhipment of road vehicles is carried out in a relatively short time and within 15 minutes. It may also parallel loading of the train.

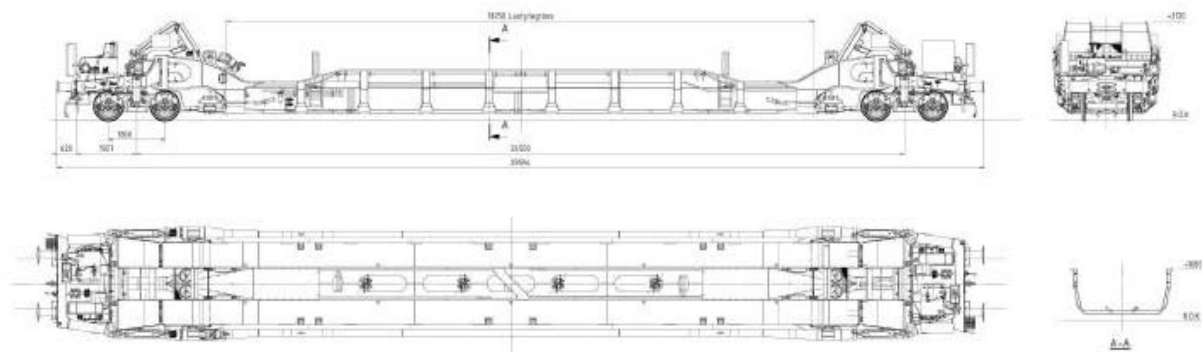


Fig. 5 - Scheme of waggon for system Flexiwaggon

The main strength of Flexiwaggon is the flexibility. The design of the waggon enables:

- transports according to schedule,
- fast, easy and efficient transhipments of cargo – only takes 6 minutes - driver operated,
- easy to load and unload – the lorry can travel on the waggon with or without the driver,
- no disruption to traffic on parallel tracks,
- individual loading and unloading of waggons,
- access to electricity: 230/400 volt 50Hz, for cooling units or engine heaters.

### 2.3 System Megaswing waggon

Megaswing is the new freight waggon that realises a major breakthrough in the long talked about and sought after modal shift from road to rail. Designed by Kockums Industrier, Europe's premier developer of innovative freight wagons, Megaswing is a truly trailblazing platform.

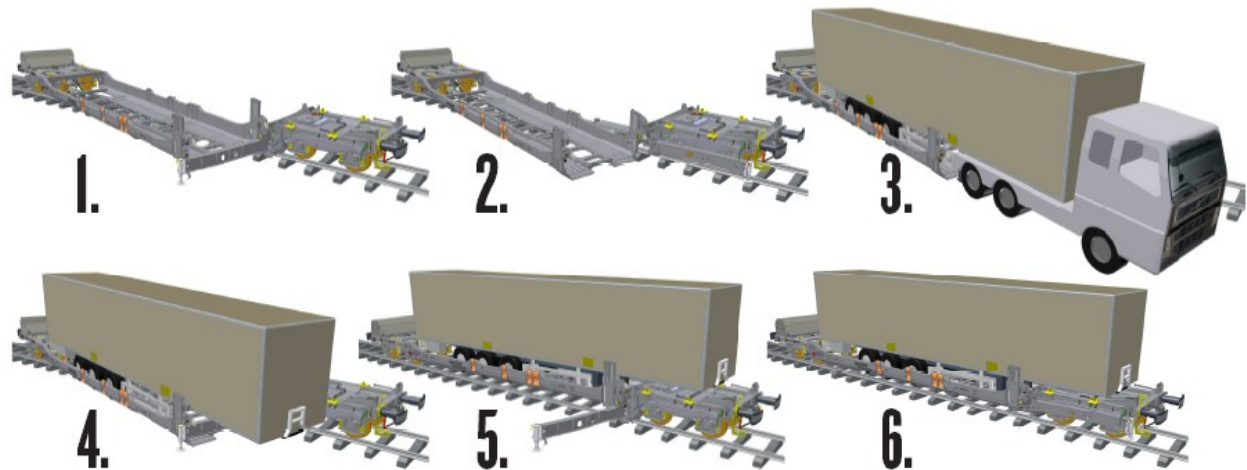
Given the environmental benefits, virtually everyone now supports the idea of shifting long-distance road transport to rail. However, rail solutions must also be commercially competitive. Megaswing brings this competitiveness.

Megaswing can carry any semitrailer and not just the small percentage that can be lifted onto traditional pocket wagons. This represents a massive expansion in the rail transport market (i.e. 100% of the trailers on European roads – not just the present 5%). Furthermore, existing terminals can increase their volumes and market shares by offering an intermodal solution for all semitrailers. The system uses terminals more efficiently and increases profitability. An entire train can be loaded in 30 minutes and a single wagon in less than 3. As terminal tractors can rapidly transfer loads to the open wagon (e.g. from a ferry or another



train), intermediate storage is unnecessary. Similarly, there is no need to use shunters – loading and unloading can be carried out under overhead contact lines. This eliminates costly train movements to/from terminals and shortens turnaround times.

Megaswing means that loading and unloading can now take place wherever there is a suitable track and trackside area for truck/trailer handling. Your very own terminal can be easily set up where it best fits your needs (temporary or permanent). Inconvenient and/or congested container terminals can be avoided.



Zdroj: [www.kockumsindustrier.se](http://www.kockumsindustrier.se)

Picture 6 - Scheme of transshipment of semi-trailers on wagon Megaswing

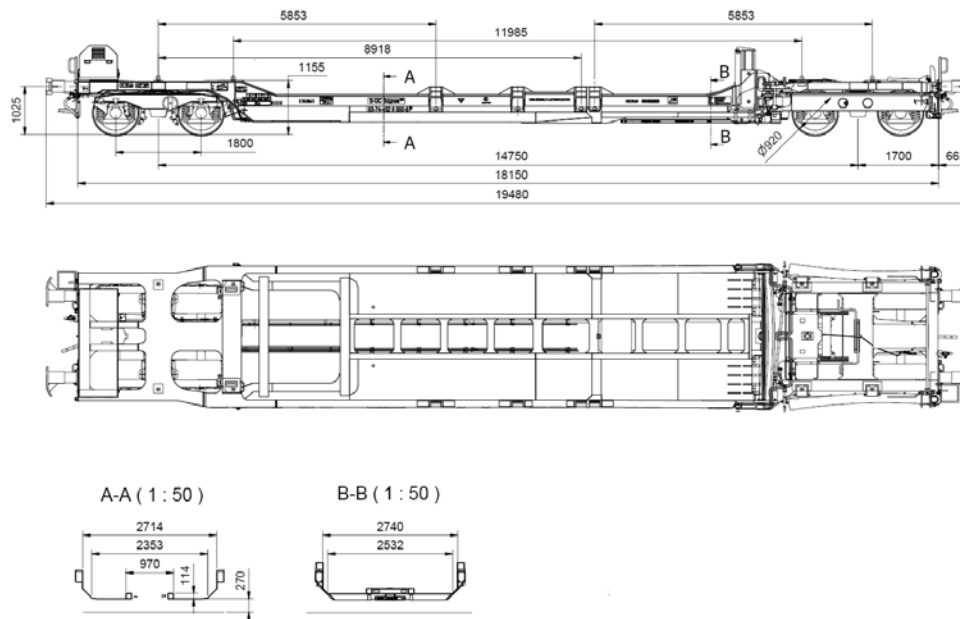
Megaswing is innovative in that the wagon separates easily into two sections. The pocket section can be swung out and lowered to the ground. A semi-trailer can then be reserved up into the pocket. Once the semi-trailer (supported in its landing gear) is released from its truck, the pocket section can be pivoted back into position.

This can be done from either side of the wagon. There is a control box at each corner. The entire sequence is completed in less than three minutes. Furthermore, all wagons in a train can be loaded simultaneously. The wagon's movable parts are operated by a hydraulic system. To prevent oil leaks, this is internally closed. Hydraulic power is generated by an electric pump. At any of its corners, a wagon can be connected to a power source. Several successive wagons can form a single electric circuit. The tare weight for a 4-axled wagon is just under 24 tonnes. This means that any fully loaded trailer allowed on European roads can be loaded, carried and unloaded without any help from external equipment (e.g. cranes or reach stackers). Megaswing is suitable for all trailers – cranable or not.

The benefits of Megaswing are:

- can carry non-cranable trailers (gain 95% of the market) and all semitrailer types (allows direct loading of megatrailers),
- allows individual wagon unloading in coupled trains,
- puts goods on tracks instead of in terminal queues,
- enables loading and unloading at own trackside warehouse rather than at a container terminal,

- brings cost savings (e.g. no lifting costs at terminals) and offers minimum investment costs (e.g. in terminals),
- reduces handling damage/wear (e.g. no lifting of trailers),
- enables loading/unloading of whole train in 30 minutes (instead of 3 hours),
- increases flexibility – loading/unloading at “hotspots” requires only a flat trackside area,
- has a 270 mm load pocket – same height as the most recent pocket wagons,
- can be used throughout Europe (G1 load profile).



Zdroj: [www.kockumsindustrier.se](http://www.kockumsindustrier.se)

Fig. 7 - Scheme of wagon for system Megaswing

## 2.4 System CargoBeamer wagon

CargoBeamer is German technology which is reflected in the first prototypes of innovative technology that tries to compete with freight service operated by semi-trailers units in road transport. It provides a solution that takes into account the conditions of competition between road and rail transport. It also provides benefits and reduces the environmental burden that is demonstrably lower than in the case of the road transport utilization.

CargoBeamer system is representative of horizontal transshipment technology of road trailers. It offers a fairly sophisticated and easy controllable horizontal transshipment system, but it is challenging for rebuilding of terminal. Also wagons have complex construction and thus their price is considerably higher than would be opportune for a system that wants to compete on the open market, especially with road transport.

The functioning of the system is shown in the figures below. Truck must pass through the gateway on his arrival. The gateway is called CargoGate (The gateway to terminals that are used to evidence of vehicles (shipments) on their arrival and departure), there the registration proceeds. The semi-trailer is hanged down from tractor at designated position and the tractor hang up other semi-trailer prepared for departure at the other one designated position. The first (hanged down) semi-trailer is waiting for the arrival of the train (CargoJet – train set for the technology CargoBeamer). The semi-trailers are removed simultaneously

from and on the wagon after train's arrival. The trail leaves when all the shipments (semi-trailers), which were prepared at designated positions along the train set, and formalities are done. The semi-trailers are jointed to tractors or parked near the track in order to wait for picking up.

The main elements of the system are:

- waggons with detachable and automatically sliding loading part,
- solid diving facility (located between ramp and transshipment tracks) with a wishbone, after which the sliding loading part of wagon is surfaced moved,
- transshipment ramp with integrated conveyor table with drive for move the separable sliding part of waggon.



Source: [www.cargobeamer.com](http://www.cargobeamer.com)

Fig. 8 – System CargoBeamer



Source: Author

Fig. 9 – The Sample terminal of CargoBeamer in Leipzig

## 2.5 System Modalohr waggon

System Modalohr designed for the transport of semi-trailers and road set (made up of a tractor and semi-trailer) is based on a completely new construction of articulated railway waggon and horizontal transshipment with the aid of swivel areas on wagons and solid ramps.

The main elements of the system are:

- articulated waggon equipped with swivel loading part for storage of semi-trailer (truck),
- inroad-ramp (oblique) with the lifting device located under the railway car.

Loading of semi-trailers is in process along the whole train set directly from the side on the obliquely adjusted loading part of wagon. Wagons are connected with the cable to control panel. This panel is situated on the ramp. The loading part of wagon is lifted up when the wagon is standing in the space of inroad-ramp. The lifted loading part is turned to inroad-ramp. This movement is assured by electric motor. The operator controls the movement of loading part. When the semi-trailer is on the waggon, the tractor is hanged down and the semi-trailer is fixed by wheel chock and elevation of turntable. When the semi-trailer has been fixed, the loading part of wagon is returned to its normal position. The loading part is fixed at normal position by double belay system. This system forced against the displacement. The unloading of semi-trailers works in a similar way. Total time needed for transshipment of the whole train set (11 articulated wagons) shall not exceed 30 minutes, but the needed number of tractors must be available.



Source: Author

Fig. 10 – Terminal of System Modalohr in Bettenburg

## 3. COMPARISON OF SYSTEMS

In this part of the paper compares the new systems for transport of trailers. Specific comparison of the most important parameters are shown in Tab. 1.

Advantages and disadvantages of each mentioned system can be found in comparison of all important parameters. The most important parameters of those systems are maximum



speed, time of transhipments, investments in systems and terminals, the necessity of additional accessories or employees. The decisive parameters that have meaningful numerical values are the necessity of the terminals rebuilding and connection of state's network with foreign network of the same system. The most important parameters are compared in the tables below.

Tab. 1 – Comparison of innovative systems

	<b>CargoSpeed</b>	<b>Flexiwaggon</b>	<b>Megaswing</b>
Maximum speed	120 km/h	120 km/h	120 km/h
Time of transhipment from train	5 min	10 min	5 min
Number of carried semi-trailers (train 750 m)	42	35	42
Transhipment in terminal	horizontal	horizontal	horizontal
Parallel loading/unloading	yes	yes	yes
The need for reloading the Terminal	yes	no	no
Necessity of employees during transhipment	yes	yes	yes
Maximum load weight	38,5 tonnes	44 tonnes	38,5 tonnes
	<b>CargoBeamer</b>	<b>Modalohr</b>	
Maximum speed	120 km/h	120 km/h	
Time of transhipment from train	5 min	5 min	
Number of carried semi-trailers	32	40	
Transhipment in terminal	horizontal	horizontal	
Parallel loading/unloading	yes	yes	
The need for reloading the Terminal	yes	yes	
Necessity of employees during transhipment	no	no	
Maximum load weight	44 tonnes	38 tonnes	

Source: Author

The development of road-rail CT largely depends on political and operational framework conditions, mostly established by the Community and national authorities. And because of its essential contribution to the fall in external costs (accidents, pollution ...) caused by the transport of freight as a whole, transport policy has been lending support to the promotion of CT since the early stages of this specific technique. Moreover, a series of measures must compensate for the disadvantages inherent to CT, such as transhipment costs.

Now it depends on objective opinions, which assumes the evaluation, and particular on the subjective views of Czech transport companies' managers and on their sympathies towards innovative technologies if the new systems will be implement. The cooperation in the field of transport services and with the companies which support implementation of those systems is necessary for the extension of those systems.



#### 4. CONCLUSION

Not only technological terms but also economic terms were followed up for all these systems in this article. The benefits, which can be offered by each system in comparison to road transport, were mentioned. The important parameters and development opportunities of those systems were introduced. These parameters would link the Czech Republic to the main European transport axes. The attitude of Czech operators and shippers in the road transport may show whether these systems are really competitive and are able to reduce the proportion of road transport. If these systems have mentioned qualities, they would show that sophisticated intermodal transport systems have their own importance and the future. The intermodal transport is sometimes wrongly forgotten during promoting of legislative support and advantages, even if it offers benefits (not only environmental).

#### 5. ACKNOWLEDGEMENT

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