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C4R project increases rail capacity without laying down new tracks

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Abstract

Rail freight transport is today characterized by inefficiencies in the use of the existing infrastructure while the growing demand is activated by giant containers vessels handling thousands of units in the ports. Lack of industrialization prevents gaining from economies of scale while bottlenecks penalize the optimization of the network use. The rail freight transport market share remains low whereas for environmental reasons immediate progress is required. Capacity4Rail intends to analyze the key factors enabling rail freight market share to increase on the most promising segments.

The innovations planned by Capacity4Rail are concentrated on three macro-areas from the concept to simulations and tests: wagon structure design, wagon equipment technology and train maneuverability.

For the wagon structure, the project focuses on the new design giving direct efficiency: better payload, less deadweight, extended usable length, maintenance cost reduction. With a reduced weight due to the use of new materials the design evolution allows to make the best use of the gauge profile.

For the wagon equipment technology a continuous electric line carrying a bus of information all along the train and bringing energy to the wagon allows placing various sensors increasing safety and reliability. With this new wagon connectivity, predictive maintenance is developed but also accurate real time information are available for the customers enhancing the planning efficiency of the next supply chain evolution. The wagons are equipped with an electric command of the pneumatic brakes for an instant and simultaneous braking and releasing. The brakes of all wagons reduces drastically the longitudinal forces in the couplings enabling progressive lengthening of the train reducing operational costs and network capacity consumption per ton transported.

For the train, this new braking system improves its maneuverability, giving access to better paths aiming to reduce the wear of the wheels created by the new brake composite shoes imposed for noise reduction.

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All these potential progress are researched and checked in terms of affordability taking into account not only the global added value created but an equitable reward of all the stakeholders having invested for such innovations. Proposed roadmaps incorporate viable business models for a progressive implementation on the basis of simulations. A virtuous circle is initiated improving the use of assets, reducing noise, informing customers more efficiently, reducing maintenance and operational costs in an affordable way.

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Keywords: transport industrialization; economies of scale; wagons design and structures; wagons technologies; continuous electric line; safety and reliability; capacity increase; trains manoeuvrability; operational costs reduction

1. Introduction

Rail freight transport is today characterized by inefficiencies in the use of the existing infrastructure while the growing demand is activated by giant containers vessels handling thousands of units in the ports. Lack of industrialization prevents gaining from economies of scale while bottlenecks penalize the optimization of the network use. The rail freight transport market share remains low whereas for environmental reasons immediate progress is required. Capacity4Rail intends to analyse some key factors enabling rail freight market share to increase on the most promising segments.

The innovations planned by Capacity4Rail are concentrated on four macro-areas from the concept to simulations or up to physical test in full operating conditions:

- wagon structure design;
- wagon equipment technology;
- train length extension;
- train manoeuvrability.

2. Beyond the state of the art

2.1. Wagon structure design

For the wagon structure design, the project focuses on the new design giving direct efficiency such as better payload, less deadweight, extended usable length, increased flexibility and maintenance cost reduction. With a reduced weight due to new materials utilisation, the new design evolution allows to take advantage of the prevailing gauge profile of the European network improving the trains' productivity. The wagons' design incorporated the market demand for increased flexibility in order to reduce the empty running making the skeletal flat wagons for containers/swap bodies, usable for other types of cargos. This is made possible by fitting these wagons with folding elements or platforms adapters perfectly satisfying all operating and safety requirements. These concepts have gone well beyond the test phase since leading wagons keepers and rail/intermodal operators introduced them into their services schedules to be offered in the market place. Some pictures of these wagons in use constitute a better description than any technical commentary.

Fig. 1. Foldable stanchions Wascosa stackable flexi freight system®. Source: Wascosa.

Fig. 2. Container loading adapter to flex car. Source: Wascosa.

The innovations described in the above pictures have been introduced in real business environment for servicing traffic flows involving a major supermarket chain in Switzerland and in international trains carrying both containers and forest products utilizing the flat platform with stanchions as per picture. In this way the train is in fact a full intermodal train. The stanchions are foldable and the platform are stackable avoiding empty running. The possibility of loading different types of cargos improves the rail system flexibility and productivity contributing to transport modernisation in line with market needs. The modular design reduces in the long run the number of specialized wagons standardizing the European rolling stock park.

Another demonstrator of the C4R project consisted in analysing the market needs by approaching two major customers involved in important trans-European traffics. The first one, Van Dieren Sweden, operating regular long distances swap bodies trains across Europe, developed the requirements for intermodal rail links incorporated in multi modal supply chains. The second, STVA, is a large car carrier. It developed the needs of specialized flows focusing on voluminous but light weight traffics which have specific requirements. These requirements, identified and developed in the project documents, have originated the inception of new wagons designs proposed to the industry, capable of intercepting the market demands. Knorr Bremse as technology equipment supplier and NTnetAB as wagon designer and manufacturer, provided together the technical specifications for implementation. The innovative designs of wagons of up to 12 axels for light weight voluminous cargo have been proposed for a stability analysis and an industrial production feasibility. The new wagons designs are aiming at making the best use of the authorized train length without reducing the classical maximum transport speed.

Fig. 3. 12 axle container wagon & car transportation design. Source: NTnetAB.

2.2. Wagon equipment technology

For the wagon equipment technology a continuous electric line carrying a bus of information all along the train and bringing energy to the wagon allows placing various sensors increasing safety and reliability. With this new wagon connectivity, predictive maintenance is developed and accurate real time information are available for the customers enhancing the planning efficiency of the next supply chain evolution. The wagons are equipped with an electric command of the pneumatic brakes for an instant and simultaneous braking and releasing. The synchronous braking of all wagons reduces drastically the longitudinal forces in the couplings enabling progressive lengthening of the train reducing operational costs and network capacity consumption per ton transported. The continuous electric wire is well known technology in the system since it is used in the Passengers' trains. The non-application to

the freight trains is due to cost factors similarly to the automatic couplers. The market needs for reducing the operating costs through longer commercially faster and heavier trains brought into the fore the need of equipping these long trains with the continuous electric wire and the automatic coupler. In order to reduce the cost the automatic coupler can be applied not to every wagon but at regular intervals all along the train. Draw bars can be also applied to wagons in order to increase stability.

The development of synchronous system of braking and/or an EOT device was introduced in the stability studies performed by KTH Royal Institute of Technology in order to assess the performances of the innovative wagons. Following the introduction of an electric wire all along the train, the synchronous braking is becoming reality, impacting on the wheels' temperatures. Researches and studies are carried out to correlate the wheels temperature to their wear and tear. The results of the first tests on bench are encouraging and they open up the field for a cost reduction of the wheels' maintenance, by minimizing the re-profiling frequency caused by solicitation of the composite shoes introduced for the noise reduction.

With the instant braking the longitudinal forces all along the train are drastically reduced. This provides the flexibility for extending the train length in the rail infrastructure whenever possible. The instant braking moreover allows a shorter stopping distance and the instant releasing of the brakes provides a greater manoeuvrability of the train creating additional capacity on the network.

The electric wire provides the availability of electricity to each wagon enabling the installation of various types of electronic sensors and energy for reefer containers. They provide continuous information on the wagon conditions. This real time knowledge increases the safety and contributes to the reliability and the asset turnover through the introduction of a predictive maintenance. This equates to cost reduction in presence of an improved level of service since the unpredicted incidents due to bad wagon conditions are greatly reduced.

2.3. Train length extension

The Marathon European Commission co financed project under FP7 scheme, demonstrated that two classical trains of 750 m long can be coupled together. The second slave locomotive is unmanned and is radio commanded by the first one through a computerized interface reading and managing the instructions coming from the driver of the front one. The existing well known technology "Locontrol" has been adapted to fulfil the European safety and security standard and by so doing a train of 72 wagons carrying 210 TEUs of 1524 m length and loaded with 4036 Tons performed a run of about 300 km travelling at 100 km/h from Lyon to Nimes satisfying all braking tests in extreme conditions. The run was performed twice both with electric and diesel traction using both Alstom and Vossloh locomotives respectively. The train tests produced an operating costs reduction of up to 30% and a capacity utilisation saving of up to 40% together with lower energy consumption. The train moreover demonstrated a great flexibility since the coupling of the two trains took no more than 15 minutes to be performed, with similar time in the decoupling. This characteristic, likewise it has happened in the test, allows the trains coupling and decoupling on long hauls along the European existing infrastructure. The intermodal trains used in the test originated from Germany and were destined to Spain. The trains were able to keep their standard schedule despite being coupled and decoupled during transit, while the end customers did not realize that this operation was ever carried out. In order to demonstrate that this concept works both with intermodal and conventional trains, a number of conventional wagons were added to the train in order to reach the desired length. Five conventional wagons were added in the first run whereas in the second run the number of conventional wagons were eight. The wagons efficiency is the relevant factor not the type.

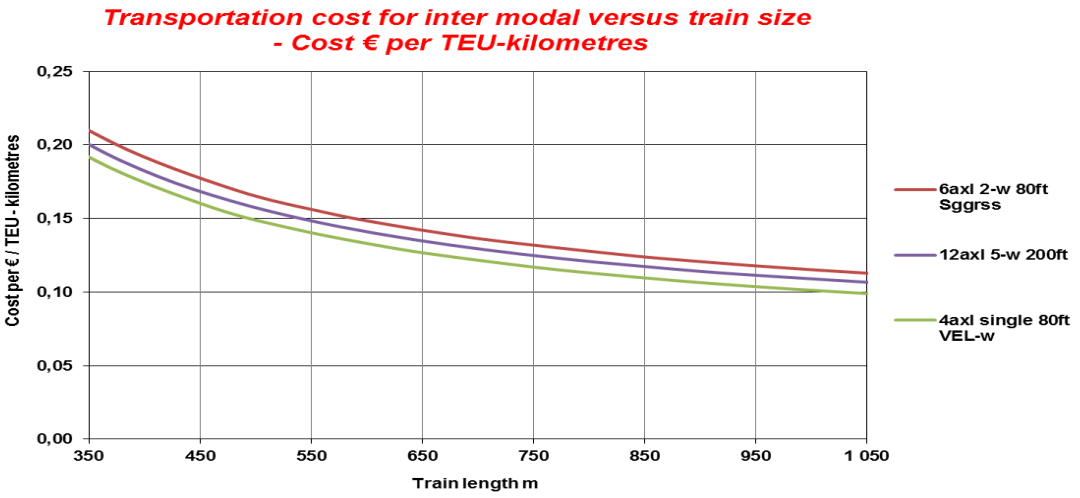

Fig. 4. Transport cost reduction by train lengthening. Source: KTH.

2.4. Train manoeuvrability

All these innovations spanning from the wagons design and technology, the new braking system, the train lengthening improve the overall train stability and manoeuvrability reducing the wear of the wheels created by the new brake composite shoes imposed for noise reduction. In addition they allow the trains to travel at a much higher commercial speed which gives access to better paths during the day in between passengers' trains delivering to the market place a much needed better service performance regularity.

3. Conclusions

All these progress are researched and checked in terms of affordability taking into account not only the global added value created but an equitable reward of all the stakeholders having invested for such innovations. Proposed roadmaps incorporate viable business models for a progressive implementation on the basis of simulations. A virtuous circle is initiated improving the use of assets, reducing noise, informing customers more efficiently, reducing maintenance and operational costs in an affordable way.

The C4R Project evaluates if these innovative concepts create viable and sustainable business cases supporting the introduction of innovative wagons in the marketplace for a long term migration strategy towards a more efficient, modern and competitive rail economy in line with market expectations.

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