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CAPACITY4RAIL project. The wagon load activity technology innovations: new freight wagons and trains

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Abstract

The Capacity4Rail freight sub project aims at improving the competitiveness , the reliability and the attractiveness of rail freight transport for responding to the more sophisticated market requirements. A continuous electric line all along the train allows the installation of electro pneumatic brakes offering much better trains manoeuvrability. It carries a bus of information conveying data showing the wagon and cargo status. With predictive maintenance, train lengthening, updated information for all interested partners, better accessible paths generate reliability, cost reduction and increased capacity on the network. The introduction of central automatic coupling fulfils traffic industrialization for reducing operating costs improving shunting yard operations rejuvenating the wagon load traffics essential for smaller and frequent shipments. Economical assessment and roadmaps for introducing technological innovations in rail transport are made.

Keywords: technology innovations ; wagons wired link ; Instant braking ; Instant release ; electronic valves ; safety information ; computerized management ; wagons trains step change technology

Résumé

Le sous-projet fret de Capacity4Rail vise à améliorer la compétitivité, la fiabilité et l'attractivité du transport de fret par fer en répondant aux exigences du marché. La pose d'une ligne électrique continue sur le train permet d'installer des freins électropneumatiques qui donnent de la manœuvrabilité. Elle porte également un bus d'information qui transporte toutes les données concernant le wagon et la marchandise. Une maintenance préventive, un allongement du train, une information rafraichie disponible pour tous les acteurs intéressés, de meilleurs sillons deviennent accessibles et génèrent de la fiabilité, une réduction des coûts, et de la capacité sur le réseau. A terme l'introduction de l'attelage automatique central permettra l'industrialisation et l'amélioration des triages et la relance des trafics par wagons isolés indispensables pour des envois plus petits et plus fréquents. L'évaluation économique et une méthodologie d'introduction de ces innovations technologiques ferroviaires sont proposées.

Mots-clé: innovations technologiques; wagons de liaison filaire; freinage instantané; libération immédiate; valves électroniques; information sur la sécurité, gestion informatisée; changement du technologie wagons des trains.

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1. Introduction: why Capacity4Rail

During a long period of time rail freight has been successful due the traffics of solid and liquid bulks such as minerals, steel, oil, and chemicals. At the same time general cargo traffics were distributed to inland destinations by the single wagon load system. The advent of containerisation impacted negatively these traffic volumes while combined transport developed rapidly across the world. The wagon load traffics became extremely vulnerable generating deficits in the various Railway undertakings accounts despite public support to the private sidings investments. At the same time road transport with its competitive offerings, flexibility and service quality took the lion's share of the market place.
Rail transport went into a very uncomfortable position losing in addition to single wagons loads also regular traffics flows transported by block trains due to its inability to find adequate market response to the challenges set by the competing modes. Unfortunately for Rail freight these traffics transported by the single wagon load system were still representing a large share of the revenue despite generating heavy fixed costs. The Railway undertakings' reaction was to develop combined transport. On this segment the transhipment operations and both the road collection and final delivery costs left very low margin on the rail leg between terminals despite public support everywhere in Europe. Facing such a difficult situation in all market segments of their interest the railway undertakings were forced to make choices for improving the financial situation of rail freight in general:

- Industrialize the production of the point to point block trains
- Reduce their losses in single wagon load traffics by different type of actions such as

a) Subcontract the last mile to low cost operators
b)Select the traffics which could pay a higher price,
c) Transfer the risk of filling the trains to the intermodal operators,
d) Develop hub and spoke solutions,
e) limit single wagon load traffics to few terminals situated in high traffic attraction zones.

In order to improve the combined transport financial situation the solution was to develop the Trans-European traffics offering long distance rail transport which could more easily absorb the transshipment and the expensive last mile costs. In fact in rail –freight the longer the journey is the lower becomes the cost per unit transported, unlike road transport where the longer the journey is the higher becomes the costs of the unit transported. This simple paradigm is dictated by the fact that a long distance intermodal train is equivalent to an industrialized transport whereas a single truck transport is linked to the drivers human needs, idle times, holidays and week-ends as well as the higher fuel consumption.
The technical difficulty encountered which is still a limiting factor for intermodal Transport is interoperability necessary to have a seamless transport chain across Europe. Multi-current locomotives equipped with multi control command system allowed to bridge that gap temporarily until a unique European rail train management system becomes available everywhere at an affordable cost.
The major shippers concern is the reliability of the rail transport which is affected by this lack of interoperability by the various rail bottlenecks in central Europe and by the priority given to passengers' trains. Despites the gaps to be overcome are well known, the problem solving is complicated since during a period of decreasing freight volumes in Europe, passengers transport is developing capturing most of the Rail infrastructure investments while Rail by-pass on congested traffic zones necessary for improving freight trains performances are still waiting.
The situation rather than improving is likely to worsen In order to develop the high speed system it is necessary to allow high speed trains to run on classical rail tracks in connecting part of the journeys. Moreover around large urban concentrations a network of frequent regional trains are organized for gathering the passengers using high speed services in connecting stations. In addition passenger trains accelerate quickly reaching speed of around 160km/h or more for intercity trains and 120km/h for suburban trains. Heavy freight trains have an economical speed of around 100km/h which implies an efficient train management system for combining all these different technical requirements. Needless to say that the priority in allocating the paths and managing the trains are higher for passengers than for freight trains. In such situation freight trains do not appear to be a priority for rail undertakings. The ultimate result is that freight customers are not satisfied by the service

reliability and the transit times offered by rail-freight. In turn this unreliability has direct consequences on the railway undertakings due to the waste of resources impacting on their financial results. This is the reason why traffics have gone back to road and it is difficult to realize the modal shift to rail despite all the efforts made by the European Commission initiatives. The gaps solution is therefore becoming paramount if the EU Commission long term objectives are to be fulfilled.

Capacity4Rail in its freight part analyses these gaps, proposes technical and operational solutions for attracting shippers and logistics operators towards a rail competitive and sustainable transport system.

2. The market needs

The market needs a door to door competitive frequent reliable and reactive service. It must be easily accessible even for smaller volumes but able to cope when necessary with rapid traffic growth. The market needs and wants a continuous information flows on the transport progress and on track and trace due to the increased sophistication of longer and more complicated supply chains. Real time connection and communications are vital ingredients for the ultimate users who need to react immediately to any emergency for avoiding any supply problem to their production lines. Such requirements do not really belong to the culture of the railways undertakings very centralized in their decision makings, driven more by production principles than by marketing approaches. A major evolution or revolution in the way of attacking the sophisticated market needs is therefore necessary. In order to satisfy the customers' needs rail-freight has to adopt several actions for revitalizing the three market segments they are serving at present which are:

- the combined transport with a network of terminals covering most of the European traffic attraction zones in conjunction with road collection and delivery for the last mile distribution. This segment equates to about 25% of the total railways traffic
- the full industrial trains for raw materials, chemicals, agriculture, steel etc equating to another 25% of the total traffic

All the above services need total reliability to be consistent, competitive and acceptable by the market place. In order to make this possible the following weaknesses representing important rail barriers, must be overcome. The freight trains are slower than passenger trains and do not accelerate as quickly. So they are frequently put aside by the infrastructure managers. Then it takes a long time finding a new slot for these trains to be restarted since they consume the equivalent of roughly 4 passenger paths. Increasing the speed of freight trains without losing the transport capacity represents an important technological challenge to be overcome at an affordable price.
An important difference between passenger trains and freight trains is the type of braking. In a freight train the order of braking comes from the driver who lowers the pressure in the continuous brake pipe all along the train. The first wagons start to brake before the last ones which means that about 30 seconds are necessary for the train to brake effectively. For releasing the brakes the compressor of the locomotive must fill in the brake pipe to release the brakes of all the wagons. This type of reaction implies that for safety reasons the path of a freight train is much wider in terms of time than the path of a passenger train.
The consequence of these quoted difficulties is that in case of incidents/problems disturbing the trains schedule the freight trains are the victims because their reactions are much different from those of passengers trains which can slow down quickly and restart quickly reaching their nominal speed within a short time.

3. The technological step change

The possible solutions available for bridging this technological gap is providing the freight trains with a better maneuverability in order to have all wagons braking and releasing instantly. This can be obtained by installing a wire all along the train carrying electricity for electronic valves adapted on the existing distributors for braking instantly when the order arrives, reducing the loss of air in the brake pipe for braking and the time for releasing the brakes. Simultaneously the electric wire carries a bus of information connected to a series of sensors. This allows to give information in real time. Such technological modifications entail that the increased maneuverability of freight trains creates usable capacity on the network, allowing more freight to be transported at the right time. It saves all extra costs created by the time freight trains are waiting to get a path among the

passengers/regional trains. It enables to modulate the braking in order to avoid any useless stops of the freight train creating waste of infrastructure capacity and other resources. This possibility of getting better paths for the freight trains is assessed by the infrastructure managers involved in the project.
As all wagons are braking simultaneously the safety of the train is enhanced by the important reduction of longitudinal forces. This simultaneous braking of all wagons is favourable to a lesser wear and tear of the couple wheel/brake blocks. The sensors to be placed on the wagon thanks to the available electricity send back to the locomotive and then to the maintenance centre all necessary information for organizing a predictive maintenance reducing the number of very costly on-line incidents. All information on wagon and cargo status are forwarded to interested parties securing the reorganization of the supply chain in case of incidents. Such information are extremely useful coupled with an updated ETA produced by the infrastructure manager in charge of the path reallocation. The sensors placed on the wagons brakes enable to perform the brake test before departure from the driver cabin saving half an hour of work at each departure impacting the asset rotation and the service cost.
The previous installation of an electric line along the train implies to couple the wires between the wagons at each train reshuffling . At the same time the withdrawal of the buffers and their replacement by a central automatic coupler for the air pipe and the electric wire reduces the dead weight and the usable length of the train. In itself such efficient and safe solution is expensive and there is a need of analyzing the possibility of introducing automatic couplers for each couple of wagons linked by draw bars. This market study would check the existence of a sufficiently large logistics market for couples of wagons. If the issue of that study is positive a simulation is conducted on the basis of a robotized decoupling of the wagons before the hump, a remote control of the pusher, a tagging of all wagons with RFID enabling the computer of the shunting yard to prepare the right composition of the departure train avoiding a second reshuffling before the final delivery. This industrialization of the marshaling yards reduces the cost of this part of the single/group of wagons transport. In order to re-launch the single/ group of wagons traffics a series of progress have to be achieved on the main trunk travel, on the shunting yards and on the last mile. The installation of central automatic couplers is a major step towards a production industrialization of this service and its competitiveness.
The design of pocket wagons able to transport P400 crane able semitrailers on gauge B+ rail tracks represents a breakthrough in the market as the major share of these type of semitrailers have a height of 400cm to 405cm. The challenge is important as this type of wagons is able to be incorporated into a typical combined transport trains enhancing the service competitiveness by the traffic bundling.

4. The solutions Implementation

The technological developments of these equipment are designed and tested by the equipment project specialists on benches to assess their on the -field possibilities. Their introduction in trains is simulated for appreciating their impacts while checking their global integration. A hazard analysis is performed ensuring the possibility of introducing them on wagons. In particular the installation of the electronic valves replacing the classical distributor need a very long test period for demonstrating their safety level, equivalent to the present pneumatic braking system. For this reason the project adds electronic valves to the present braking system and introduces a default detection with an automatic fall-back position which is the use of the classic pneumatic brake. The brake pipe ensures in any case a safe fall-back position as long as the length of the train remains in certain limits to be determined by the project.
The introduction of the central coupling increases the safety level since the coupler bears higher Longitudinal efforts than a traditional UIC coupling buffer creating much less risks of derailment in case of compression forces because of its central position. The impact of all sensors on maintenance costs are based on the knowledge of the wagon keeper participating in the project. Theoretical studies on the wheels impact of a lighter and more regular braking force applied by the composite shoes is conducted by the universities associated to the project.

5. Economic analysis

All these developments are estimated at an industrial level to perform the cost benefit analysis. The impact on traction costs is assessed by the railway undertaking involved in the project and by the operator of a fleet of wagons for new car transport. This assessment enables to select the most efficient investments to reach a real step change in competitiveness, reliability and renewed attractiveness of rail freight transport. A specific attention is dedicated to the impact on a possible wagonload activity if the study on the couple of wagons logistics concludes positively. In order to monitor the future progress the economic analysis identifies significant KPIs characterising fundamental factors like reliability, cost reduction and network capacity. For a global analysis these assessments integrate the progress made in terminals studied in other parts of Capacity4Rail.

6. Roadmap to implementation

The final step in developing such researches and innovations is to organize them in logical sequence for a progressive integration. Such totally new systems have to be introduced on a convincing scale replacing existing systems when they become obsolete or when they are amortized. The project is limited to simulations but the impact of the possible innovations on the stakeholders supply chains is assessed enabling to appreciate the introduction effects on the market place. The project considers first the improvements bringing a direct return to the investor. This is the case for an improved wagon design which efficiency can be tested o prototype after the design phase. Subsequently it will consider some components integration creating a subsystem that can be tested on a wagon and introduced on a train at a specific position. The electrification of one wagon with new electronic valves complementing the existing pneumatic distributor equipped with some sensors is possible next to the locomotive. The impact on the manoeuvrability of this future freight train is tested during the elaboration of a new time schedule by an infrastructure manager. The automatic coupler and the decoupling robot can be tested separately subject to covering the risk of such an investment in a robot specifically designed.
The final stage of the road map is represented by the study of a global on-line demonstrator associating all the supply chain stakeholders for assessing the economic impact of all components integration already validated evaluating the added value created. The study of the infrastructure managers on the added value generated for the different stakeholders is necessary showing the possibility of inserting all these innovation in the market with success.

7. Conclusions

The project has four components:

a)A scientific research on a more efficient wagons design, on metal structure, on information simulation, on structural stresses, on wear and tear under pressure of the brake shoes

b)An Operational research for analysing the impact of a better manoeuvrability on path drawing, driving methodology in degraded modes for longer train with buffer or central couplings

c)An Economic analysis with a cost benefit study for the various new components and for their integration in the train system, for various new design, for new operational procedures

d)A strategic research for finding the best way of introducing the innovations in a system largely governed by ancient practices needing modernisation.

Capacity4Rail creates capacity on the network and set the basis for a viable, renewed competitive rail freight activity. Modernization and technological advancements and innovations are necessary for changing encrusted practices and processes. For existing point to point services it will allow a better profitability by a lower maintenance cost, a better use of available infrastructure, higher productivity, efficient rolling stock and human resources usage. It will help to progress in the direction of the targets set up by the White Paper of the EU Commission: shifting traffics from road to rail for a long term environment friendly, competitive and sustainable freight transport system.

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