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SHUNT-E
Autonomous zero emission shunting processes in port and hinterland railway operations
by

Dr. Iven Krämer[1]

ABSTRACT

Hinterland connectivity is one of the most competitive distinguishing factors for today's sea- and dry ports. Therefore innovations with a clear focus on autonomous and emission free port operations are crucial to safeguard a prosperous future of global ports. Significant steps for this are the optimization and gradually atomization of rail operational processes on the last mile including necessary modern and transparent IT systems and to design autonomous shunting processes. Together with partners ISL (Institute of Shipping Economics and Logistics Bremen), BIBA (Bremen Institute for Production and Logistics) and IVE (Institute for Transport, Railway Construction and Operation in Brunswick) in connection with associated business partners the project "*Shunt-E 4.0 - Autonomous zero emission shunting processes in port and hinterland railway operations*." has been applied for at the German Federal Ministry of Transportation in the funding initiative IHATEC (Innovated Harbour Technologies) – and had won a grant to perform the proposed work. The practical research program is conducted together with Bremen's port railway which is regarding to the modal share of rail hinterland transport the leading European port railway system. This article highlights the overall objectives ambitions and expected outcomes of this project.

1. TODAY'S PORT RAILWAY PROCESSES

The railway operation in port areas in Europe is characterized by split-up responsibilities, a high number of players and a lack of comprehensive planning and optimization of all relevant processes. Still innovative technologies and business processes are useful to achieve key steps on the way to overall optimization. A substantial part of the European rail freight transport has its origin or its destination in an inland or sea port. Considering the railway system, ports play a more important role for urgently needed innovations than the pure interfaces between sea and land transport. Especially ports with their own railway system have a greater responsibility in this matter.

Port railway operations today are comparably complex processes. The general container train process which involves different partners like railway undertakings, shunting operators, infrastructure providers, energy providers, terminals operators, port management organizations etc. is on the example of a typical European railway system (Bremen's port railway) divided in various steps as follows:

- Train arrival with separation of the electrical main-line locomotive in the port area
- Transport of train section or wagons with shunting locomotives (diesel) towards forwarding groups and later on to the terminals
- control and supervision works by terminal operators on the train and on the cargo (i.e. seal-check), unlocking of containers
- Unloading and loading processes by terminal operators
- Transport of train section or wagons with shunting locomotives towards forwarding groups
- Brake tests, checking procedures by railway operators
- Train departure

[1] Free Hanseatic City and Ports of Bremen (Germany), Head of Port Economy and Shipping, iven.kraemer@wah.bremen.de

As a consequence of these steps the first cargo movements can and do only start hours after train arrival in the port area. A comparable long procedure is (still) needed after completion of train loading process. Trains with import goods need to have specific brake tests and load control works with following shunting processes. Just by these rules they remain in the port area for an average of two hours before they can start towards the national and European hinterland destinations. As a result port railway operation today is much more complex and thus disadvantaged compared to truck and barge processes. The reasons are mainly self-made rules and regulations by the industry sector. In intermodal transport on European level it would be possible to improve productivity by at least 20 percent alone by optimizing the railway operation on the last mile.

2. EXAMPLE: PORT RAILWAY OPERATION IN BREMERHAVEN

The port railway network in Bremerhaven (Figure 1) is non-discriminatory accessible and part of the public infrastructure company "*Bremische Hafeneisenbahn*" who belongs to the Free Hanseatic City of Bremen which takes care of its infrastructure with related operational and technical service providers. Currently the tracks are regularly used by more than 30 European railway companies with 60 more having license agreements. These companies connect the ports of Bremen with national and international hinterland traffic.

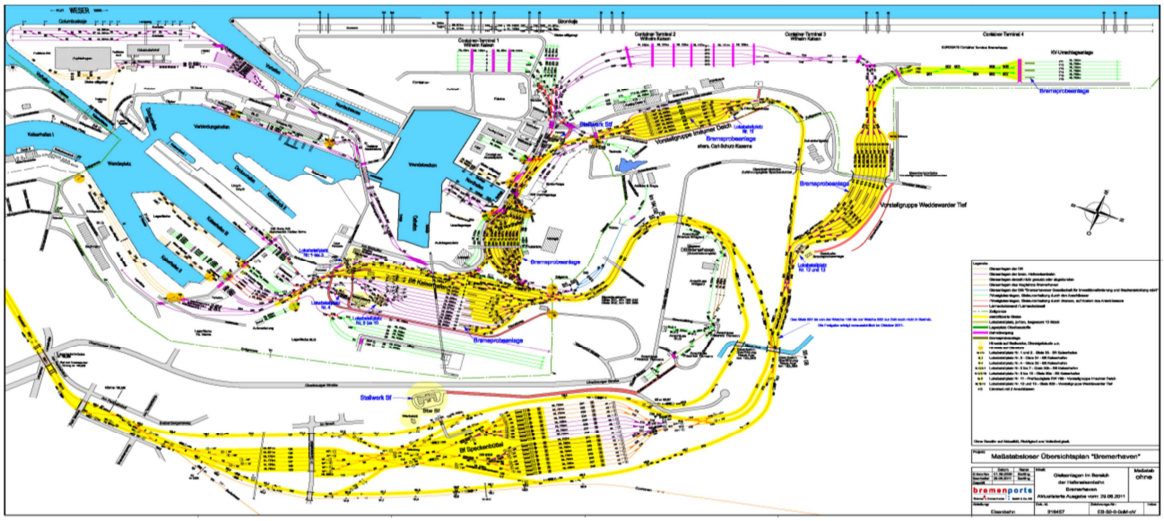

Figure 1: Port Railway Network within the Port of Bremerhaven (electrified tracks are marked in yellow)

Several competing shunting companies take the task of transporting the trains and wagons within the harbour area – which are usually loaded with vehicles or containers in Bremerhaven – from the starting rails to the receiving terminals and vice versa. They carry out the tasks on behalf of the corresponding railway company which in return make sure to provide the electrical operated mainline locomotives including their destined train drivers for entering and leaving the port area right on time. Currently there are 13 shunting locomotives of different type and age – all Diesel operated- being active 360 days a year in a 24/7 system. To operate a shunting locomotive a train driver and a shunting worker is needed. Shift planning for them is done by the on-site managing clerk of the respective railway company. The actual driving and shunting operation is based on the regulations of Bremen Port Railway. Their managing staff organizes the track use and their dispatcher at the signal box sets and authorizes the driving route. The handling companies set with their loading and unloading processes the pulse for the train movements. In Bremerhaven, loading and unloading containers as well as automobiles follow slot times specified beforehand. The processes also take into account the load levels of the specific wagons to avoid idle and waiting times.

There is no direct contractual relationship between the terminals, the port train operator and the shunting companies so that communication and coordination between the involved parties is of major importance.

All together Bremen's Port Railway system has been developed over more than 150 years always being an integral part of the overall port system and development strategy. As a result the port of Bremerhaven today has a leading railway modal share in container hinterland transportation of about 50 percent (Figure 2)

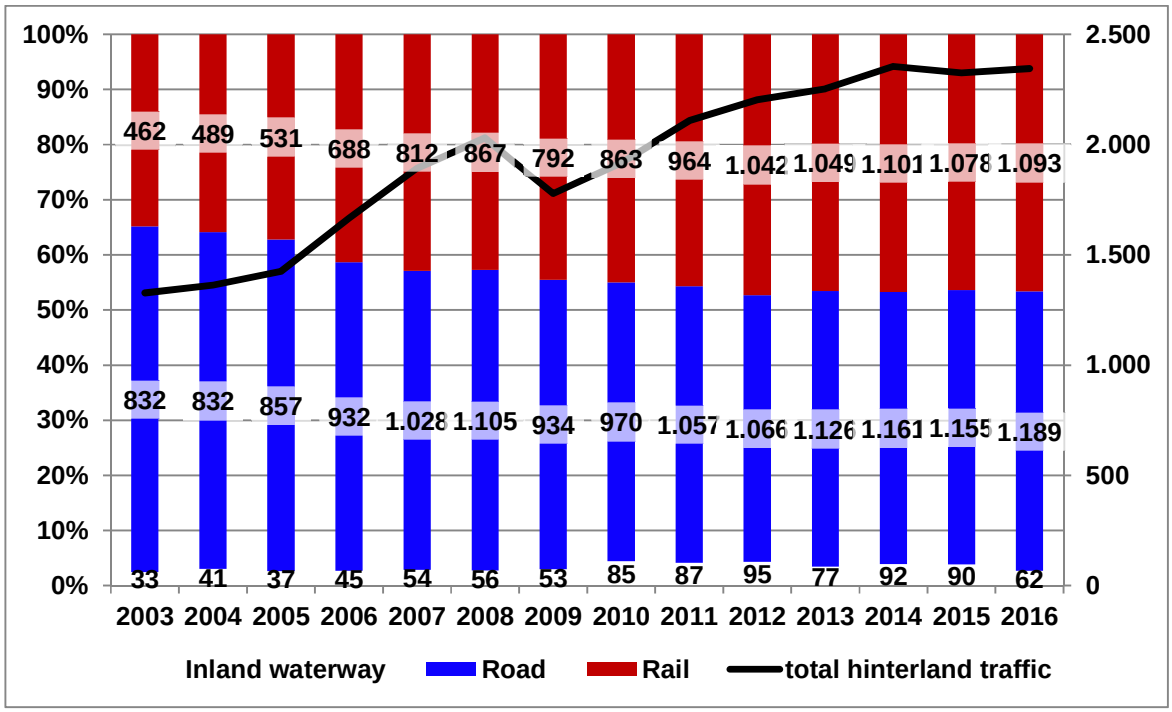

Figure 2: Modal split development in Container Hinterland Transport in Bremerhaven in TEU

In terms of the automobiles transported from the German and European factories to the port the rail share is even higher with almost 90 percent.

3. NEED FOR ACTION MORE THAN OBVIOUS

Innovations in cargo rail sector are rare, even if good ideas do exist. Many previous projects on automatization and process optimization failed or were stopped by various reasons. In fact technical solutions like automatic clutches, automatic brake tests, remote train control systems, automatic load controls, obstacle detection and many more rail related optimization measures are technically feasible and were successfully tested in the past. But, they didn't make it to the broader market.

As a consequence rail transport of goods until today is in most regions of the world very traditional and old-fashioned. Especially in comparison to truck transport the rail sector is falling back. Ongoing innovative projects like truck-Platooning or autonomous trucks endanger the system advantage of rail and thus the transport-political perspective of rail transport. If global ports want to improve railway transport they strongly need innovative port railway systems and processes.

4. PROJECT SETUP

On Bremen's port railway today various competing companies offer shunting services to the railway operators within Bremerhaven port area. It's their task to move the train sections and wagons between the forwarding groups and the terminals. The main-line transport to and from the national and European hinterland is conducted by currently about 80 different companies (Railway undertakings). These companies also take care that enough train drivers are in place at the time when they are needed for the port leave. The railway undertakings are the purchasers of shunting services.

With the support of Germanys Ministry of Transportation Bremen's port railway has been selected as a test bed for autonomous emission free shunting processes as an example for general port railway systems. Scientific partners in the project "*Shunt-E 4.0 - Autonomous zero emission shunting processes in port and hinterland railway operations*" are:

- ISL (Institute of Shipping Economics and Logistics), Bremen,
- BIBA (Bremen Institute for Production and Logistics) and
- IVE (Institute for Transport, Railway Construction and Operation) in Brunswick.

Besides these scientists there are several supporters and partners from the ports and logistics sector directly involved in the project. These are:

- Eurogate (Container terminal operator),
- BLG Logistics Group (Automobile terminal operator as well as railway undertaking)
- DB Cargo (railway undertaking as well as port shunting operator)
- Elbe Weser Verkehrsbetriebe - evb (railway undertaking as well as port shunting operator)
- Verband deutscher Verkehrsunternehmen VDV (Assoziation of German Transport Companies).

5. PROJECT OBJECTIVES

The aim of a totally autonomous shunting operation can and will be reached only with intermediate process automatization steps. The expected effects of autonomous emission free shunting operations to date are the following:

- Simplification of operational rail processes
- Avoidance of empty-locomotive-drives
- Reduction of the overall shunting stock (Savings of about 30 percent are expected)
- Avoidance of communication-interfaces
- Optimization of infrastructure use with savings on future investments
- Reduction of operational efforts and costs (on the locomotive and in the offices) through reduction of personnel
- Safety-Improvements
- Disruptions reduction in port railway operations

Compared to the actual system with manned shunting locomotives (most of them many decades old and running on diesel) and dispatchers within the train control centres *Shunt-E* will be able to operate on her own. To do so *Shunt-E* will continuously check and monitor its current position and status, she will know about and plan all upcoming transfer orders and she will via IT interfaces have access to all necessary information from terminal operators (time slots, loading and unloading status, customs declaration, dangerous cargo…) port officials and railway undertakings (planned as well as real

arrival and departure times, train and cargo status, availability of train drivers…). Building on these information *Shunt-E* will be able to plan and conduct optimal transfer procedures which leads to an optimised infrastructure utilisation. Shunt-E will be able to operate 24/7 with no delays due to shift changes, staff meetings etc. And finally *Shunt-E* will be operated either electrically or on fuel cells which makes the whole shunting process or the last mile in intermodal transport emission free.

The research work done with this project will identify the necessary technical, organisational as well as legal measures to improve the overall performance of rail transport in port hinterland transport. It is expected that a minimum of two hours can be saved for every single train in long-haul port services. Furthermore the costs for operational personnel on board of the shunting locomotives as well as in related offices can be drastically reduced, so that autonomous shunting locomotives will be in service in various ports of the world at least from 2030 onwards. It is not yet clear if Bremerhaven with its traditionally grown port infrastructure will be the right place for a Shunt-E implementation or if instead an “easier” port system like green field projects might be better testbeds.

6. RELEVANCE FOR THE GLOBAL PORT COMMUNITY

Shunt-E 4.0 - Autonomous zero emission shunting processes in port and hinterland railway operations” is of high relevance to the global port community as it combines the necessary innovation approach for future port development with a sustainable greenports strategy.

ACKNOWLEDGEMENTS

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The port administration of Bremen expresses their appreciation of the partnership with all the companies and institutions involved.