INTEGRATED PLANNING AND CONTROL ON RO-RO TERMINALS

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ABSTRACT
In vehicle logistics several logistics service providers are involved across the process chain ranging from transport of new vehicles to the automobile terminal via storage and technical modifications on the terminal to delivery of the vehicles to the customer. Today, coordination of the process executors is marked by a short planning horizon, as none of the involved parties have access to all necessary planning information of the entire process. Currently no integrated process design of the logistic chain is executed.

This contribution deals with developing an integrated planning and control method for collaborative vehicle logistics processes. The method considers both vehicle terminal processes as well as transport processes executed by automobile logistics providers.

The logistic effects of applying this method will be determined in a simulation study using discrete event simulation. The method will be implemented in real automobile terminals by means of a prototypical software based control centre.

Keywords: automobile logistics, planning and control, Ro-Ro terminals

1. INTRODUCTION

This contribution deals with integrated planning and control of order processing in vehicle logistics performed at automobile terminals. Such terminals are situated at strategically important traffic nodes, like sea harbours, and provide a network of service points that is essential for vehicle supply chains marked by steadily increasing internationalisation of production and sales.

The German automotive industry e.g. in 2006 exported 70% of the production volume, or 3.9 million cars and 290,000 commercial vehicles, including 650,000 cars and 8,300 commercial vehicles to North America and 350,000 cars and 12,600 commercial vehicles to Asia. On the other hand, ca. 30% of all cars newly licensed in Germany in 2006 were produced by foreign manufacturers, while an additional 23% were cars of German brands but not produced in Germany (N.N. 2007).

Consequently vehicle outbound transhipments via European ports of the North Range (Zeebrugge – Hamburg) during the 1990s more than tripled whereas inbound transhipments remained stable (Mattfeld 2005).

A large part of the vehicle exports as well as many inland sales are conducted via automobile terminals. At the automobile terminal of the German sea port Bremerhaven, which will serve as an implementation partner for the method proposed in this contribution, nearly 2 million new vehicles (1.85 million vehicles in 2006) are handled each year on their way from the manufacturer to the dealer or retailer and are exposed to a variety of value added services.

These services include shipping or arrival both from sea or land side, storage, finishing and technical modifications to meet the multitude of individual customer requirements for the ordered vehicles as well as distribution to the retailers. Thus the service portfolio of automobile logistics service providers includes not only transport logistics, but also services falling into the field of production logistics.

The typical process chain of an automobile terminal can be structured into a set of process steps as illustrated in Figure 1. These process steps can be described as follows (Böse and Windt 2007, Mattfeld 2006):

1. Intermodal transport of the new vehicles to the terminal is normally performed by ship (often with Ro-Ro ferries), train or flat-bed trailers. Terminals are normally situated with very good access to the traffic infrastructure, so that imported vehicles arriving by ship can be unloaded directly onto the terminal. For ship transports to the terminal the expected time of arrival as well as a freight list are sent to the terminal several days before arrival.
2. Vehicle registration on the terminal includes registration and collection of all relevant vehicle data and transfer of these data into the operational software systems. Each vehicle is identified by its vehicle identification number (VIN) from the terminal staff, often by using mobile data entry de-vices, which can read barcodes. The vehicle identification number than allows identification of the vehicle during all later processes.
3. Storage at the terminal area: Based on pre-defined priorities the IT control system

allocates a storage location of a storage area as a storage position to each vehicle. A handling employee moves the vehicle to the assigned storage location.

4. Technical treatment and the subsequent allocation and delivery processes are normally triggered by arrival of the delivery request for that vehicle. After receipt of the delivery request the vehicle is removed from stock. The sequence of the technical treatment stations a vehicle has to run through is specified in the technical treatment order of the vehicle. The technical treatment steps include e.g. re-coating of vehicles, or washing and removal of separate coating layers (e.g. from wax) temporarily added for vehicle protection during transport. For individual customer orders, additional technical services may include installation of special equipment like radios or satellite navigation de-vices, and removal and replacement of certain parts or components.
5. Allocation and delivery: Upon completion of all technical treatment tasks, the vehicle is provided to the shipment area of the terminal, where the transport service provider can take it over.
6. Transport from the terminal to the automobile dealer or customer is normally executed by specialised transport service providers using special transport vehicles like e.g. flat bed trailers or low-loading trucks.

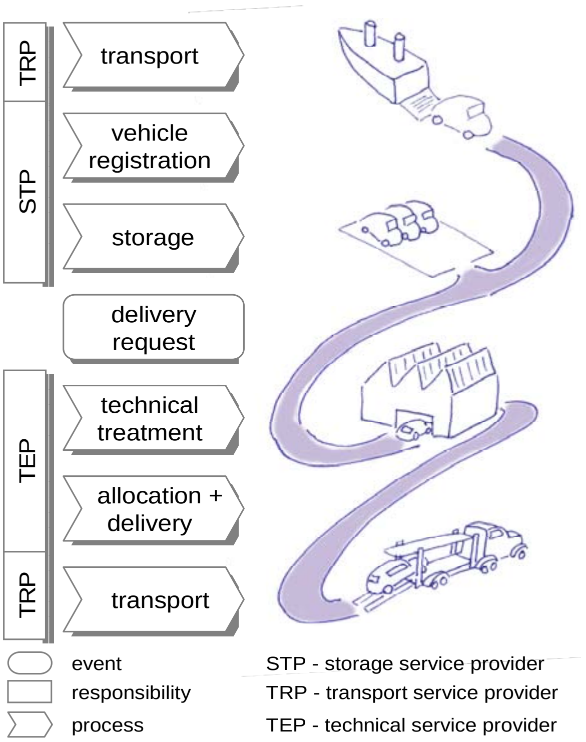

Figure 1: Process Chain of an Automobile Terminal

As not every sea port terminal offers all technical ser-vices, such as removal of transport protection systems, re-pair and coating, or mounting of special devices, the terminal services are frequently offered jointly by several specialised and cooperating companies, which fosters increased participation and cooperation of the automobile logistics service providers (automobile producers, transport carriers, automobile terminals, automobile retailers) in cross-company networks.

Typically storage services are provided by the storage service provider, while technical treatment is performed by separate technical service providers situated on the automobile terminal and transport to the terminals and from the terminals to the customers is performed by specialist transport service providers.

In the mentioned Bremerhaven sea port automobile terminal e.g. arrival and storage services are executed by BLG LOGISTICS AUTOMOBILE acting as the storage service provider, while technical services are executed by EHH AUTOTEC acting as technical service provider. The transportation of the vehicles is achieved by EHH Auto-mobile-Logistics operating as transport service provider.

2. CURRENT PROCESS EXECUTION AND RESULTING WEAKNESSES

Until today no integrated planning and control systems have been established for the order execution of an automobile terminal that integrate processes and information of related logistic services like e.g. transport logistics. Additionally planning and control of order execution processes on automobile terminals like e.g. management of parking positions or scheduling and sequencing for technical stations is mostly performed manually and thus unsystematically.

Thus the generally existing logistic target conflicts between interests of the customers (high logistic service quality) and those of the service providers (low logistic service costs) are intensified by lacking coordination and partially competing interests of the separate operating process executors.

For example, vehicles arriving by ship are temporarily stored on intermediary buffer positions to optimize lay days and waiting times of ships in the harbour. Storage position management, however, tries to minimize vehicle transport times on the automobile terminal and thus, if possible, reduce or prevent storage relocations. Vehicle transfer to transporters has to cope with similar weaknesses stemming from sub-optimal coordination with terminal providers.

Coordination of the process executing parties is generally characterised by a short term planning horizon. Vehicle call-off orders by technical service providers can only be executed, when a call-off order for the respective vehicle has been called by the vehicle producer or retailer and the technical processing is due the next day. This situation results in bottleneck effects and high occupancy of commissioning areas, preventable restoring activities and reduced adherence to delivery dates.

Vehicle commissioning and transfer from terminal provider to transport carrier is mostly executed at short notice, too. Transport times to the automobile retailer are considered for scheduling during the disposition of the vehicles by the terminal provider; however they are not considered for optimization efforts of costs and times. Avail-able transport capacities and relations of the transport carrier are not considered during planning and control of the terminal processes.

Based on the requirements of capacity planning and sequencing of orders at the technical treatment stations the terminal provider determines, which vehicles are allocated for transport and when transport dates are scheduled. Vehicles, which are prepared for transport, are messaged to the transport carrier's disposition system only after they have been allocated to the consignment areas and can only then be disposed of in the route planning procedures of the transport carrier. Duly timed transport capacity planning and route plan optimization (in the sense of a high payload factor and a low number of empty drives) are thus made more difficult.

Negative effects of the lacking coordination between terminal providers and transport carriers include high occupancy of the already large consignment areas, non-optimal utilization and efficiency of the carrier lorries, high uploading times for the vehicles, which are insufficiently concentrated and thus spread over a large area and non-optimal adherence to delivery dates. Insufficient utilization of transport carrier lorries due to short planning horizons with limited timeframes for search of amendment loads results in a larger traffic load on harbour to hinterland communications.

3. METHODICAL PROCESS IMPROVEMENT

Optimization of single processes of the closely interrelated vehicle logistics process chain in isolation is only possible to a limited extent and in numerous cases adversely affects previous or successive processes.

Logistic and manufacturing processes on automobile harbour terminals characterised by several involved logistic service providers, like e.g. the automobile terminal of the German sea port Bremer-haven, have to be regarded as a unified system, which also can be optimized only as a whole system. Thus an integrated planning and control method, such as proposed in this contribution, has to consider both, terminal as well as transport processes.

A graphical software control centre (Kurbel 1999) will provide all relevant information to all process executing parties, thus enabling a more efficient and timely planning and control of order execution and related processes on sea port automobile terminals.

The data contributed by the three parties, which are considered by the integrated control centre proposed in this contribution, are shown in Figure 2.

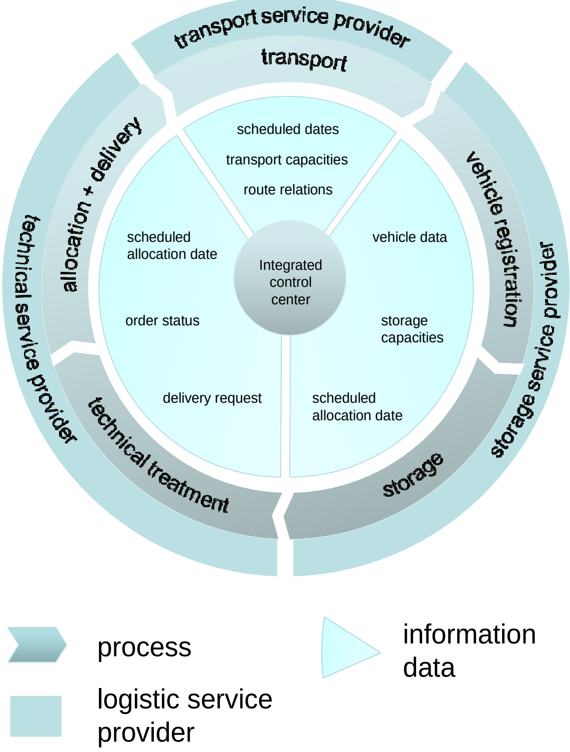

Figure 2: Integrated information management by means of an integrated control centre

The contributions can be described as follows:

- The transport service provider is responsible for transport of the cars to the customer. Relevant process planning and control data of the transport provider includes route relations (starting points and end points), transport capacities of lorries, and scheduled vehicle transport and delivery dates.
- The technical service provider is responsible for technical treatment and modifications of the cars such as e.g. coating or mounting special equipment. Relevant process planning and control data of the technical service provider includes delivery requests, order status as well as scheduled allocation dates of vehicles.
- The storage service provider is responsible for registration and storage of vehicles at the automobile terminals area. Relevant process planning and control data of the storage service provider contains vehicle data (such as vehicle identification number, vehicle orders), storage capacities as well as dates of vehicle allocation.

This way transparency of the planning relevant information will be increased for all process executors, who will be able to communicate their respective process requirements to the other parties involved and thus influence planning of the operational process execution. This will increase their benefit as well as contribute to improved over-all process execution effectiveness.

The collaborative process planning and control method will be described in the next section.

4. DESCRIPTION OF THE METHOD

Figure 3 outlines the activity chain of collaborative process planning and control of automobile terminal processes.

As already explained, the method involves the de-scribed roles of an automobile terminal storage provider, an independent technical service provider situated at the terminal and an automobile transport provider delivering the automobiles to the customers.

As shown in Figure 3, the collaborative planning and control method for the integrated terminal process consists of number sequential and parallel planning and information transfer steps, which are periodically performed by the respective process executors in a timely and logical sequence during both the process planning and execution phase.

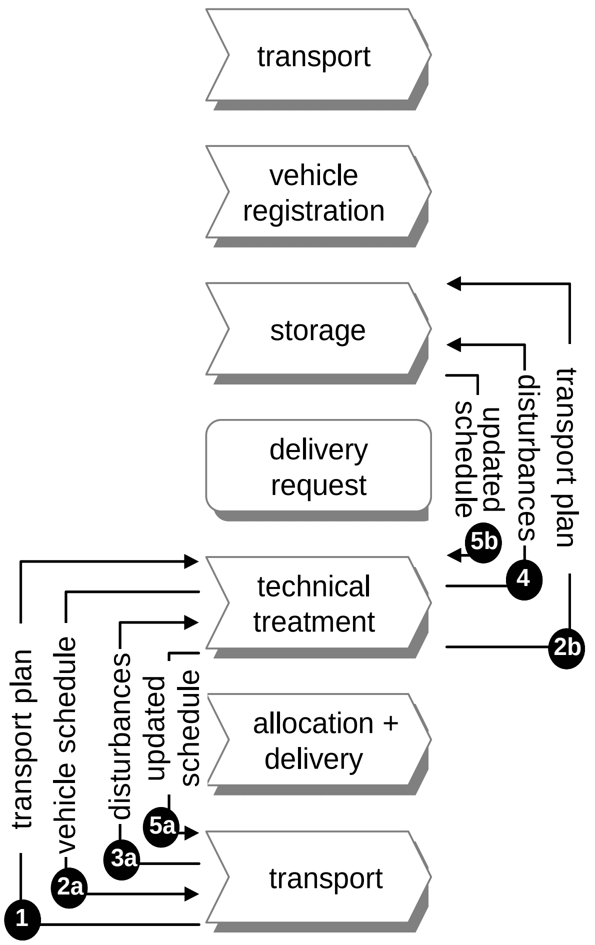

Figure 3: Activity chain of collaborative terminal process planning and control

These steps effect in the creation of mutually adjusted transport plans, technical treatment plans and storage allocation plans. The actions performed during the steps can be de-scribed as follows:

- Step 1: The car transport provider transfers information on his preliminary transport plan data to the technical service provider situated at the automobile terminal. This information includes mainly data on transport route relations (starting and end points of transport movements), data on the capacities and a rough schedule of transport carrier movements. This data determines the planned magnitude of the vehicles to be trans-ported during the planning period. The technical service provider receives this data and uses it for his own process planning, which will take into ac-count the data from the transport provider.
- Step 2a): After the technical service provider has created his own draft technical service plan for the planning period, he sends the sequence of technical service orders and scheduled treatment dates and times as of this plan back to the transport ser-vice provider, who uses the data to modify and re-fine his transport plan.
- Step 2b): Parallel to step 2a the technical service provider sends the data on the scheduled technical treatment dates of the vehicles to the storage ser-vice provider, who takes this data into account for creation of his own vehicle allocation schedules. Steps 2a and 2b and the respective actions taken by the transport and storage provider finish the planning and scheduling process.
- Step 3a: During the execution phase the transport service provider immediately sends any information on disturbances of his own transports like e.g. delays or breakdowns of transport vehicles to the technical service provider, who adapts his own schedules accordingly. If e.g. transport of several vehicles is announced to happen later than originally scheduled, technical treatment of these vehicles may be delayed and more urgent technical treatment orders may be brought forward in the sequence.
- Step: 4: The technical service provider in turn in-forms the storage provider on all disturbances of his own process execution. These may include e.g. changes in his own order sequence and schedules due to disturbances of the transport service provider or delays in the technical treatment processes, e.g. by machine failure.
- Step 5a: Based on the disturbance reports of the transport service (step 3a) provider the technical service provider adapts his own schedules and re-ports the modified schedules of the treatment orders back to the transport service provider who in turn can also adapt his own transport schedules.

- Step 5b: Based on the disturbance reports of the technical service provider the storage service provider adapts his own vehicle allocation schedules and sends the modified schedules back to the technical service provider, who can in turn modify his schedules accordingly.

5. EFFECTS

Employment of the method will increase transparency of the planning relevant information for all process executors, who will be able to communicate their respective process requirements to the other parties involved and thus influence planning of the operational process execution. This will increase the benefit of their operations as well as contribute to improved over-all process execution effectiveness.

Bundling of the transport orders already during order processing planning of the automobile terminal would make execution of the transport more economical. Better utilisation and efficiency of the transport carrier space capacities and a reduction of the transport cycle rates and acquisition effort for load amendments could be achieved.

Automobile terminal providers in their function as technical modifiers of the vehicles would profit from lower capital commitment costs due to reduced storage inventories and from lower vehicle processing times by preventing sequence errors or modifications at the technical stations. Across the process chain as a whole, adherence to delivery dates can be increased.

Application of the method is expected to result in the following potential improvements:

- Capacity increase of the automobile terminal (number of orders processed) due to more efficient use of resources (number of transport means, technical stations, personnel etc.).
- Reduction of total process costs of the whole terminal process chain.
- Reduction of the total vehicle order execution time from storage to delivery.
- Increase of adherence rates to delivery dates and prescribed maximal order execution times.
- Reduction of required disposition areas and carrier lorry loading times,
- Increase of carrier lorry utilisation rate and reduction of rate of empty drives.
- Reduction of traffic load at the port terminal and between port and hinterland.

Increased process security due to improved planning and control of order execution along the whole vehicle logistic process chain is regarded as an important additional criterion for success.

6. CONCLUSION AND OUTLOOK

The concept of an integrated planning and control strategy and its effects on logistic process quality will be validated by execution of a computer based simulation of a process scenario along the whole logistic process chain, thus going beyond the limits of one service provider's process execution.

The scenario will be based on real terminal processes, as performed at the automobile terminal at the sea port Bremerhaven, including initial transport, storage, handling, technical stations and distribution, performed by a terminal service provider (BLG LOGISTICS AUTOMOBILE), a specialised car storage service provider (EHH AUTOTEC) and a transport carrier (EHH Automobile-Logistics).

The simulation study will simulate and compare three different process scenarios. Vehicle order management will be modelled (a) as practised today, and be compared with (b) locally optimized processes and (c) an optimized, integrated management across the complete process chain, with all significant interests and requirements of the different parties considered.

Vehicle processing from the time of arrival on the terminal via storage and technical treatment at the terminal to delivery of the modified vehicles on the consignment areas will thus be scheduled with full consideration of estimated processing times, available buffer times until the order delivery date, and available technical and transport capacities and constraints.

As a tool for the simulation study, discrete event simulation will be used, which allows modelling of vehicles, storage areas and storage positions, delivery areas, technical treatment stations as separate entities. Such discrete event simulation models of automobile terminals have al-ready been used in simulation studies to compare the effects of different storage allocation strategies on vehicle transfer times on the terminals (Böse and Windt07).

The procedure for creation of the simulation model and calculation of the simulation results includes definition of the simulation scenarios, collection and preparation of the simulation input data, which will be taken from the real-world process data of the service providers, model creation, model validation, definition and execution of the simulation runs, and documentation and analysis of the simulation results.

Based on the validation by the simulation results, the planning and control method will be prototypically implemented as a software control centre. This control centre will provide a real-time process and status overview with capabilities for regulatory operations provided for all process executing parties mentioned in the reference scenario.

The proposed support method for planning and control of terminal and transport logistics services in vehicle logistics will allow to increase logistic performance.

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REFERENCES

Böse, F., Windt, K., 2007: Autonomously Controlled Storage Allocation on an Automobile Terminal. In: Hülsmann, M.; Windt, K., eds. *Understanding Autonomous Co-operation and Control in Logistics – The Impact on Management, Information and Communication and Material Flow.* Berlin:Springer, 351-363.

Kurbel, K., 1999: *Produktionsplanung und –steuerung. Methodische Grundlagen von PPS-Systemen und Erweiterungen.* München, Wien:Oldenbourg.

Mattfeld, D. C., 2005: Development of Vehicle Transshipment at European Ports. Proceedings of the 16th Mini - EURO Conference and 10th Meeting of EWGT, pp. 379-385. September 13-16, Poznan (Poland).

Mattfeld, D. C., 2006: *The management of transshipment terminals: decision support for terminal operations in finished vehicle supply chains.* New York (New York, USA):Springer.

N.N., 2007: *Jahresbericht 2007.* Verband der Automobilindustrie e.V. Available from: http://www.vda.de/de/ service/jahresbericht/files/VDA_2007.pdf [accessed 2 June 2008].

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