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INLAND WATERWAY TRANSPORT OF CONTAINERISED CARGO: FROM INFANCY TO A FULLY-FLEDGED TRANSPORT MODE

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ABSTRACT

In a time span of twenty five years, container transport by barge has acquired a significant share in the hinterland modal split for containers of the seaports of Rotterdam and Antwerp. In other European load centres, barge container transport as yet plays a modest role, but the interest in the barge option is growing. This paper addresses the dynamics in the European barging industry that have taken place in the last twenty five years. The paper analyses structural changes in liner service schedules by barge, the changing functional interdependencies between inland terminals in the network and the organizational changes in the industry. The paper will conclude by discussing some current issues related to the barging network in the Rhine basin, but also outside this main waterway artery.

THE DEVELOPMENT OF THE EUROPEAN CONTAINER BARGE NETWORK

The European container barge network up to now has always been primarily focused on maritime container flows. As such, the development pattern of the barging network is strongly entwined with the development of the associated seaport system. The container barge network in Europe has its origins in transport between Antwerp, Rotterdam and the Rhine basin, and in the last decade it has also developed greatly along the north-south axis between the Benelux countries and northern France. Figure 1 provides an overview of the core of the European inland waterway network.

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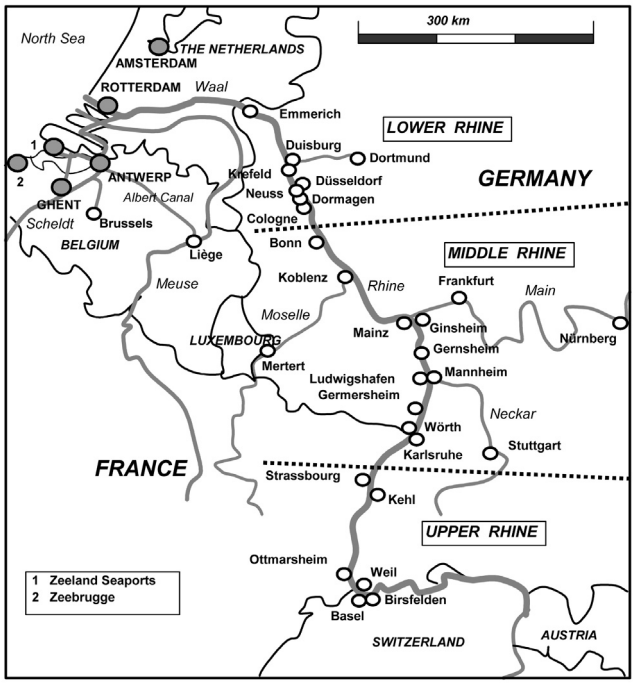


Figure 1: The Rhine axes: core of the European inland waterway network.

It is possible to distinguish four phases in the historical growth pattern of the European container barge network, each with distinctive characteristics related to terminal development, barge service design, container volumes and market organisation. These four elements are strongly entwined and together explain the dynamics in the European container barge industry.

FIRST PHASE (MID-1968 TILL EARLY 1970s)

The first phase is the pioneering stage of container transport by barge. Small containerised volumes were carried at irregular intervals by conventional barges from Rotterdam to conventional transhipment points on the upper Rhine (Basel and Strasbourg) and middle Rhine (Mannheim and Karlsruhe) (Van Driel, 1993). These services primarily grouped empty containers in the immediate vicinity of the users. The first container terminal was set up in Mannheim (lower Rhine) in 1968. This was followed shortly afterwards by specialised terminals in Strasbourg and Basel (upper Rhine). The first phase featured only few pioneering barge operators in the market such as NRM. Cargo volumes remained low. Total annual transport volume on the Rhine did not exceed 10.000 TEU until 1975. Since the service offered by barge operators did not include transhipment and pre- and endhauls by truck, barge transport long remained unattractive to deepsea carriers and shippers, despite the price advantage per TEU.

SECOND PHASE (MID 1970S TILL MID 1980S)

By the mid 1970s, the growth in maritime container transport and the limitation in the number of ports of call led to a high concentration of container volumes in just a few seaports. This port concentration resulted in a gradual build-up of the necessary critical mass for the more volume-oriented barge container transport. Hence,

scheduled liner container services by barge developed gradually. For this purpose, operators divided the Rhine into three navigation stretches, namely the Lower Rhine (as far as Cologne/Bonn – only limited number of services at that time), the Middle Rhine (from Bonn up to Karlsruhe) and the Upper Rhine (from Karlsruhe up to Basel in Switzerland) – see also figure 1. Barge transport quickly gained in competitiveness once punctuality could be guaranteed by fixed departure schedules for each navigation area, with exceptions only occurring in case of problems with water levels. Annual transport volumes on the Rhine grew from 20.000 TEU in 1976 to 210.000 TEU in 1985. The market was dominated by carriers such as CCS (48% of the barge container market in 1985), Rhinecontainer (31%) and Frankenbach (12%). Each carrier operated own liner services.

Terminal development kept pace with the rising volumes. A number of established inland ports along the Rhine set aside part of the existing multifunctional terminals for container transhipment. New terminals were also set up within the perimeter of existing ports, or at new locations along the main navigation route. No less than twenty new Rhine terminals were opened in the period 1980-1987. The initiative for setting up inland waterway terminals now also came from the Rhine carriers, who saw the operation of their own single-user terminals as a way to guarantee success of their liner services. Independent terminal operators tried to get around the system of single-user terminals by setting up common-user terminals. A good example is the opening of ICG (Inland Container terminal Germersheim) in 1984.

THIRD PHASE (MID 1980s TILL MID 1990s)

In phases 1 and 2, the terminal initiatives mainly developed along the upper and middle Rhine. The Rhine carriers and other terminal operators took the view that barge container transport could only be competitive with road transport over distances of at least 500 km, given the comparatively high fixed costs and low variable costs. The development of the basic volume for barge transport only started to bring large-scale initiatives on the lower Rhine from 1985 onwards. The volumes carried on the Rhine increased from about 200,000 TEU in 1985 to 800,000 TEU in 1995. In Antwerp containerised barge traffic evolved from 128,700 TEU in 1985 to 675,000 TEU in 1995, in Rotterdam from 225,000 TEU to 1,15 million TEU.

In order to raise the level of service and prevent destructive competition, the existing barge carriers started to operate joint liner services on the different navigation areas of the Rhine, backed by operational collaboration agreements. These are characterised by a limited degree of central planning and commitment of barge units, with each of the participating parties maintaining its own commercial identity and freedom. Examples are the Fahrgemeinschaft Oberrhein (Upper Rhine transport collective founded by Haniel Container Line, Interfeeder Ducotra, Haeger & Schmidt and Rhinecontainer) and the Fahrgemeinschaft Niederrhein (Lower Rhine

transport collective). CCS, Rhinecontainer, Haniel and Haeger & Schmidt set up Fahrgemeinschaft Niederrhein at the beginning of 1992 to tackle the problem of low load factors and heavy losses in the industry. By setting up collaboration in capacity the load factor was soon above 60% and the carriers were put back into the black (Van Driel, 1993, Konings, 1999 and Boer, 1999). The partners streamlined their sailing schedules so as to offer a high frequency of departures from the seaports to the lower Rhine. Other co-operation agreements involved the Danube (e.g. Penta Container Line with initial partners Danser Container Line, Rhenus Alpina, CCS, CNFR, Conteba and Natural Van Dam) and the link Antwerp-Rotterdam (e.g. Barge Planning Center with partners CEM, Eurobarge, WCT-MTA and Interfeeder). Jointly operated and frequent liner services to each of the three navigation areas on the Rhine (i.e. line-bundling services with typically five inland ports of call per loop) were complemented by a limited number of direct point-to-point shuttles.

FOURTH PHASE (SINCE MID 1990s)

Terminal developments

Since the mid 1990s, container transport by barge started to outgrow the Rhine basin. The growing realisation of the potential offered by barge container shipping led to a wave of investment in new terminals in northern France, the Netherlands and Belgium (table 1). The Benelux and northern France now have over 40 container barge terminals (excluding barge terminals in seaport areas). In 1991 there was still no terminal network on the north-south axis (only two terminals), while the Rhine basin already had 25 container terminals. This coincided with the emergence of a new set of terminal operators offering their own shuttle services to and from the main ports Antwerp and or Rotterdam. A noteworthy feature of this development is that some of the new terminals are located at a short distance from the seaports (even less than 50 km). The growth of the terminal network has been partly initiated by financial incentives given by local, regional or national authorities, with government subsidies in some cases encouraging the emergence of less viable terminal initiatives. As governments are now curbing direct subsidies to the barging industry, a rationalisation in the Benelux terminal network is to be expected. Clear signs of this rationalisation process can already be observed in the eastern part of the Netherlands and along the Sea Canal Brussels-Rupel in Belgium (from four terminals in 2002 to only two successful ones today, i.e. TCT Belgium operated by Rotterdam-based ECT and Cargovil Container Terminal). In other parts of the Benelux, the number of terminals is still increasing.

The fourth phase also meant the introduction of barge services and inland terminals outside the Rhine-Scheldt-Meuse basins. Noteworthy examples are the terminal of Gennevilliers near Paris along the Seine, terminals along the Rhône Saône Basin (Lyon, Mâcon and Chalon) and new container handling facilities along the Elbe river.

Table 1. The start of operations at new terminals (number of terminals per navigation area).

	Start of terminal activities (number of terminals per navigation area)					
	Before 1985	1985-1990	1991-1997	1998-2002	N.A.	TOTAL
Upper Rhine	4	2	0	1	1	8
Middle Rhine	7	5	2	2	0	16
Lower Rhine	3	4	0	3	1	11
Northern France & Luxembourg	0	0	4	1	0	5
Belgium	0	1	2	9	0	12
the Netherlands	0	1	6	19	0	26
Total number of terminals	**14**	**13**	**14**	**35**	**2**	**78**

	Start of terminal activities (number of terminals per navigation area)			
	Before 1985	Before 1991	Before 1998	Before 2002
Rhine Basin (D, F and CH)	100%	93%	66%	43%
Other navigation areas	0%	7%	34%	57%
Total number of terminals	**14**	**27**	**41**	**76**

Remark: barge terminals in seaports and along the Danube river are not included
Source: author based on individual terminal data

Despite the spatial concentration of freight in terms of carriers, the number of terminals in the Rhine basin is still increasing. This is partly the result of new terminal operators arriving on the market (e.g. ECT in Duisburg since 1999 and the P&O Ports/Logport combination also in Duisburg in 2002). However, it is also due to new terminals appearing along the Rhine and its tributaries, e.g. Aschaffenburg, Hoechst terminal, Krefeld and Mannheim Container Terminal.

A number of inland terminals are increasingly concentrating on complementarity between rail and barge transport. The German inland terminals are seeking to emphasise the trimodal character of the facilities offered, seeking connections to the KLV (Kombinierten Ladungsverkehr) network operated by Deutsche Bahn. Emmerich, Neuss, Mainz, Mannheim, Cologne, Duisburg and Dortmund are some of the inland ports trying to combine their leading role in barge transport with a hub function in international intermodal rail networks. However, in most of them there is still no combined barge/rail transport to speak of: the transit volumes between barge and rail on most of the Rhine terminals are still very low.

Barge service schedules

After a period of decentralisation in the Rhine basin, the large container carriers are following a strategy aimed at concentrating river freight volumes in just a few freight terminals. This rationalisation in the number of Rhine terminals served (in particular on the lower and middle Rhine) opened up the possibility of larger barges being introduced. Exceptional examples are the sister ships Jowi and Amistade,

motorised barges with a slot capacity of 398 TEU used on the CCS services between Antwerp/Rotterdam and the Rhine. Outside the Rhine basin and the Antwerp-Rotterdam link, smaller barges are used in a direct shuttle configuration. The next step is to arrive at a network of liner services connecting several terminals outside the Rhine basin. For instance, some container barge services from the Lille-Kortrijk border region (France-Belgium) to the ports of Antwerp and Rotterdam are now organised on a line-bundling principle, which means they load/discharge at another inland terminal along the route before proceeding to the seaport of destination.

Barge container volumes

The Rhine remains by far the most important corridor, notwithstanding rising volumes in the other navigation areas and on the link Antwerp-Rotterdam (figure 2). The middle Rhine still accounts for nearly half of the total container volumes on the Rhine (table 2).

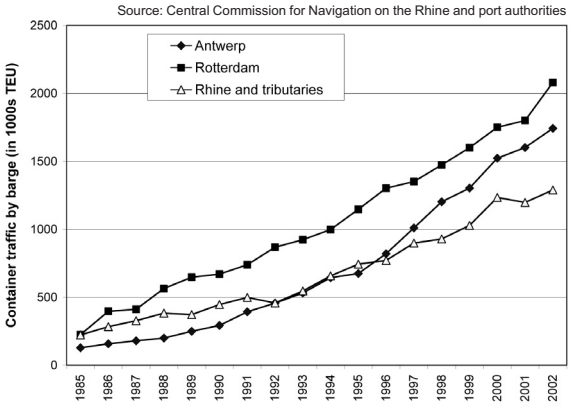


Figure 2. Growth of container traffic by barge in Antwerp, Rotterdam and on the Rhine (in TEU)

Rotterdam and Antwerp account for around 95% of barge container transport to and from the European seaport system. Table 3 summarises the modal split in a number of European load centres. The German ports have developed a strong orientation on rail shuttles, whereas Antwerp and Rotterdam heavily rely on barges to reach water-linked hinterland regions. Most ports have

Source: Central Commission for Navigation on the Rhine.

	Lower Rhine	Middle Rhine	Upper Rhine	Total Rhine (in TEU)
1994	28.9%	56.3%	14.8%	657000
1995	29.6%	54.5%	16.0%	743492
1996	26.6%	57.3%	16.1%	771000
1997	28.4%	56.0%	15.7%	898983
1998	31.2%	52.2%	16.6%	929398
1999	32.2%	51.2%	16.6%	1028681
2000	32.0%	49.8%	18.2%	1233670
2001	32.9%	49.5%	17.6%	1196866
2002	31.9%	50.4%	17.7%	1289424

Table 2. Relative importance of the navigation areas on the Rhine (based on volumes in TEU).

achieved a considerable modal shift in hinterland container transport, but rail and inland navigation still have not reached their maximum potential. Trucking remains the most important transport mode in all ports, especially in traffic relations to France and to inland destinations outside the large economic centres.

Source: based on data respective port authorities.

	Rail			Road			Barge		
	1998	2001	2003	1998	2001	2003	1998	2001	2003
Rotterdam	14,5%	13,0%	10,0%	51,3%	48,7%	50,0%	34,2%	39,0%	40,0%
Antwerp	7,8%	8,8%	9,5%	64,5%	61,3%	59,5%	27,7%	29,9%	31,0%
Le Havre	14,3%	11,4%	12,4%	84,6%	85,3%	82,8%	1,3%	3,1%	4,8%
Zeebrugge	34,4%	41,9%	40,2%	50,6%	48,8%	55,1%	15,1%	9,2%	4,7%
Dunkirk	9,0%	13,5%	20,5%	90,0%	82,5%	76,7%	1,0%	4,0%	2,7%
Hamburg	29,7%	28,7%	28,7%	70,1%	69,9%	69,8%	0,2%	1,4%	1,7%
Bremerhaven	33,1%	36,0%	30,6%	65,0%	62,0%	67,3%	1,9%	2,0%	2,0%

Table 3. Container modal split for load centres in the Le Havre – Hamburg range (in %, excluding sea-sea transhipment).

In the other container ports of the Hamburg-Le Havre range, barge container transport as yet plays a modest but increasing role. Inland navigation had a market share of some 4.8% in the modal split of Le Havre in 2003 (based on TEU-figures), compared to only 1.3% in 1998. The barge services of GIE Logiseine (a company founded in 1994 by barge operator Compagnie Fluviale de Transport, terminal operator Terminaux de Normandie of Le Havre and Paris Terminal SA) carried 37,500 TEU between Le Havre, Rouen, Gennevilliers (Paris) in 2002, compared to 19,500 TEU in 1999 and 6,000 TEU in 1995. Logiseine has developed relationships with around 15 trucking companies for the delivery of containers in a radius of up to 120 km around Gennevilliers. Since 2003, Bonneuil sur Marne (east of Paris) has been added as inland port of call in the Logiseine line-bundling network along the Seine, bringing total volumes to 151,900 TEU in 2003. Barge units of up to 176 TEU unit capacity are used. In December 2004, Mediterranean Shipping Company started two barge services between Le Havre (Terminal TN/MSC) and Gennevilliers. In 2005 traffic volumes reached about 20,000 TEU.

Hamburg is slowly developing barge services on the Elbe, with annual volumes in 2003 exceeding 60,000 TEU compared to only 30,000 TEU in 2000 and 1,755 TEU in 1997. Barge transportation is being used more and more on the Elbe from Hamburg in the direction of Magdeburg, Aken, Torgau, Riesa, Dresden even as far as the Czech Republic to places such as Decin, Usti, Melnik, Prague, Kolin and Pardubice. Also the Elbe side canals to Berlin, Hanover and Lübeck are regaining significance for the inland waterway traffic.

The port of Marseilles is supporting the development of barge services in the Rhône Saône basin. Two operators are active on the link: (a) Rhône Saône Conteneur, a subsidiary of CMA-CGM with services between Marseilles-Fos to Lyon, Mâcon and Chalon, and (b) Alcotrans with services from Fos to Lyon and Valence.

Rhône Saône Conteneur transported 33,000 TEU in 2003 for different clients, including Ikea, Danone, DHL, Géodis, Michelin and Volvic. The unit capacity of the barges of Rhône Saône Conteneur amounts to 132 TEU. The transit time Fos-Lyon is around 38 hours upstream and 24 hours downstream.

Market organisation

The new millennium brought rising pressure on the existing co-operation agreements on the Rhine as more and more operators are eager to start services independently from their partners. For instance, CCS withdrew from the Fahrgemeinschaft Niederrhein collective on 1 January 2000, but the collaboration agreement continued with the three remaining partners, under the name of NFG 2000. The departure of CCS from Fahrgemeinschaft Niederrhein occurred against the background of a strongly expanding market. In 2006, the Fahrgemeinschaft Oberrhein (OFG) nearly ceased to exist when Rhinecontainer and Haeger&Schmidt decided to step out of the OFG partnership and to start up the Upper Rhine Container Alliance (URCA). The two remaining operators, Interfeeder and Alcotrans, kept operations of OFG up and running. A major restructuring of the barge services within OFG took place once Interfeeder was taken over by Contargo in October 2006. The new OFG with partners Contargo and Alcotrans introduced reconfigured service schedules in early 2007. The above examples demonstrate a clear shift from partnerships with a large number of barge operators towards independent operators or partnerships with only few partners. The only large partnership still operational is the Penta Consortium on the Upper Rhine with partners DCL, SRN/Natural (Danser), Conteba/Swiss Terminals, CFNR and Contargo subsidiary Basler Marine Terminals (BMT).

Collaborative agreements are making their appearance in other navigation areas such as shuttle services between the two leading seaports in the Benelux, namely Antwerp and Rotterdam. Joint ventures, mergers and takeovers form a relatively new aspect, aimed at increasing the geographical scope of the services offered, and at developing the operators' own barge transport networks. The initiatives being developed in this connection are aimed at increasing the geographical scope of the services offered, and at developing the operators' own barge transport networks. Danser Container Line, for instance, which offers services on the Rhine and Neckar and between Rotterdam and Oss, acquired Eurobarge from Nedlloyd Rijn & Binnenvaart in 1999. Eurobarge mainly operates barges on the Antwerp-Rotterdam route. Since January 2006, Danser Container Line controls the barge services of Natural Van Dam AG, an operator formerly owned by the logistics group Cronat from Basel. Both companies already worked together before the takeover, i.e. in the framework of Penta Container Line. In 2000, Rhinecontainer acquired Container Exploitatiemaatschappij (CEM), a main player on the Antwerp-Rotterdam axis with 160,000 TEU in 2000. In the same year, CCS and SRN Alpina came under the

same ownership, as a result of Rhenus (the parent company of CCS - SRN Alpina) acquiring the Swiss holding company Migros. Since 2004, Rhenus Logistics integrated Combined Container Service (CCS) in its container transport division Contargo.

A number of operators are now focusing on expanding their service packages outside the Rhine basin. For instance, Alcotrans is active on the Rhône river and Danser Container Line offers container services to Brussels.

In addition, the leading barge container carriers are increasingly trying to achieve a functional vertical integration of the container transport chain by extending the logistical services package to include complete door-to-door logistical solutions. Combined Container Service (CCS) was the first Rhine carrier to begin operating on this principle, as early as in 1976 (Denis, 1999). Rhinecontainer too was able to offer a wider logistical service to customers soon after been set up in 1978, thanks to the logistics know-how of its co-founder Kühne & Nagel. In practical terms, the barge operators will if required take care of the entire continental route from the seaport to the consignee's door. For the actual transport operation on the continental route, the leading barge carriers call on independent bargees, who frequently own just one or at most a few units, together with road hauliers for the feeder services. The desire for direct access to the shippers has led the barge operators to enlarge their role as transport organisers, by setting up joint ventures with forwarders and other logistics operators.

In the 1990s, three logistics holdings got a strong grip on the barging market. Wincanton controlled 33% of containers moved by barge in the Rhine basin in 2004. Wincanton is the mother company of Rhenania with subsidiary Rhinecontainer (375,000 TEU in 2004). Rhenus Logistics, mother company of Contargo (including SRN Alpina and CCS), reached a market share of 22% and Imperial Logistics Group, mother company of Alcotrans, 15% (Zurbach, 2005). Alcotrans transported around 220,000 TEU on the Rhine in 2006. The Contargo network, comprising of 19 inland container terminals in Germany, the Netherlands, France and Switzerland, handled some 840,000 TEU in 2006. The integration of leading barge operating companies in the structures of highly-diversified logistics groups further strengthens the functional integration in the logistics chain.

Inland terminals often play a key role within the logistics strategy followed. Some two thirds of the barge carriers on the Rhine operate one or more Rhine terminals and/or participate as a shareholder in a terminal. Barge container carriers in fact control about half of the Rhine terminals. A large number of the remaining inland barge terminals are operated by subsidiaries, parent companies or allied companies of container terminal operators based in seaports. The remaining inland terminals are operated by rail operators (who wish to exploit the complementarities of rail and barge transport by setting up trimodal hubs), independent logistics service providers (who set up terminal activities to assure their own supply of freight),

inland port authorities (such as the Port Autonome de Strasbourg, who sees a barge terminal and the associated logistics activities as a means of regional development and as a way of increasing regional competitiveness) and holding companies (they acquire stakes in inland terminals in order to diversify their portfolio or package of activities).

A last and fairly new aspect of the vertical integration strategy followed by barge operators is the desire to fully exploit the complementarity with rail transport, by forging closer links with existing rail companies, or if required even acting as rail operator themselves. The present market consolidation in European rail transport leaves a certain limited scope for barge operators to position themselves as rail shuttle operators, allowing them to overcome the restricted geographical coverage of the European inland waterway network. Rhenania Intermodal, one of the market leaders in container hinterland traffics of the European sea ports, launched a number of river-rail services in 2005 in association with German rail operator Conliner. In 2006 the Conliner services were taken over and restructured by the Stinnes Group. Rhenus Logistics offers a similar service through the RheinRail Service of CCS. In both cases, the ports of Antwerp and Rotterdam are linked by barge to an inland port from where onward rail connections bring the goods to the final destinations. Rhenania uses Mannheim as rail-river facility for all-rail destinations such as Stuttgart and Nürnberg. CCS uses its terminal network on the Rhine to offer river–rail services to Dresden, Leipzig and Munich.

CURRENT ISSUES IN THE EUROPEAN CONTAINER BARGE NETWORK

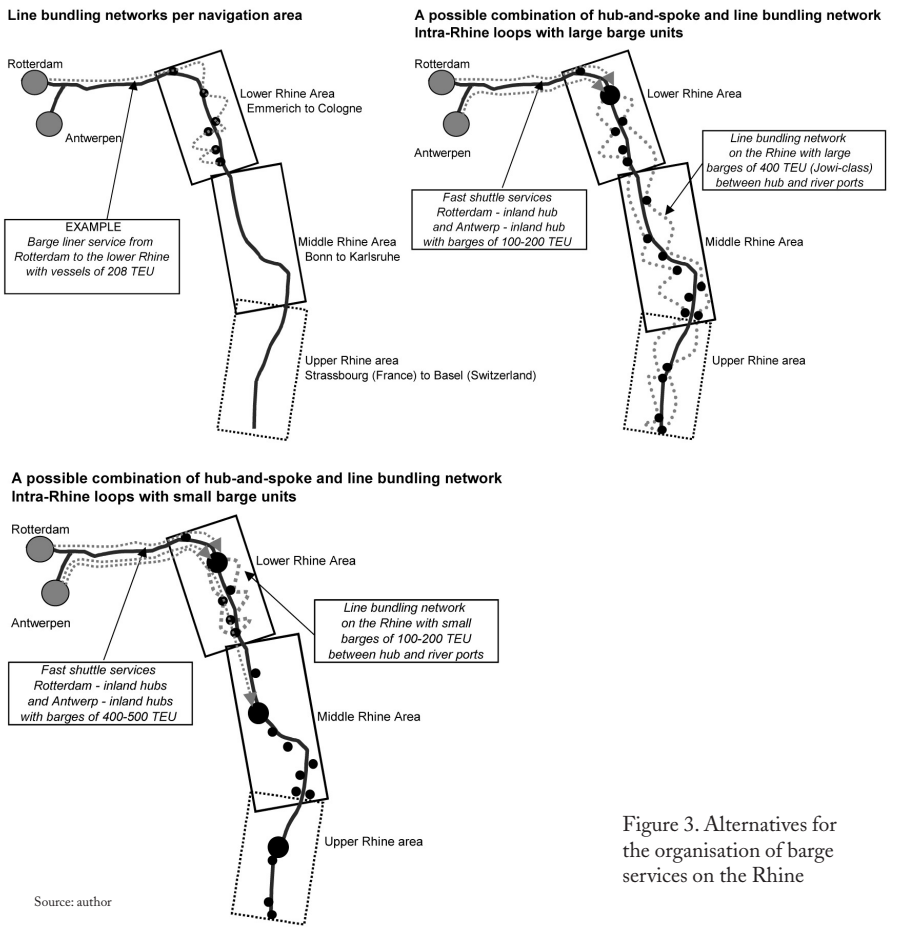
Towards a reconfiguration of service networks ?

At present, the liner service networks offered on the Rhine are mainly of the line bundling type with each rotation calling at 3 to 6 terminals per navigation area (Lower Rhine, Middle Rhine, Upper Rhine), while in the seaports the average number of terminal calls can be as high as ten. The inland vessels used on the Rhine have capacities ranging from 90 to 208 TEU, although some bigger units and push convoys of up to 500 TEU can be spotted occasionally. The average frequencies of barge services out of Rotterdam and Antwerp to the Rhine now amount to at least a daily service. Rotterdam has a strong position on barge traffic from/to the lower Rhine and middle Rhine, whereas Antwerp and Rotterdam are equally strong on the upper Rhine.

Dependent on transport volumes and the usability of different vessel sizes, a reorganisation of barge services on the Rhine is not unthinkable. The hub-and-spoke model built around an inland hub could form an alternative to the existing line-bundling services on the Rhine (figure 3). The cost savings on the trunk route will to some extent be absorbed by the transhipment from the trunk to feeder route, but the net benefit might be an improvement of the cost performance of barge services to

these regional terminals. An example is the Rhein-Waal Shuttle between Rotterdam/Antwerp – Duisburg DeCeTe (trunk route) and Duisburg - Dortmund (feeder route). Key elements in setting up hub-and-spoke networks in the barging industry relate to the location of hub and feeder terminals and the matching of arrival and departure times of trunk and feeder lines.

In navigation areas outside the Rhine basin, vessels typically call at only one end terminal in the hinterland, thereby reducing turnaround time and increasing reliability. The basic conditions for developing line bundling networks and hub-and-spokes networks outside the Rhine basin seem not favourable because of the high number of new terminal initiatives and the limited scale of many of these facilities (i.e. annual terminal capacities lower than 10,000 TEU are quite common). A network based on many small terminals leads to fragmentation of cargo volumes, which can partly or even completely obviate the scale advantages. As mentioned earlier in this paper,



Source: author

Figure 3. Alternatives for the organisation of barge services on the Rhine

it is therefore expected that in the years to come a partial rationalisation (as a result of mergers/acquisitions and terminal close downs) and specialisation (e.g. terminals focused solely on the transport of containerised waste) will take place within the terminal networks outside the Rhine basin. This would pave the way for major revisions of sailing schedules and network architecture.

The role of deepsea shipping lines in shaping the container barge industry

The organisational control over hinterland transport via carrier haulage is an important strategy for shipping lines to control the logistic chain and to generate additional revenues (Notteboom, 2004). Some shipping lines, such as CMA-CGM, have already entered the barging industry. Carriers will have great interest to concentrate transport volumes to a very limited number of inland terminals to take full advantage of economies of scale in sailing (large vessels) and terminal operations (including block stowage and scale benefits in repositioning and depot activities). These conditions will encourage the development of some local hubs (large inland terminals) that will be directly served from the seaport (one-stop services). If transport volumes are large enough and carrier haulage is dominant ultimately direct point-to-point services might emerge. It is most likely that the port and inland terminals strategically located near the major load bases and to on-going rail and barge connections will be most eligible for this hub status (e.g. Duisburg, Ludwigshaven, Mannheim and Basel).

The functions of inland terminals

In the last fifteen years, the dynamics in logistics networks have created the right conditions for a large-scale development of inland ports throughout Europe. The range of functions of inland logistics centres is wide ranging from simple cargo consolidation to advanced logistics services. Many inland locations with multimodal access have become broader logistics zones. They not only have assumed a significant number of traditional cargo handling functions and services, but also have attracted many related services, a.o. distribution centres, shipping agents, trucking companies, forwarders, container repair facilities and packing firms. The concept of logistics zones in the hinterland is now well-advanced in Europe: e.g. 'platformes logistiques' in France, the Güterverkehrszentren (GVZ) in Germany, Interporti in Italy, Freight Villages in the UK and the Zonas de Actividades Logisticas (ZAL) in Spain. Logistics zones are usually created within the framework of regional development policies as joint initiatives by firms, intermodal operators, regional and local authorities, the central government and or the Chambers of Commerce and Industry.

Quite a few of these logistics zones are competing with seaports for what the location of European distribution facilities are concerned. Shortage of industrial premises, the high land prices, congestion problems, the inland location of the Euro-

pean markets and severe environmental restrictions are some of the well-known arguments for companies not to locate in a seaport. The availability of fast, efficient and reliable intermodal connections is one of the most important prerequisites for the further development of inland terminals. The interaction between seaports and inland locations leads to the development of a large logistics pole consisting of several logistics zones. Seaports are the central nodes driving the dynamics in such a large logistics pole. But at the same time seaports rely heavily on inland ports to preserve their attractiveness. For example, the ports of Antwerp and Rotterdam have become the main drivers of a large logistics pole covering the Benelux, northern France and western Germany (figure 4). The existing geographical concentration of logistics sites has stimulated the development of inland terminals in these areas.

Source: author

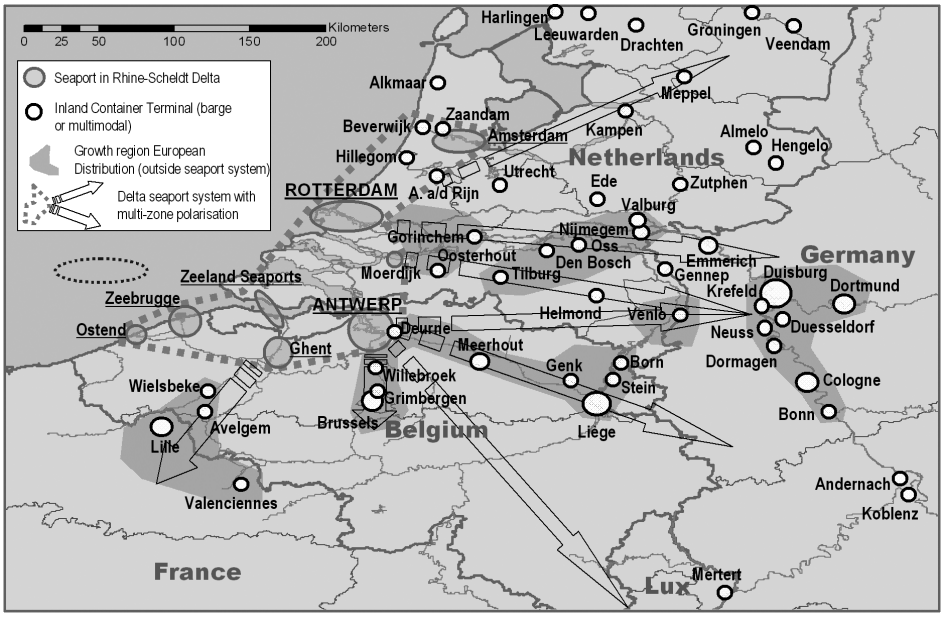


Figure 4. Logistics polarisation in the Benelux

Traditionally, container transhipment centres for barge transport play a regional function for distribution and collection of maritime containers and consolidation of containerised freight. The area served by the average container terminal covers a radius of between 25 and 60 km. As the distance between the inland terminal and the maritime loading centre becomes larger, the relative proportion of pre- and end-haul by truck in the total door-to-door cost structure becomes lower, while the potential area served by the terminal becomes greater.

A number of terminals are still trying to manifest themselves more in intra-European haulage of continental containers to terminals located farther upstream. But so far, continental transport of containers has not met with success. When it comes to maritime containers, the inland terminals are generally not located in the centre of the area served, but instead tend to be closer to the maritime loading centres.

Frequently, the necessary basic volume is supplied by just a few large shippers, who form a solid basis for the market and participate in new terminal initiatives. For example, Nike is by far the largest customer of WCT in Meerhout, while Barge Terminal Born mainly deals with DSM. The large shippers ensure that the basic volume of the container terminal is very homogenous and repetitive in nature. A terminal in the immediate vicinity of a large shipper often plays an important role as a depot, for the purpose of JIT deliveries. Manufacturers can call up the full import containers whenever the container load is needed in the production process, and by the same token they can call up empty containers in order to fill them with export loads.

Barge container transport has an influence on competitive relationships within the European container port system. It enables the Benelux ports in particular to create a patchwork of overlapping areas served by individual inland terminals, within which it is possible to achieve a cost advantage over other European container ports. The huge scale of barge operations in Rotterdam and Antwerp generates advantages not found in smaller container ports. The advantages are apparent in the clustering of barge operators and related companies (e.g. ship repairs and ship chandlers). However, the development of barge container transport is sometimes handicapped by large time losses in those seaports, due to the deepsea container terminals being too widely spread out in the port area, and due also to the non-priority character of barges in comparison with seagoing vessels. Both Antwerp and Rotterdam have taken initiatives in the past few years to reduce this by making use of IT for quay planning and electronic document processing, and by building specialised barge terminals within the port area.

The supremacy of Rotterdam and Antwerp does not mean that other European ports cannot also profit from the upward growth spiral in the inland barging industry. Le Havre, Marseilles, Hamburg and Zeebrugge are some of the load centres seeking to give inland barging a more prominent place in their inland distribution patterns of maritime containers.

Barge networks versus rail networks: competition and cooperation

The development of barge networks is different from rail networks, given specific geographical and operating conditions. First of all, there is the geographical component. River systems typically have a treelike structure with limited or no lateral connections between the different branches. Under these conditions, a network design based on the hub-and-spoke concept is less obvious compared to rail systems

consisting of many lateral connections. Secondly, the deployable vessel capacity is restricted and not homogeneous due to variations in draft limitations and other physical conditions in segments of the river system. Thirdly, wagons of shuttle and block trains can be regrouped quite easily through shunting. As such, the handling of containers in rail networks can be based either on horizontal operations (i.e. shunting of wagons) or on vertical operations (i.e. the loading/unloading of containers). In inland barge networks the regrouping of containers requires vertical container handling operations by crane. Horizontal operations might only occur when an operator uses push barges in view of regrouping large container batches. But even in that case the flexibility of push convoys is rather limited compared to trains.

Fourthly, there is the organisational component. The railway industry historically was dominated by national railway companies. They acted as monopolists on each of the national railway networks they managed and owned (captive infrastructure). Government intervention was high and customer focus rather poor. Due to European liberalisation (see e.g. Directive 91/440 of the European Commission and subsequent directives in 1995, 2001 and 2003), the railway industry is opening up and new licensed players are entering the market. Moreover, infrastructure management is being decoupled from the actual rail services as to allow licensed railway undertakings to operate services on the formerly national railway networks. In contrast, the barge industry historically is a family-driven industry with independent skippers offering services to barge operators. Even today, 90% of all barge owners possess no more than one vessel (figures for Belgium provided by National Institute for Statistics). There has always been a strict division between inland barge operations and the provision and maintenance of the inland waterway infrastructure (canals, locks and natural waterways). All barge operators in principle can get access to the same inland waterway network (shared infrastructure), which gives impetus to strong competition in the industry and an elevated customer focus.

Barges are competing with rail services on quite a number of major transport corridors (Rhine basin, corridors in Benelux, Seine axis, Rhône axis). But at the same time, attempts are being made to develop the rail-river business. Given certain convergence in the organizational aspects of the barging and rail markets, it can be expected that the feasibility of such rail-river initiatives will increase in the future. A growing number of terminals could develop into real rail-river transit ports.

CONCLUSIONS

Barge container transport has won a significant share of the market in a number of transport corridors between the Rhine-Scheldt-Meuse delta and the European hinterland. The improvement in the position of barge container transport has gone hand in hand with radical organizational changes in the barging industry, together with the explosive growth of the European inland terminal network. The develop-

ment of inland terminals has contributed to a modal shift, with part of the collection and distribution function of the port areas being transferred to the hinterland. In this way, the container sorting function is to a certain extent being displaced from the maritime terminals to the inland terminals. This enables seaports to take full advantage of the comparative advantages, while limiting the possible disadvantages of scale arising from the growing volume of maritime throughput.

The rise of inland terminals is also being driven by new players such as large logistics groups, shipping lines and container terminal companies based in seaports, prompted partly by the realization that efficient hinterland transport has become a very important element in the competitive battle for control over logistics chains. Barge transport and inland terminals have won their place in the supply and collection systems for manufacturers, and as such play an undeniably important role in the further logistical development of major economic centres in the West-European hinterland.

Barge container transport is still closely associated with point-to-point service and line bundling services to and from the large loading centres of Antwerp and Rotterdam. Important challenges for the future are for barge container transport to be opened up further to other seaports, and for this mode to fit in better with rail-river activities. It is possible for barge container transport to overcome the limitations of the inland waterway network by linking up with rail transport. There are also opportunities for forming better networks among inland terminals, many of which are very recent. A sustainable network of inland terminals is not necessarily the same as having many terminals, but it does mean a network that makes maximum use of the functional interdependencies with seaports and other transport modes, offering added value in logistics activities.

It is very likely that barge transport operations will continue to change in the near future. The terminal hierarchy is under scrutiny by shipping lines, barge operators and other market players. It is expected that some selected strategically located terminals will obtain a hub status with important exchange functions (between barges and barges and rail) and serving very large and on long distance located markets, while other terminals become subordinated to these hub terminals concentrating on serving local and regional markets. This configuration will meet the demand for large transport volumes to a selected number of terminals which will be served directly and possibly by very large vessels even with high frequencies, and demand for fine-meshed transport to small terminals with fast small to medium-sized vessels.

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