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By M. Zachcial

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LAND/SEA TRANSPORT FLOWS IN EUROPE

1 Establishment of land/sea trade and traffic flows: A severe methodological problem

There is an urgent need for valid and reliable data concerning freight flows information along the whole transport chain including mixed/combined land/sea movements. This also includes the wide variety of ferry and ro/ro traffic from/to the Continent. Several attempts have been undertaken to create consistent data on this topic. In most cases, individual trading areas have been analysed. A full-scale consistent approach, however, does not yet exist. For several reasons the use of these data causes substantial methodological problems.

1.1 Foreign trade data

Even the quality of overall foreign trade data among European countries and also between these and countries overseas reveal remarkable inconsistencies. This is particularly true for land/sea trade flows. Adequate shipping statistics are lacking. Therefore seaborne foreign trade and its separation from land transport must predominantly be elaborated from foreign trade statistics.

OECD trade statistics (after certain refinements) can be used as key data supplemented by EU external trade statistics by mode of transport. The mode of transport used relates to the moment when the goods cross borders into or out of importing or exporting countries. The foreign trade transport data are available since 1989 for intra and extra community trades. There are several national data sources available concerning trade, transport, ports and ferry/ro-ro operations. They show, however, substantially different levels of quality, validity, and reliability. Figures of OECD, and this is also true for EU external trade statistics, are not identical with regard to the importing and exporting countries. In some cases there exist substantial differences between figures of import recorded by an importing country and figures of export recorded by the relevant exporting country.

The main reason for these differences seems to be that goods recorded as exports by an exporting country are not recorded as imports by the importing country because they are in transit or stored in a customs warehouse. Moreover, they might be recorded during a later period as imports and/or classified under a different statistical heading. There exists also a good chance for discrepancies because it is never possible to eliminate all errors in data return or processing of statistics.
Further problems arise with regard to differences in the methodology between national figures (OECD) and Community statistics. Community statistics are, as far as imports are concerned, divided into two categories. External trade statistics (extra-EU trade) are generally based on country of origin. Statistics between member states (intra-EU trade) record the country of consignment in order to avoid double counting at Community level.¹

Countries like the United Kingdom systematically use the country of consignment for their national statistics. The country of consignment means the country from which the goods are transported to the reporting country. The country of consignment method leads to discrepancies for goods originating from non-Community countries which are transported via a transit country. Discrepancies of this kind especially occur in trade figures between the Netherlands and the United Kingdom. Due to a so called "Rotterdam Effect" imports from non-EU countries are wrongly classified as imports from the Netherlands. Thus, imports from EU-countries are overstated and imports from non-EU countries are underestimated. Obviously, the foreign trade statistics of the transit countries, especially the Netherlands, include an element of "disguised transit traffic", i.e. transit goods which are classified as imports and which are then re-exported.

Within a current study ISL figured out that in view to the intra-EU trade, in more than 400 cases there have been discrepancies of at least 50,000 t between import and export figures. The analysis indicates further that differences are to a large degree attributable to UK related trades due to the Kingdom's definition of seaborne foreign trade.

There is no doubt that the only way to set up a more or less acceptable data base of foreign trade data among the European countries and especially among them and others is to balance out indiscrepancies by assessment of algorithms based upon functional relationships and matrix operations. Respective results have then to be cross-checked against other data sources of national and regional information.

1.2 Transit data

In order to evaluate the seaborne trade potential and the loaded/unloaded seaborne transport potentials of EU member countries it is necessary to expose transit and warehouse traffic as well. Transit and warehouse traffic is in almost all cases excluded from the external statistics.

It should be mentioned that the port of transit which passes through a country without transhipment is ignored due to the fact that it is neither part of the country's international trade nor does it belong to the cargo traffic which is loaded or unloaded in the country in question.

Land/Sea Transport Flows in Europe

The EU external trade statistics include, as far as the mode "sea" is concerned, only seaborne trade directed via national ports (direct seaborne foreign trade). In order to determine the total foreign trade of the various countries under review it is necessary to include the transit/transhipment volumes via transit countries as well. This "indirect" seaborne trade volumes are mainly attributed to Belgium and the Netherlands and to a lower extent to Germany, France, Spain and Italy.²

For cross-checking purposes, the German foreign trade statistics can be used being available in the following specifications (see also Section 6):

- By 52 (24 commodity groups);
- By country of origin and estimation;
- By border section;
- By mode of transport when crossing the border section;
- By Bundesland in Germany.

These data are quite complete for 1992, but show deficiencies for recent years due to the change of data collection and data processing of the statistical system concerning INTRA-EU trade.

2 Approach towards modal split and route choice in Europe

The attempt to figure out freight traffic flows along the whole transport chain in Europe can only be reasonably successful if sea and land trades as well as the coastal areas of loading/unloading can be identified. Given the difficulties of data quality and of different procedures it is very difficult to set-up a full-scale pattern or even several patterns for individual commodity groups or loading categories such as dry bulk, liquid bulk, general cargo/breakbulk, the latter further disaggregated by conventional cargo, container and ro/ro.

A puristic approach based upon NST-R-2 digits (= 52 commodity groups) causes substantial problems when trying to solve the wide range of irregularities involved in the various origin/destination flows and hence in the various loading/unloading pairs. In order to get a better insight into the data quality, the results for the 52 commodity group matrices (multiplied by 2 directions and 2 concepts = foreign trade and loaded/unloaded) should always be controlled by very thorough individual analyses for the major commodity groups, such as iron ore, coal, grain and other dry and liquid bulk, especially crude oil and petroleum products. The remaining quantities of general cargo/breakbulk should be treated as one major loading category which can better be balanced out concerning discrepancies in the

²In most cases, detailed commodity-specific data are not available in transit traffic (NST-R). Almost total quantities moved or containerised are shown, if any. The approach is more complex as can be described here since the country-specific information have to be harmonised (gross/net weight of cargo etc.).
cargo flows compared to a number of more than 40 individual - partly very small - commodity groups. The adjusted matrices for this summarised loading category can then be distributed down to the level of commodity groups by using balancing procedures similar to FRATAR.

For transport policy issues it seems to be sufficient to show the trends and structures of European land/sea trade and transport for major bulk goods and loading categories, namely conventional general cargo, containers and ro/ro cargo.

### 2.1 Modal split estimates

The objective of this paper is the separation of freight flows into land and sea components. It does not show the split of land transport into road, rail, inland waterways and pipeline transportation which is topic of additional research.

Looking at the transport structures within Europe it is evident that, except for the United Kingdom (before opening of the Channel Tunnel) and Ireland, various transport modes can be used for foreign trade movements. Problems arise when foreign trade comprises several transport movements with various means of transport. As mentioned above, the overall transport chain information cannot directly be derived from the external trade statistics or any other statistical information. In other words, the modal split for a country-to-country relation is different for the importing and the exporting (reporter) country due to various modes included in the total transport.

Modal split assumptions are mainly based on EU foreign trade data supplemented by seaborne transit data. These splits exposing the seaborne foreign trade per origin/destination and commodity group are related to the OECD foreign trade data. The deduction of the three basic loading categories was provided alternatively by:

- A commodity-based analysis using a classification of commodity types;
- A transport related approach using information on ship types per commodity group (NST-R).

Compared with the commodity-based analysis the ship type related approach provides a higher proportion of general cargo. This seems likely as within European trades cargo units are smaller and even bulk commodities are carried by general cargo ships. Based upon cargo considerations and modal split estimates in combination with an analysis of the distances between areas of loading/unloading, general cargo can furthermore be disaggregated into container, ro/ro and conventional cargo. The following Figure 1 shows the basic ideas on the identification of seaborne trade and its transformation into loading/discharging flows, this for two cases:
CASE 1: Seaborne trade between countries which are not countries of transit

LOADED
Country of Origin (A)
OECD based Seaborne Foreign Trade by NSTR Commodity Group

Country of Transit
Sea
Transhipment
Sea
Land

UNLOADED
Country of Destination (B)
OECD based Seaborne Foreign Trade by NSTR Commodity Group

Loaded/Unloaded Volumes According to Loading Categories

CASE 2: Seaborne trade between countries with an EU partner country as country of transit (flow from A to B)

LOADED
Country of Origin (A)/ Country of Transit (A)
OECD based Seaborne Foreign Trade by NSTR Commodity Group
Transit Trades

Σ Transit
Σ Transhipment
Land

UNLOADED
Country of Destination (B)
OECD based Seaborne Foreign Trade by NSTR Commodity Group

direct seaborne trade (A/B)
for B (A)

Loaded/Unloaded Volumes According to Loading Categories

Figure 1: Evaluation of Seaborne Trade Flows Loaded/Unloaded in EU-Countries
Section I - Maritime Networks and Modal Split

- Seaborne trade between countries which are not transit countries;
- Seaborne trade between countries with an EU partner country as transit country (flow from A to B).

2.2 Route choice

Figure 2 shows the basic idea about setting up the choice of route by using direct and indirect traffic by mode as well as transhipment flows. Purely land transport must be separated from total transport in order to identify the following sea transport related components.

![Diagram of route choice]

Figure 2: Systematisation of deriving loaded/discharged traffic flows

In reality, there are several cases of manyfold transit flows. To give an example: a container from Austria goes by truck via Germany, then crosses the Netherlands,
there loaded onboard at the Port of Rotterdam and transported to a port at the US East coast from where it is transhipped to Mexico.

3 Estimation of European maritime transport by loading categories

With regard to the topic of this contribution concerning land/sea transport flows, the assessment of general cargo flows is of higher relevance compared to dry or liquid bulk flows. In many cases dry bulk cargoes remain in the vicinity of the ports or are transboarded onto rail wagons and inland waterway vessels. Liquid bulk imports are either processed in refineries close to the ports or are pumped through pipelines into the hinterland. Generally, bulk flows can more easily be identified compared to general cargo flows consisting of containers, ro/ro or conventional cargo. Therefore, the following analysis is concentrated on general cargo, differentiated as mentioned before.

3.1 Trends and structures

There is a comprehensive statistical basis concerning the EU foreign statistics.\(^3\) There are, however, some inconsistencies included in the data concerning both total trade volumes between EU-members and between EU-members and third countries. The following graph indicates - already on the high aggregation level of total tons moved - the various problems when compiling INTRA-EU foreign trade. The first of the two bars for each year means trade reported from the exporters' point of view, the second one means trade reported from the importers' point of view. Both figures were nearly identical in 1989 (despite strong deviations on a country-to-country level). From 1990 until 1992 quantities reported by importing countries have been substantially higher than those reported by exporting countries (1990: 4%, 1991: 7%, 1992: 9%). While in 1993 the figures were more or less identical those of 1994 statistics showed higher volumes of INTRA-EU trade from the exporters' standpoint (3%).

The mode-specific differentiation shows in some cases serious deviations which can be summarised as follows:

- Foreign seaborne trade shows for each year higher quantities announced by exporting countries compared to importing countries.

- This is different with regard to inland waterways transport where - except for the year 1993 - the quantities counted by exporting countries were lower than those of importing countries.

If adding seaborne and inland waterways transport, the differences between figures stated by importing and exporting countries became smaller, but still remain remarkably.

The official data for inland waterways transport in 1993 are obviously wrong, especially the information collected from importing countries. Instead of 80.5 million tons stated the correct quantity should be about 125 million tons. Also the data provided for 1994 are most probably incomplete and should be about 147 million tons instead of 120.5 million tons.\(^4\)

### 3.2 Foreign trade pattern

After several refinements carried out by ISL, the most probable quantities of INTRA-EU foreign trade were as follows:

---

\(^4\)The correction of the official EUROSTAT statistics has been carried out by using data of 1991 to 1994 for the international river transports between the Netherlands and Germany.
The split according to loading categories indicates that the internal seaborne foreign trade between EU countries is largely determined by general cargo flows. In 1994 this loading category had a share of 50% of the total internal seaborne foreign trade of the Community.

<table>
<thead>
<tr>
<th>Loading category</th>
<th>1,000 tons</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid bulk</td>
<td>86.7</td>
<td>38</td>
</tr>
<tr>
<td>Dry bulk</td>
<td>22.8</td>
<td>10</td>
</tr>
<tr>
<td>General cargo</td>
<td>118.5</td>
<td>52</td>
</tr>
<tr>
<td>Total</td>
<td>228.0</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: Eurostat/ISL adjustments

Table I: Intra-EU seaborne foreign trade by loading categories 1994

- The seaborne foreign trade, measured in tonnes, shows a strong concentration on the NSTR-commodity groups: 32-Fuel derivatives, 31-Crude petroleum, 61-Sand and gravel, 01-Cereals and 81-Basic chemicals. In 1992 these five commodity groups represented more than 50% of the total internal EU seaborne foreign trade potential.

- A country-to-country analysis illustrates the high importance of seaborne trade for the UK, France and Germany. More than 52% of the total import volume and approx. 58% of the export trade in 1994 is attributable to these three EU-countries.

- The EU countries had an import volume of 1,000 million tons in 1994 originating in external partner countries (1980: 700 million tons). The non-EU European countries had a share of 22% in all external seaborne imports of the EU, whereas the non-European partner countries contributed 78% to the total external imports in 1994.

- In 1994 the seaborne exports to external partner countries had a volume of 275 million tons. The EU seaborne export volume for non-European countries reached 200 million tons in 1994, whereas the trade volume for partner countries in non-EU European countries amounted to 75 million tons.

3.3 Pattern of loading/discharging

The results of complicated ISL research activities for 1992 and a preliminary update to 1994 can be summarised as follows:
Section I - Maritime Networks and Modal Split

- In 1994 the total Intra-EU seaborne trade volume loaded/unloaded in ports of the EU amounted to 268 million tons, a substantial increase compared to the mid 80s of about 150 million tons.

- The loaded/unloaded seaborne trade which includes besides seaborne foreign trade shares of EU countries also transit potentials, generally shows the same structure with regard to NSTR commodity groups and loading categories as indicated in the foreign trade analysis. The transit traffic potentials included in the internal community's seaborne trade amounted to approx. 15% in 1994. General cargo volumes are largely determining the seaborne trade structures. In 1994 this loading category had a share of 50% of the total seaborne trade. The latter is contributed to containers (54 million tons), ro/ro (53 million tons) and conventional general cargo (27 million tons), totalling in 134 million tons.

4 Approach to estimate ro/ro and ferry freight traffic volumes

There are three major areas of ro/ro traffic in Europe, namely:

- Baltic Sea;
- North Sea, Channel and Irish Sea;
- Mediterranean and Black Sea.

Increasing relevance is to be observed within the Black Sea. Especially trades between Turkey and the former USSR countries are significantly growing.

In many cases ro/ro transport of trucks, trailers (powered vehicles, unaccompanied trailers) is more or less a short part of a combined land/sea transport (for example an Austrian truck crosses Germany and either France, Belgium or the Netherlands, then uses a ferry over the Channel to reach UK). For a sound derivation of seaborne transport the various routes including their individual legs have to be identified. Since this is a very ambitious approach, cargo analysis has been restricted to unit loads without differentiation of the 52 NST/R-2-digits main commodity groups. It is, however, evident that the predominant share of ro/ro and ferry movements contain high-valued goods belonging to commodity section 1 (foodstuffs), 8 (chemical products) and especially 9 (manufactured goods). The main objective of this chapter is to allocate cargo and hence vessels to the individual routes around Europe.

Complete and valid statistics on ferry and ro/ro cargo traffic are not available but have to be derived from several national sources and/or from shipping information which are helpful as tentative indicators for estimating cargo volumes.
Out of the various indicators published by WILD (Int.)\(^5\) such as the number of ships, gross tonnage, lane metres, container capacity etc., the first two indicators are suitable to show the freight ro/ro capacities. Freight transport capacities of passenger/freight ferries are not contained in the following Chapter 4.1, but are shown separately in Chapter 4.2.

According to ISL research activities total ro/ro and ferry freight movements amounted to about 82 million tons (weight of vehicles excluded), contributed by Intra-EU-traffic with 64 %, cargo loaded in EU countries with 14 % and discharged with 22 % (Sweden and Finland yet treated as Non-EU-countries).

A substantial share of the total of roughly 82 million tons (MT) is transit traffic. In order to split bilateral trades and transit traffic, various national statistics (trade, transport, transit, port and ferry statistics) have been analysed in detail. The most accurate information have been found for the Baltic Sea (information from Germany and Nordic States) and for all trades to/from UK/Ireland. In addition, data from Belgium and the Netherlands could be used for splitting UK traffic into bilateral trades and transit cargo.

To give a better insight into the relevance of transit traffic, the following examples have been taken from the full data set derived from various sources, procedures and algorithms:

- Total ro/ro traffic between the UK and Germany was around 8.0 MT in 1994, thereof about 35 % direct trades and 65 % transit via Dutch, Belgian and French ports(terminals, contributed as follows: 24 %, 32 %, and 44 % respectively.

- Total ferry and ro/ro traffic between Germany and Scandinavia/Finland is contributed by 55 % bilateral trade and 45 % transit traffic.

- Total ferry and ro/ro traffic between Denmark and Sweden of 7.3 MT consisted of 75 % bilateral trades and 25 % transit traffic via the Oresund. Transit traffic is split up by 50 % for German trade and 50 % for transit traffic crossing Germany, respectively.

- In case of UK/Spain traffic the transit traffic of unit load cargo through France amounts to 67 % of total unit load traffic between the two countries. Even between UK and Portugal, the share of transit land traffic through France is substantial (38 %).

These and many other individual information have been derived as a result of intensive research work which has been carried out on behalf of the EU/DG VII. It must be stated that the Mediterranean area required clearly more information.

Section I - Maritime Networks and Modal Split

Assumptions since the statistical basis is substantially weaker compared with those of the Baltic and the North Sea/Channel. Moreover, the political/military situation in former Yugoslavia has led to several erratic cargo flows which are only partly covered by statistics published.

4.1 Ro/Ro traffic volumes

Specific means of ro/ro traffic including particular vessels carrying both accompanied vehicles and unaccompanied trailers are employed in European shortsea trades. A summary of the potentials is given in Table II.

<table>
<thead>
<tr>
<th>Region</th>
<th>Vessels</th>
<th>Gross tons (1,000)</th>
<th>Lane (1,000 m)</th>
<th>TEU (1,000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>UK-Ireland-North Continent</td>
<td>55</td>
<td>410.2</td>
<td>70.6</td>
<td>12.0</td>
</tr>
<tr>
<td>Baltic Sea</td>
<td>87</td>
<td>775.1</td>
<td>102.4</td>
<td>20.9</td>
</tr>
<tr>
<td>North Sea</td>
<td>48</td>
<td>378.8</td>
<td>68.7</td>
<td>116.3</td>
</tr>
<tr>
<td>Mediterranean</td>
<td>234</td>
<td>1,438.5</td>
<td>245.6</td>
<td>60.9</td>
</tr>
<tr>
<td>Total</td>
<td>424</td>
<td>1,002.6</td>
<td>487.4</td>
<td>110.1</td>
</tr>
</tbody>
</table>


Table II: Summary of European shortsea ro/ro capacity (beginning of 1994)

The information on the supply side of the European ro/ro market has been used in order to estimate the geographical structure of ro/ro traffic flows under consideration of the number of departures, distances and speed. This means that the average quantity of tons moved related to the capacity offered is much higher on routes between UK and the North Continent compared to several routes in the eastern Baltic and the Mediterranean.

Since most of short-distance freight traffic over sea is conducted by ferry operators (combined passenger/freight vessels), the number of freight ro/ro vessels deployed in the eastern Channel and southern North Sea is limited to 34 ships with 294,000 gross tons. This is even more the case within the western Channel.

With respect to eastern Baltic trades with UK/Continent concerning ro/ro traffic and because of its geographical position Finland has developed to become the predominant country. The distances are too long for regular ferry operations, but suitable for ro/ro instead of container services. The share of ro/ro capacities from/to Finland amounts to about 54%.

The southern and western part of the Baltic Sea is dominated by ferry services on short routes between Germany and Denmark. Thus, typical ro/ro services are less dominant compared to the eastern Baltic.
Land/Sea Transport Flows in Europe

The Mediterranean Sea is a very important ro/ro service area with shares of about 50% each of the western and eastern Mediterranean. Because of the long coast lines of the countries in the West Mediterranean, there exists a substantial share of domestic trades. Moreover, there are several operators offering ro/ro services on a mixed liner/tramp basis which can hardly be attributed to individual countries (total capacity of 127 vessels with 715,000 gross tons\(^6\)).

Intra-Mediterranean trades account for more than 70% of total capacities (regarding to lane metres and TEU). The majority of ro/ro services is observed in either domestic traffic to Spain and Italy (33%) or South Europe/North Africa (40%) and other intra-Mediterranean trades (27%). The extra-Mediterranean capacities of 224,500 gt are contributed by about 68% of intra-EU trades (Italy/France-North Europe). The remainder consists of services either between Baltic Sea-Mediterranean or between Belgium/France-Northern Africa.

The ro/ro capacities in the eastern Mediterranean amount to about 723,000 gt. About 13% of total capacities are related to trades between the East Mediterranean and North Europe and 23% to those between East Mediterranean and Black and Red Sea, respectively. The majority of the ro/ro capacities in the eastern Mediterranean is related to internal trades (64%).

4.2 Ferry Traffic

There are specific traffic areas in Europe where freight volumes are moved by combined passenger/freight ferries instead of purely freight ro/ro vessels. These combined vessels are operating especially between Denmark and Sweden, Denmark and Germany and between Sweden and Germany. The other major ferry traffic area is the UK Channel. According to our estimates, more than 70% of total ferry freight traffic in northern Europe are related to these areas.

There are several major traffic links between Scandinavia and Central Europe. The German-Danish traffic from and to Jutland and Funen is directed across the border and via the bridge of the Small Belt. The isle of Sealand with its capital Copenhagen can be approached more easily via ferry connections. Thereby, the rail and lorry/car ferry "Vogelfluglinie" Puttgarden-Rodby is playing a dominating role due to the short travelling time of only one hour (it carries Danish, Swedish and even Norwegian and Finnish traffic). A substantial share of Sweden traffic finds its way via Denmark. The traffic flows run via Jutland and the Kattegat, especially via Fredrikshavn to Gothenburg. They do, however, not reach the importance of the direct traffic flows that choose the following routes:

- Kiel-Gothenburg;
- Travemunde-Gothenburg;

Section I - Maritime Networks and Modal Split

- Travemunde-Malmo/Helsingborg;
- Travemunde-Trelleborg;
- Rostock/Saßnitz-Trelleborg.

The direct ferry traffic between Germany and Norway is restricted to Kiel-Oslo (600,000 ton p.a.). Indirect traffic between Germany and Norway is routed through Denmark and then by ferry via Hirthals. The lorry traffic with Finland runs via Sweden and predominantly via the direct ferry Travemunde-Helsinki. Based upon these ferry services a lively ro/ro traffic could be established (one to three daily departures from Lubeck to Finnish ports). These services carry trucks and trailers, containers and load units as port-to-port traffic flows. Because of the longer transhipment time the Finland ro/ro traffic consists mainly of unaccompanied trailers.

For a sample of 23 ferry routes time series have been conducted (1986-1995) which indicate a strong growth between 1986 and 1990, followed by a phase of stagnation until 1993, and then again by a substantial growth between 1993 and 1995. The average annual growth rate during the whole period was 5%.

![Figure 4: Development of ferry traffic by truck and trailers between Scandinavia and the continent (source: compiled from Cruise and Ferry Info, various issues)](image)

In addition to trailer transport capacities on ferries there are some vessels with rail wagon capacities in operation. The most important link for this kind of service is the so-called "Vogelfluglinie" between Puttgarden/Germany and Rodby/Denmark carrying about 190,000 wagons and 3.6 million tons in 1995. Compared to the
Land/Sea Transport Flows in Europe

rapidly growing trailer traffic, rail cargo developed moderately and recently even stagnated.

The traditional railway ferry line between Warnemunde/Rostock and Gedser is no more in operation since all railway wagons from/to Denmark under DFO control are now routed via Puttgarden.

The rail ferry traffic between Germany and Sweden is contributed by three services, namely:

<table>
<thead>
<tr>
<th>Route</th>
<th>1994</th>
<th>1995</th>
</tr>
</thead>
<tbody>
<tr>
<td>Travemunde-Malmo</td>
<td>20,600</td>
<td>20,000</td>
</tr>
<tr>
<td>Saßnitz-Trelleborg</td>
<td>108,300</td>
<td>79,000</td>
</tr>
<tr>
<td>Rostock-Trelleborg</td>
<td>23,000</td>
<td>50,000</td>
</tr>
</tbody>
</table>

The data presented indicate a shifting of cargo from the traditional Saßnitz-Trelleborg route to Rostock-Trelleborg.

Another important link is the rail ferry Travemunde-Hanko. Between 1990 and 1994 three rail ferries (Railship I, II, III) were in operation. In 1995, Finncarriers/Poseidon decided to operate only with two railway ferries and to employ the third vessel within the regular service between Travemunde and Turku. Total cargo transported by the Railship-group amounted to a stable 1 million tons during recent years, thereof about 700,000 tons carried by 25,000 rail wagons. Contrary to the service on the Puttgarden-Rodby route with freight and passenger transport, railship cargo is not indicated as ferry cargo, but as ro/ro cargo (no passenger service).

Finally, between Poland and Sweden cargo is transported by about 35,000 rail wagons between Swinoujscie and Ystad.

4.3 Establishment of european ro/ro traffic matrices

The setting up of Europe-wide matrices of ro/ro and ferry cargo flows can only be a result of a step-by-step estimation procedure. Since original data are not available, several sources of information in combination with own market knowledge and calculations (for example: compilation of tons moved based upon vehicle number and average tons per vehicle moved) have to be obtained. First of all, some conversion factors are shown for selected routes:

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Trucks/trailers  
Gothenburg - Frederikshavn  12.7  
Halmstad - Grena  15.3  
Varborg - Grena  15.9  
Landskrona - Tuborg  15.7  
Oslo - Frederikshavn  14.2  
Moss - Frederikshavn  14.6  
Trelleborg - Travemunde  15.6  
Gothenburg - Kiel  15.8  
Gedser - Rostock  13.0  

Rail wagons  
Rodby - Puttgarden  20.9  
Saßnitz - Trelleborg  23.8  
Travemunde - Hanko  27.2  

Table 111: Intra EU ro/ro cargo loaded and discharged 1994 (1,000 tons)

<table>
<thead>
<tr>
<th>Import by</th>
<th>France</th>
<th>Belgium</th>
<th>Netherlands</th>
<th>Germany</th>
<th>Italy</th>
<th>UK</th>
<th>Ireland</th>
<th>Denmark</th>
<th>Greece</th>
<th>Portugal</th>
<th>Spain</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>France</td>
<td>1225</td>
<td>0</td>
<td>20</td>
<td>1</td>
<td>5654</td>
<td>514</td>
<td>37</td>
<td>204</td>
<td>55</td>
<td>342</td>
<td>7069</td>
<td></td>
</tr>
<tr>
<td>Belgium/Lux.</td>
<td>0</td>
<td>4</td>
<td>2</td>
<td>6</td>
<td>4115</td>
<td>12</td>
<td>24</td>
<td>0</td>
<td>37</td>
<td>171</td>
<td>4372</td>
<td></td>
</tr>
<tr>
<td>Netherlands</td>
<td>6</td>
<td>0</td>
<td>6</td>
<td>6</td>
<td>3153</td>
<td>12</td>
<td>1</td>
<td>18</td>
<td>15</td>
<td>60</td>
<td>3317</td>
<td></td>
</tr>
<tr>
<td>Germany</td>
<td>1</td>
<td>16</td>
<td>60</td>
<td>1</td>
<td>759</td>
<td>0</td>
<td>3616</td>
<td>0</td>
<td>5</td>
<td>1</td>
<td>4469</td>
<td></td>
</tr>
<tr>
<td>Italy</td>
<td>440</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>12</td>
<td>0</td>
<td>1099</td>
<td>18</td>
<td>337</td>
<td>1912</td>
<td>1912</td>
<td></td>
</tr>
<tr>
<td>UK</td>
<td>8694</td>
<td>6521</td>
<td>4966</td>
<td>757</td>
<td>12</td>
<td>105</td>
<td>773</td>
<td>72</td>
<td>4</td>
<td>43</td>
<td>23147</td>
<td></td>
</tr>
<tr>
<td>Ireland</td>
<td>751</td>
<td>12</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>105</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1058</td>
<td></td>
</tr>
<tr>
<td>Denmark</td>
<td>37</td>
<td>24</td>
<td>11</td>
<td>385</td>
<td>0</td>
<td>449</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>4336</td>
<td></td>
</tr>
<tr>
<td>Greece</td>
<td>263</td>
<td>0</td>
<td>18</td>
<td>0</td>
<td>733</td>
<td>104</td>
<td>0</td>
<td>2</td>
<td>12</td>
<td>126</td>
<td>1266</td>
<td></td>
</tr>
<tr>
<td>Portugal</td>
<td>42</td>
<td>7</td>
<td>15</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>0</td>
<td>2</td>
<td>12</td>
<td>85</td>
<td>108</td>
<td></td>
</tr>
<tr>
<td>Spain</td>
<td>301</td>
<td>115</td>
<td>16</td>
<td>5</td>
<td>320</td>
<td>43</td>
<td>0</td>
<td>120</td>
<td>37</td>
<td>1099</td>
<td>53000</td>
<td></td>
</tr>
</tbody>
</table>

Table III: Intra EU ro/ro cargo loaded and discharged 1994 (1,000 tons)

As shown in Table III, a volume of 53 million tons of Intra-EU ro/ro and ferry freight has been compiled. The leading country is UK with more than 36% of total tons moved, followed by France (17%), Belgium (10%), Germany (9%), the Netherlands (8%) and Denmark (8%).

7Low value due to a substantial share of empty wagons (1995: 27%).

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5 European container transport

Besides ro/ro and ferry traffic, also container transport plays an important role in European land/sea trades, differentiated in deepsea, Intra-EU and feeder traffic.

In 1994 the total European container port throughput amounted to about 30.3 million TEU as compiled by Ocean Shipping Consultants. This quantity was contributed by deepsea (56 %), Intra-EU (23 %) and feeder traffic (21 %). Due to substantial changes of several container routings - especially shifts from Scandinavian deepsea to feeder traffic with respective double countings in Scandinavian and North Range ports - the market share of feeder traffic rose remarkably.

5.1 Future development

As stated by OSC, all types of trade - direct European trades, feeder and deepsea trades - have substantially increased. However, since 1980 Intra-EU container seaborne trade and traffic has fallen from 25 % of total port demand to 23 % in 1994. Contrary to this feeder traffic raised its market share from slightly more than 12 % to about 21 %.

According to conclusions drawn from a recent study published by Ocean Shipping Consultants European container port throughput is expected to grow from 30.3 million TEU in 1994 to 43.0 million TEU in 2000 and to nearly 60.0 million TEU in 2005. Based upon trend analysis, Ocean Shipping Consultants' forecast a further decline of the Intra-EU market share of 21 %, while the share of feeder traffic is expected to rise to nearly 24 %, leaving 55 % for deepsea traffic in 2005. These shifts imply the following growth rates:

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>inter-Europe</td>
<td>5.5 %</td>
</tr>
<tr>
<td>feeder</td>
<td>7.6 %</td>
</tr>
<tr>
<td>deepsea</td>
<td>6.3 %</td>
</tr>
<tr>
<td>total</td>
<td>6.5 %</td>
</tr>
</tbody>
</table>

Some years ago we had carried out a forecast for the future European container shipments by sea until 1995 and 2000, based upon 1988 data. Compared to recent data of 1994/1995 it must be stated that:

- Deepsea traffic forecast for 1995 was very close to the actual quantity (predicted: 17.6 million TEU, actual: 17.9 million TEU);
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- Total European (inter + feeder) could be predicted quite adequately (predicted: 12.9 million TEU, actual: 13.8 million TEU);\(^9\)
- The split between inter-European and feeder traffic has been predicted wrongly, possibly because of unreliable data for 1988;\(^10\)
- Total TEU predicted for 1995 (30.5 million) was by 1.26 million underestimated compared with the actual figure of 31.76 million TEU (-4 % over a period of 7 years).

If looking at the growth dynamics - especially in feeder traffic - our earlier forecast for the year 2000 regarding total container port throughput based upon 1988 data, seems to be too conservative (38.2 million TEU instead of 43.0 million TEU as recently predicted by OSC).

5.2 Assessment of the future intra-EU/feeder traffic by main trading areas

Based upon 1994 data published by Ocean Shipping Consultants\(^11\), the regional origin/destination matrix (6 x 6 regions) of Intra-European container traffic has been established. The most important region is the North Continent (27 %), followed by UK/Ireland (19 %), West Mediterranean (17 %), Scandinavia/Baltic Sea (17 %), East Mediterranean (12 %) and Atlantic (8 %). Leading trades are North Continent/UK/Ireland (13 %), Intra-West Mediterranean (11 %) and North Continent/Scandinavia/Baltic (8 %).

Based on individual forecasts of shipments within the Intra-EU and feeder services and on the basic matrix of O/D flows between major European regions we have predicted the 2005 O/D-matrix for Intra-EU trades. The forecast of the recent 1994 O/D-matrix to 2005 was carried out by applying the so-called FRATAR algorithm which is frequently applied in transport engineering and transport planning. This matrix balancing program leads to a new O/D matrix under the constraints of row and column totals within a rather small number of iterations. In our case, with a rather small 6 x 6 matrix, only 33 iterations were necessary to achieve a full mathematical solution. The result is presented in Table V.

5.3 Hinterland traffic in european container shipping

Land/sea trade flows are not only relevant for Intra-European trade, but also for deepsea container traffic.\(^12\) A comprehensive analysis on the hinterland container

\(^9\)The OSC data for 1992 are quite consistent with those published by MDS Transmodal (11.7 million TEU compared with 10.4 million TEU). The difference might be attributed to containers on ro/ro vessels.

\(^10\)The problem of not fully reliable data (especially of feeder and container traffic) has also been discussed in: MDS Transmodal: Container by Sea, 3rd Ed., Chester 1994, p. 10.

\(^11\)see source above.

\(^12\)Bulk transhipments are not treated in this paper, they have, however, substantial significance for liquid as well as for several dry bulk cargoes.
## Table IV: European container shipping, 1994 (1,000 TEU)

<table>
<thead>
<tr>
<th>To From</th>
<th>North Continent</th>
<th>Scand./ Baltic</th>
<th>UK/Ireland</th>
<th>Atlantic</th>
<th>West Med.</th>
<th>East Med./ Black Sea</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>North Continent</td>
<td>78</td>
<td>1,050</td>
<td>1,730</td>
<td>442</td>
<td>97</td>
<td>194</td>
<td>3,591</td>
</tr>
<tr>
<td>Scandinavia/ Baltic</td>
<td>1,050</td>
<td>720</td>
<td>369</td>
<td>32</td>
<td>31</td>
<td>24</td>
<td>2,226</td>
</tr>
<tr>
<td>UK/Ireland</td>
<td>1,730</td>
<td>369</td>
<td>171</td>
<td>114</td>
<td>95</td>
<td>38</td>
<td>2,517</td>
</tr>
<tr>
<td>Atlantic</td>
<td>442</td>
<td>32</td>
<td>114</td>
<td>500*</td>
<td>49</td>
<td>20*</td>
<td>1,157</td>
</tr>
<tr>
<td>West Mediterranean</td>
<td>97</td>
<td>31</td>
<td>95</td>
<td>49</td>
<td>1,491</td>
<td>498</td>
<td>2,261</td>
</tr>
<tr>
<td>East Med./ Black Sea</td>
<td>194</td>
<td>24</td>
<td>38</td>
<td>20*</td>
<td>498</td>
<td>845*</td>
<td>1,619</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>3,591</strong></td>
<td><strong>2,226</strong></td>
<td><strong>2,517</strong></td>
<td><strong>1,157</strong></td>
<td><strong>2,261</strong></td>
<td><strong>1,619</strong></td>
<td><strong>13,371</strong></td>
</tr>
</tbody>
</table>

Source: Ocean Shipping Consultants: Market Prospects for European Containerisation, Chertsey, 1995 - own estimates (*).

## Table V: European container shipping 2005 (1,000 TEU)

<table>
<thead>
<tr>
<th>To From</th>
<th>North Continent</th>
<th>Scand./ Baltic</th>
<th>UK/Ireland</th>
<th>Atlantic</th>
<th>West Med.</th>
<th>East Med./ Black Sea</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>North Continent</td>
<td>167</td>
<td>2,589</td>
<td>3,036</td>
<td>880</td>
<td>194</td>
<td>392</td>
<td>7,258</td>
</tr>
<tr>
<td>Scandinavia/ Baltic</td>
<td>2,590</td>
<td>2,051</td>
<td>748</td>
<td>74</td>
<td>72</td>
<td>56</td>
<td>5,590</td>
</tr>
<tr>
<td>UK/Ireland</td>
<td>3,035</td>
<td>748</td>
<td>246</td>
<td>187</td>
<td>156</td>
<td>63</td>
<td>4,436</td>
</tr>
<tr>
<td>Atlantic</td>
<td>880</td>
<td>74</td>
<td>187</td>
<td>928</td>
<td>92</td>
<td>38</td>
<td>2,198</td>
</tr>
<tr>
<td>West Mediterranean</td>
<td>194</td>
<td>72</td>
<td>156</td>
<td>91</td>
<td>2,795</td>
<td>943</td>
<td>4,252</td>
</tr>
<tr>
<td>East Med./ Black Sea</td>
<td>392</td>
<td>56</td>
<td>63</td>
<td>38</td>
<td>943</td>
<td>1,618</td>
<td>3,110</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>7,258</strong></td>
<td><strong>5,590</strong></td>
<td><strong>4,436</strong></td>
<td><strong>2,198</strong></td>
<td><strong>4,252</strong></td>
<td><strong>3,110</strong></td>
<td><strong>26,844</strong></td>
</tr>
</tbody>
</table>

Source: Ocean Shipping Consultants: Market Prospects for European Containerisation, Chertsey, 1995 - own estimates (*).

Table V: European container shipping 2005 (1,000 TEU)

Traffic has been published in 1994 by MDS Transmodal using 1992 data.\(^{13}\)

\(^{13}\)MDS Transmodal: Containers Inland 1994, p. 42.
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Related to a total port traffic in Europe of 23.3 million tons, MDS derived a percentage of about 77% inland traffic flows, contributed by road of 58%, rail of 14% and inland waterways of 5%. A summary of these findings is shown in Table VI.

<table>
<thead>
<tr>
<th>Country (Group)</th>
<th>Total traffic</th>
<th>Thereof</th>
<th>Hinterland, thereof</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Transhipments</td>
<td>LCL</td>
<td>Road</td>
</tr>
<tr>
<td>Nordic Countries</td>
<td>1,472</td>
<td>24</td>
<td>1,269</td>
</tr>
<tr>
<td>Germany</td>
<td>3,597</td>
<td>99</td>
<td>2,330</td>
</tr>
<tr>
<td>Netherlands</td>
<td>4,201</td>
<td>1,214</td>
<td>2,729</td>
</tr>
<tr>
<td>Belgium</td>
<td>2,379</td>
<td>443</td>
<td>1,699</td>
</tr>
<tr>
<td>France</td>
<td>1,302</td>
<td>73</td>
<td>1,099</td>
</tr>
<tr>
<td>Spain/Portugal</td>
<td>2,643</td>
<td>986</td>
<td>1,478</td>
</tr>
<tr>
<td>Italy</td>
<td>1,910</td>
<td>125</td>
<td>800</td>
</tr>
<tr>
<td>East Europe</td>
<td>968</td>
<td>50</td>
<td>4,784</td>
</tr>
<tr>
<td>UK/Ireland</td>
<td>4,866</td>
<td>1,425</td>
<td>17,904</td>
</tr>
<tr>
<td>Subtotal</td>
<td>23,338</td>
<td>4,005</td>
<td>17,904</td>
</tr>
<tr>
<td>Others</td>
<td>2,897</td>
<td>---</td>
<td>1,091</td>
</tr>
<tr>
<td>Total</td>
<td>26,235</td>
<td>---</td>
<td>17,904</td>
</tr>
</tbody>
</table>


*) Greece, Malta, former Yugoslavia missing. Difference calculated from OSC data 1992

Table VI: Derivation of inland traffic flows 1992 (1,000 TEU)

6 From country-to-country trade flows to inter-regional origin/destination matrices

Our research activities concerning land/sea freight flows during the past six years revealed that:

- Full-scale interregional cargo flows information within Europe are generally not available and very difficult to be obtained and/or estimated;
- International freight flow information on a country-to-country level are in many cases not sufficient to solve specific sea/land transport planning problems;
- The process of establishing interregional freight flow matrices has to be carried out in combining various statistical sources and estimation algorithms;
- The procedures of coming into force is only possible by individual analyses, beginning with those countries that have the reputation to provide rather reliable data.

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About four years ago a rough description of an adequately seeming methodology had been presented based upon German international trade and transport data.\(^{14}\) This approach has been used in recent projects such as a study about a possible Fehmarnbelt fixed link. The basic ideas are summarised in the following.

### 6.1 Problems from German point of view

Since beginning of the 90s the German government is trying to find possibilities of shifting cargo from road to sea.\(^{15}\) The objective was and is to find traffic corridors crossing the German highway network over long distances (for example between Scandinavia and coastal areas in Germany, but also in neighbouring countries or in third countries such as Spain, Portugal, Italy, Greece, Turkey etc.) which might be interesting for shifting cargo from road to sea.

In order to identify such corridors it is necessary to have a good insight into the long-distance origin/destination flows by mode of transport and by route, differentiated by commodity groups or at least by loading categories (as mentioned in Section 2 of this paper).

In an earlier study on behalf of the Federal Ministry of Transport\(^{16}\) it could be shown that the approach generally can be solved for Germany as one important country within the centre of Europe. Similar approaches have been made by the Netherlands and Scandinavian countries, but merely on national level. The same is true for studies conducted by Transmodal with relation to container transport.\(^{17}\)

Based upon a comprehensive modelling procedure it could be proved that fairly complete and reliable data about traffic flows along the transport chains can be made available by commodity groups and origin/destination pairs (80 regional units in Germany and 20 of surrounding countries multiplied by 36 countries/country groups in Europe/overseas).

### 6.2 Brief description of the compilation process

There are three main types of data used for compiling the O/D flows by mode and route:

- German foreign trade and transit data as defined in Section 1;


\(^{17}\)MDS Transmodal: Containers Inland, Chester, 1994.

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- German freight movement data and additional information of several surrounding countries (especially the Netherlands, Belgium etc.);
- German maritime transport statistics including port and ferry statistics, assisted by port and transit statistics of the Netherlands and Belgium.

An example of how to use the various sources of information is contained in an earlier contribution. This example was related to imports of consumer goods from the USA to Germany/Bundesland Hessen by modes of transport, border sections, and ports when more than one port can be reached via border section and vice versa.

Step 1: Total import volumes of consumer goods of Hessen from USA, by border section.

Step 2: Split of import volumes into direct and indirect seaborne trade.

Step 3: Modal split pattern by border section relevant for indirect seaborne trade.

Step 4: Modal split pattern in Germany seaports' hinterland traffic.

Step 5: Split of mode-specific freight flows by traffic zones in Hessen and by border sections.

Step 6: Further split of indirect seaborne trade into ports related to relevant border section(s).

Step 7: Assignment of port traffic to border section by mode of transport.

Step 8: Derivation of a full-scale matrix of Hessian imports from the USA by traffic zones, modes of transport, border sections and ports.

7 Concluding remarks

It could be shown that the statistical basis for setting up consistent land/sea trade flows in Europe is very weak. There are only few companies/institutions which deal with this problem. One of them is MDS Transmodal who provide container transport flows for both sea and hinterland traffic. Our own analysis has identified the urgent need for improving the procedures on data collection and processing. ISL will continue to contribute to respective approaches and is going to establish Europe-wide origin/destination matrices by mode including multimodal traffic in order to strengthen the statistical basis for European transport planning.
INTERMODAL LINK BETWEEN GREECE AND THE REST OF THE EU COUNTRIES: STATUS AND PROSPECTS

By O.D. Schinas and H.N. Psaraftis

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5 Recommendations ................................................ 53
References .......................................................... 54
THE INTERMODAL LINK BETWEEN GREECE AND THE REST OF THE EU COUNTRIES: STATUS AND PROSPECTS

Abstract

The purpose of this paper is to critically investigate the transportation link between Greece and the rest of European Union (EU) countries. Greece is the only non-island EU country which is not adjacent to the rest of the contiguous EU countries. Since the breakout of the war in the territory of the former Republic of Yugoslavia, the main land link through the Balkan peninsula has become dangerous and inadequate to carry the continuously growing transport load. The other link of Greece to the rest of the EU is intermodal: it connects western Greek ports with eastern Italian ports via the Adriatic Sea. Under the present circumstances, and in spite of many problems, this particular link represents the only promise for a viable connection between Greece and the rest of the EU.

The volume and value of the trade between Greece and the rest of EU countries are continuously growing. However, the existing network has reached its capacity, and problems of insufficient land traffic interconnections are now becoming more complex, demanding immediate action. The paper has two major objectives: the first is to describe the network by analysing the statistical data provided by public and private sources and by making references to the institutional framework. All land and sea connections, including port infrastructures, are also described. Extensive analysis of data provides an image of the traffic in ports and an ability to make aggregate projections of the traffic in the future.

The second objective is to foresee what may happen in the near future. As new fast ships may enter the routes of the Adriatic, and a new institutional environment is taking shape by EU rules and regulations, this trade will never be the same again. In order to achieve this objective, the paper estimates the transport cost and performs a modal split analysis. The new technology fast ships are technically and economically investigated. The analysis shows that a major problem is the economic viability of the fast ships, which leads to a higher required fare and thus prohibits some carriers to use them. To the best of our knowledge, this is the first time such an analysis has been performed for the Adriatic Sea link.

The paper ends with several conclusions and recommendations, which point to the inadequacies of the system and can suggest ways for a better performance of nodes, modes, branches and the whole network in general.
1 Origins and Scope of the Study

In considering the transport problem between Greece and the rest of the EU countries, it can be easily said that the traditional way of transporting products in and out of the Greek territory has been in many respects irrational. Greece is isolated by land from the rest of the EU countries. In fact, Greece and Ireland (which is an island) are the only two EU countries which are not directly linked by land to another EU country, and which, barring some extraordinary developments, will never be in the future. The UK recently left the “club of disconnected countries” due the Channel Tunnel, and Sweden, and, by extension, Finland, will soon be connected via a system of bridges to Denmark and to the contiguous EU. Before the breakout of the war in Yugoslavia, transport flows to and from the rest of the EU were quite extensively oriented in the Balkan road system (and rail system secondarily). The road linking Athens, Thessaloniki, Belgrade, Austria and Munich offered a cheap and fast way to transport goods in and out of Greece. The sea-borne road of the Adriatic sea, although cheaper, took longer (about half a day more), and that was the reason of the preference of carriers for the road mode. So for the last 30 years, Greece exported and imported mainly via the Balkan States, and until 1989 mainly via the former Federal Republic of Yugoslavia. Due to the war, Greece’s land connection to the rest of the EU became jeopardized, and flows of goods had to find alternate routes. The sea-borne connection with Italian ports was suddenly asked to accommodate much of these flows. It was very ill prepared to do so. The Greek seamanship and capability in running maritime business is commonly known worldwide. However, a remarkable observation is that for many years Greek ship operators did not invest seriously in the Adriatic Sea corridor, because of low profit margins. But since the breakout of the war in Yugoslavia, these operators invested heavily in new ships and new marketing approaches to the main new users of this corridor, the truck drivers and the transportation companies. This was really a fast reaction to the new regime. Unfortunately, investment in port infrastructures and hinterland connections could not, and did not follow suit. The result: severe bottlenecks and congestion. The analysis of this paper focuses on commodities transport by truck, but a brief report and references to the car and passenger traffic is also made, aiming to complete the general picture and to help finding the economic survivability of the investment in new technology fast ferries for passengers and cars. Transport by cargo ships such as general cargo, container or bulk, and air transport are not analysed in the paper.

It is difficult to predict the institutional environment in which Greek and other European carriers will operate in the future, but EU Legislation affects (and is expected to affect) virtually every area of economic activity, including the maritime and transport logistics industries in general. Many institutional changes are already on their way. Experience has shown that those who keep abreast of EU legislative developments tend to be better placed than those who believe that these developments will pass away. The role of Brussels is increasing and not only in transportation by rail, road and inland waterways (Title IV - Articles 74-84 in the Rome Treaty), but also in maritime business and industry with several newly adopted rules and regulations. The European Court of Justice obliged the Council
Section I - Maritime Networks and Modal Split

to promote a European Common Transport Policy (CTP) in 1985. The White Paper on transport was released in December 1992. It developed the principles of CTP, enforcing by all possible means the freedom of every European carrier to provide services within EU borders, with no exception for residents or non residents. It also provided for a common competition law through legal harmonisation of private and state aids, taxes and fees, and by prescribing safety issues and the protection of the environment. Finally it provided for the technical harmonisation, the transport planning (considering environmental factors), and the relations of the EU to third countries.

From 1/1/1993 the Common Market is functioning under continuous liberalisation (regulation 184/88), so the only thing a land carrier needs to have is a license, provided by the Union, based upon quality criteria, which refers to the ability of the carrier as a professional. But the liberalisation is stepwise and there is no way for it to be completed before 1996. From this date every carrier cannot act only according to the Law of the country in which he is already established. By having also the license from the EU to provide services within EU borders, he may also provide services in a member state of which he is not a resident. Actually there was a transition period of three years (1/1/93 to 31/10/95), where several member states could permit only a percentage of transport services to be carried out by residents of other member states (5% for 1993, 6% for 1994 and 7% for 1995); there is also a proposal to cancel the full liberalisation to 1997. All legal acts about land transport aims in the abolition of any restraining percentage in transport quantities and the creation of a cabotage environment, protecting EU carriers from the entering in the market of carriers not belonging to a member state. The new legal environment permits the free entrance in the EU transport market, grants free professional admission, according to regulations 561/74 and 438/89, if the carrier satisfies the three main criteria of reliability, training and financial resources, and enforces common social regulations i.e. same professional terms as far as they concern labour factors such as working and resting hours.

European rail organisations and companies will face a totally different environment. An increase of their competitiveness as servers, emphasising where railways have already an advantage or take an advantage due to application of telematics, new technologies, environmental friendliness, decreased unit cost of cargo etc is not only a sound premise. Rule 561 obliges a fairing and normalisation of economic terms rail organisations face due to former actions taken by the States and this may also help the improvement of infrastructure, because in many countries they are the exclusive users and exploiters of the networks. The improvement of infrastructure will also be subsidised by the development of sophisticated and efficient intermodal links and interchanges in port and other land nodes.

On the other hand experts analyse the prospects in a different way and support that there will be less cargo transport, due to competition from trucks but increased passenger traffic, due to the development of high speed links between major cities. They also believe that the provision of fully integrated intermodal services in collaboration with trucks, more reliable timetables and schedules, decreased fares and concentrated services in certain links and short of transport shall be expected. EU aims to the strengthening of intermodal services but not many things can be achieved without unitised cargoes, port and rail networks.
infrastructure and harmonisation in technical, telecommunicational and EDI matters. Every action already taken has the same objective; to enforce the intermodality. For this particular transport system, the Adriatic Sea network with sophisticated intermodality may be the only vital solution, which fully complies with the spirit of the "White Paper".

The Greek fleet of trucks is old-aged and not suitable for transport services within EU borders, because they are not compatible to the demanded technical rules of several countries. The fleet of Car/Passenger ferries connecting ports in the Adriatic Sea is also old aged and not capable to face the challenges of the future. On the other hand marine technology develops itself rapidly and as a result in a few years the fast transportation means will be common and indispensable. Fast ferries will connect many European ports, smart material handling system will provide a fast, safe and cheap transhipment, fast rail systems will be another part in the intermodal chain of the transport and trucks will serve door to door customers all over Europe.

So there are two parameters to be concerned: the Common Transport Policy and the developments in transport technology. Under the term "transport technology" we mean not only new fast ferries or marine technologies but also new road vehicles, fast trains, port facilities, and applications of every technological advance in the transport field, such as advanced telecommunications, packaging and handling. Technology and the new institutional environment, which is formed within the EU, will bring changes, demanding solutions in existing problems and several recommendations in order to prevent the EU transport network from new problems due to the developments.

2 Trade, Traffic and Network Analysis

Aggregate trade statistics

For a researcher to find data worthy of consideration for our specific problem (connection Greece- EU) is an extremely difficult task. This is so because the State collects data in a raw form from port authorities and from companies having interests in this traffic system. The result is that port authorities collect some data of interest to them and companies collect some other data of interest to them. Many times the collected data is uncorrelated, inconsistent, or irrelevant. Even under the same labels or fields of the data different people mean different things, and figures attributed to these labels may be different, depending on the source. Fundamental misunderstandings of statistical results can arise when words or phrases are unwisely assumed as synonyms or when analysts apply terms inconsistently. Data from different sources vary a lot from each other. This is the reason why in this study the analysis is based on as few as possible sources.

There is a strong belief that data from ESYE (the Greek National Statistical Service) are the most accurate. This is so because they are cross-checked from State sources and also collected by the companies. They are also provided in a suitable form for further processing and represent the traffic volumes from and to Greece (or Italy).
According to data provided by ESYE (1992 data) 23.1% of the quantity of Greek imports is coming from other EU Member States and their share of value is 63% of the whole. Greek exports to other EU Member States are 59% of total export quantity and 67% of its value. Table I forms a first image of the trade between Greece and the rest EU - Member States.

<table>
<thead>
<tr>
<th></th>
<th>1992</th>
<th>1993</th>
<th>1994</th>
</tr>
</thead>
<tbody>
<tr>
<td>IMPORTS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>quantity</td>
<td>6,686,087</td>
<td>7,077,773</td>
<td>5,066,887</td>
</tr>
<tr>
<td>value</td>
<td>2,828,301</td>
<td>3,030,004</td>
<td>2,128,499</td>
</tr>
<tr>
<td>EXPORTS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>quantity</td>
<td>13,018,838</td>
<td>8,751,405</td>
<td>6,420,351</td>
</tr>
<tr>
<td>value</td>
<td>1,332,522</td>
<td>1,082,246</td>
<td>789,919</td>
</tr>
</tbody>
</table>

Source: ESYE, values in 1,000 GRD and quantities in 1,000 tonnes

One can see that imported volume is 2.25 times less than the exported volume and the imported value is 2.1 times more than the exported value. The unit value of an imported tonne from the rest of the EU is about 1994 GRD ( $8) and the equivalent value for an imported tonne is 422 GRD ( $1.68), meaning that the unit value of imports is 4.7 times that of exports. This leads to the conclusion that Greece imports lightweight highly priced products and exports heavy cheap ones. According also to the same trade statistics the mean annual growth of imports is about 26.9% (1988 - 1992 period) and 27.05% for exports, and the most important markets are those of Germany, Spain and Italy but the trade is spreading all over EU territory, in contrast to the past when trade was focused on certain countries and cities {1}. Table II provides a breakdown per mode for 1992 and refers to the trade between Greece and all other countries in the world (including EU - Members).

Regrettably, a breakdown per mode is not available for the trade between Greece and the rest of the EU. However, no less than 95% of the rail and road flows in and out of Greece are associated with trade to and from the rest of the EU. From the above table a significant remark can be made: Although trucks serve only 8% of the whole volume, they transport goods representing 33% of the whole value. Looking closer, only 5.7% more tonnes were imported than those exported, but with a value of 145% more than the value of the exported ones. This also explains the difference of 132% of the unit values. It shall be noted that under the term transport by trucks are included also intermodal movements with trucks and other means.
The Intermodal Link Between Greece and the Rest of the EU Countries

<table>
<thead>
<tr>
<th></th>
<th>quantity</th>
<th>value</th>
</tr>
</thead>
<tbody>
<tr>
<td>sea</td>
<td>26,310,870</td>
<td>2,388,265,600</td>
</tr>
<tr>
<td>rail</td>
<td>552,120</td>
<td>258,526,065</td>
</tr>
<tr>
<td>road</td>
<td>1,881,260</td>
<td>1,517,806,828</td>
</tr>
<tr>
<td>total</td>
<td>28,831,000</td>
<td>4,554,921,745</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>quantity</th>
<th>value</th>
</tr>
</thead>
<tbody>
<tr>
<td>sea</td>
<td>19,155,500</td>
<td>1,147,677,926</td>
</tr>
<tr>
<td>rail</td>
<td>183,450</td>
<td>22,497,527</td>
</tr>
<tr>
<td>road</td>
<td>1,780,000</td>
<td>618,179,573</td>
</tr>
<tr>
<td>total</td>
<td>21,152,450</td>
<td>1,880,763,358</td>
</tr>
</tbody>
</table>

Source ESYE, values in 1,000 GRD and quantities in 1,000 tonnes

Table II

Geography, networks, ports

The Greek road network is generally poor, and does not permit high capacity and speed. The network of "national roads" (roads that do not necessarily have full motorway specifications) has a total length of 9,526 km and 85% of it is characterised by the Ministry of Public Works as good. The network is sufficiently preserved but is poorly designed. Viewing the map of Greece (Figure 1) one can see that there is no North-South motorway on the western side of the mainland, one that could permit the easy transport of goods and persons. Also there is no main East-West road axis. This means that there is no link between the productive Greek eastern mainland and the ports of western Greece, the ones that are closest to Italy.
Section I - Maritime Networks and Modal Split

The most significant port in the western Greek coast is Patras, where an industrial zone of major importance exists. The port of Patras serves mainly the international traffic of car/passenger ships heading to Italy or Yugoslavia and some cruise ships. However, the cruise ship business has not been properly developed and presently the ships are using the port of Katakolo, west of Patras. The traffic to and from Italy has increased, but the growth is not the expected one. The road connections are sufficient, due to the lack of a proper bridging between Rio and Antirrio, the truck traffic to the north side is hindered and the car traffic is forced in a way to remain low.

Patras is the only western port with a rail connection. However, the railway network in the Peloponnese peninsula (where Patras is located) is incompatible with the rest of the network in Greece but also with the rest of Europe rail networks due to a smaller gauge of 1.0 m width. So as far as rail is concerned,
The Intermodal Link Between Greece and the Rest of the EU Countries

Patras can only serve the trade needs of the Peloponnese, and the capacity of the line to Athens is very low.

The other major port of the western Greek coast is Igoumenitsa. This port is the endpoint of the future Egnatia highway, an East-West axis that will connect the EU via the Adriatic Sea, to Igoumenitsa and then to Thessaloniki and Turkey. The port has two main functions: to handle the coastal ferry traffic and connection with Corfu (the distance is only 18 sea miles) and to serve the international ferry traffic with Italy or Yugoslavia. No cargo facilities are provided and the port is limited to serve Ro/Ro or Car/Passenger traffic. Igoumenitsa is located in Epirus, a mountainous area where no significant economic activities are taking place. If there is an improvement in land interconnections then Igoumenitsa will accommodate more traffic, as happened although there was no improvement of facilities provided during the war in Yugoslavia. Epirus has no rail network, and it is not planned to build one before the end of the century.

Corfu has a port of minor importance, which has two main and distinct functions: to handle the local traffic to and from the mainland and to handle the international traffic to and from the island. The main activity of both classes of traffic is tourism, and the movements of merchandise cargo are limited.

For the railway network in Greece the only thing that can be said is that there is no integrated network at all, since the line serving the Peloponnese ends in a railway station terminal in Athens and the rest of the network is a standard gauge axis connecting Athens with Thessaloniki and further on to Balkan countries in the north. The two lines are disconnected in Athens because of their different gauge and because of infrastructure problems of the Greek Railway Organisation (OSE) (even the terminal stations are different). OSE has the exclusive right to exploit all facilities of the national railway network, to provide any available rail service within Greek territory and to cooperate with foreign railway organisations about anything concerning services and administrative matters. The total length of the network is only 2,126 km, and 62% of it has a normal standard gauge. Only 9.7% of the total provides a second (double) track. No electrification currently exists, although there are plans for doing so in the future. The achieved speeds are comparatively very low, and often derailments or several other accidents happen. But the major problem is the complete lack of terminals and organised nodes. Perhaps the only port for which some real physical connection between rail and ship can be achieved in the one in Thessaloniki (which is of no consequence to our analysis). So, for the purposes of our specific study, no real rail-ship intermodality can be achieved. The cargo traffic has been decreasing year by year. During the war in the Balkans trains passed through Bulgaria and Romania, almost along the same routes as trucks did.

The main Italian ports facing the Adriatic Sea are Trieste, Ancona, Bari, Brindisi, and Otranto. For the needs of this study only the ports of Ancona, Bari and Brindisi and their land connections will be analysed. By contrast to Greece, in Italy substantial road and rail networks exist. OSE has cooperated usually with the rail organisations of Yugoslavia and Austria, but never with the Italian rail organisation (Ferrovie dello Stato- FS) due to incompatibility of the gauges between Patras and Italy. In Italy the road networks are excellent and high speeds can be achieved. The rail networks serve all the Italian mainland and can connect all major ports in the Adriatic Sea to markets anywhere in Europe.
One of the safest and deepest port in the Adriatic Sea is Ancona: a well protected and adequately equipped port that can serve cargo, passenger and ro/ro traffic. The road and rail links need an improvement and Italian Authorities have taken into serious consideration the further development of the port. Of course, as long as Greece has no real rail port the existence of good rail facilities and connections in Italy is important only for theoretical considerations.

Bari is a very important port linked to all road and rail Italian networks. But further improvement of the railway node is necessary. Traffic analysis will prove that it is wise to consider a common future for the ports of Brindisi and Bari. Brindisi has a natural port which serves passenger traffic along the summer season. There is an adequate rail connection but the connection to the motorway system is not ready yet. Many works are in progress, financed by special reserved funds, but a great amount of work is still to be done such as relocation and reconstruction of the whole port.

Although many technical problems exist, thus far Greek operators and users typically have preferred to disembark in Bari or Brindisi. Now the future is quite unpredictable, because a newly adopted Italian policy wishing to free the road networks in the south may oblige indirectly Greek trucks to disembark in a northern port, such as Venice or Trieste. But even if the traffic figures remain the same for the next decade, the port facilities in southern Italy shall be improved.

In closing this paragraph it should be noted that the road networks through the Balkan States are insufficient and narrow, but no significant traffic jams occur except in custom houses or near major cities. In the rest of EU countries, including Austria, the networks are very good but often jammed due to heavy traffic. The main problem for Greek carriers are the new technical rules (about environmental protection and labour matters) followed by many controls and checking during the trip. Many controls are performed from Italian Authorities. This may revive the port of Trieste and the utilisation of intermodal links between Trieste and Verona or Villach (in Austria); from Verona any western market is easily reachable and from Villach any central European or eastern market is similarly accessible.

Traffic figures

The figures describing the traffic of trucks also include "intermodal" traffic between trucks and any other mode. This includes the traffic when trucks cross the Adriatic onboard car/passenger ships.

There are four main "gateways" (custom houses) through which trucks enter or leave Greece:

1. Euzonoi, to and from the Former Yugoslav Republic of Macedonia (FYROM);
2. Patras, to and from Italy;
3. Promachon, to and from Bulgaria;
4. Igoumenitsa, to and from Italy.

The traffic figures (expressed in number of trucks) are as follows (this data is actually the most up to date that can be officially provided by ESYE).
The Intermodal Link Between Greece and the Rest of the EU Countries

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Euzoni</th>
<th>Total Patras</th>
<th>Total Bulgaria</th>
<th>Total Igoumenitsa</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>In</td>
<td>Out</td>
<td>In</td>
<td>Out</td>
</tr>
<tr>
<td>1989</td>
<td>75,596</td>
<td>88,287</td>
<td>47,463</td>
<td>61,267</td>
</tr>
<tr>
<td>1990</td>
<td>63,783</td>
<td>85,394</td>
<td>27,317</td>
<td>60,247</td>
</tr>
<tr>
<td>1991</td>
<td>81,095</td>
<td>82,645</td>
<td>35,551</td>
<td>54,513</td>
</tr>
<tr>
<td>1992</td>
<td>102,349</td>
<td>143,472</td>
<td>31,158</td>
<td>39,731</td>
</tr>
</tbody>
</table>

Source: ESYE. Trucks of international transports crossing the frontiers. Distribution by custom-house. Note: including transit.

Table III

In every custom house the procedure of control for the vessel as well as for the cargo is exactly the same and several statistical figures are collected. A striking observation from Table III is the tenfold increase in the Patras outbound traffic from 1991 to 1992. Oddly enough, this is not matched by an equivalent increase of the inbound traffic, leading to the suspicion that there might be something wrong with the data. Unfortunately, there is no further information on this from any other official table, or even a note about it. Anyway, a general observation from the table is that carriers seem to use now more frequently the Adriatic Sea link. But the gateway of Euzoni that was dominating with 66% of the traffic in 1989, due to the war fell in 1992 to only 30%. By contrast, the gate of Promachon (Bulgaria) has increased its share from 3.2% to 44% in 1992. Apparently carriers prefer to send their trucks through Bulgaria and Romania instead of using the Adriatic Sea link.

In the next paragraphs the results of the statistical investigation will be presented. In the first paragraph statistics from year 1985 to 1994 are analysed per year and Greek or Italian ports. The traffic of passengers and cars represents a main stream of tourist flow to Greece, which is highly seasonal and creates congestion in the ports during the summer. It is also a great income source to the shipping companies, not only as fares, but also as hotel services. On the other hand the traffic of trucks is almost continuous with little seasonality. The trucks are the original users of the sea - linking network and preserve a standard income to the companies during the winter, when tourist traffic is negligible. Sasonality hinders trucks to cross the Adriatic in the summer, and the lack of traffic in the winter forces the shipping companies to reduce sailings.

Passengers (Table IV)

These figures do not represent the absolute totals of the network because traffic from several ports of minor importance is omitted. But they represent at least the 97% of the whole traffic. The passenger traffic has a total growth of 5.1% per year on the average during the pre war era and 4.4% during the war period (1992-1994). With a difference of 6.8% between inbound and outbound traffic it can be assumed that there is a balanced traffic between the two countries.
Table IV

Cars (Table V)

<table>
<thead>
<tr>
<th>Year</th>
<th>Patras</th>
<th>Igoumenitsa</th>
<th>Corfu</th>
<th>Ancona</th>
<th>Bari</th>
<th>Brindisi</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>in</td>
<td>out</td>
<td>in</td>
<td>out</td>
<td>in</td>
<td>out</td>
</tr>
<tr>
<td>1985</td>
<td>418,521</td>
<td>418,259</td>
<td>118,581</td>
<td>89,992</td>
<td>139,290</td>
<td>133,841</td>
</tr>
<tr>
<td>1986</td>
<td>367,622</td>
<td>377,609</td>
<td>111,812</td>
<td>86,178</td>
<td>133,069</td>
<td>129,790</td>
</tr>
<tr>
<td>1987</td>
<td>400,388</td>
<td>422,990</td>
<td>117,389</td>
<td>95,678</td>
<td>139,195</td>
<td>137,310</td>
</tr>
<tr>
<td>1988</td>
<td>456,266</td>
<td>456,606</td>
<td>127,076</td>
<td>83,163</td>
<td>164,216</td>
<td>177,834</td>
</tr>
<tr>
<td>1989</td>
<td>486,827</td>
<td>468,216</td>
<td>137,700</td>
<td>100,174</td>
<td>169,714</td>
<td>174,116</td>
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<tr>
<td>1990</td>
<td>518,873</td>
<td>502,434</td>
<td>184,626</td>
<td>126,163</td>
<td>203,789</td>
<td>195,172</td>
</tr>
<tr>
<td>1991</td>
<td>549,009</td>
<td>456,874</td>
<td>286,161</td>
<td>218,009</td>
<td>189,980</td>
<td>175,046</td>
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<td>1992</td>
<td>537,498</td>
<td>501,838</td>
<td>311,429</td>
<td>261,572</td>
<td>211,521</td>
<td>186,852</td>
</tr>
<tr>
<td>1993</td>
<td>508,484</td>
<td>462,050</td>
<td>424,813</td>
<td>401,386</td>
<td>198,953</td>
<td>178,369</td>
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<tr>
<td>1994</td>
<td>503,104</td>
<td>482,077</td>
<td>378,994</td>
<td>365,350</td>
<td>202,076</td>
<td>170,894</td>
</tr>
</tbody>
</table>

Table V

The average annual growth of car traffic has been 7.6% until 1991 and 5.5% from 1992 to 1994. The growth rates are more or less equal, but the interesting remark is the difference between the car traffic coming to Italy and the traffic leaving Greece. This is not a statistical mistake, but due to bad land interconnections in the mainland and the existence of some interesting tourist islands, ships transport often cars from Patras to other ports and vice versa.
The average growth of the total truck traffic is 13.2% from 1985 to 1991 and 23.9% from 1992 to 1994. Note here that there is no information about the quantity and kind of their load.

As data in the previous table may look totally different from the data on truck movements as reported by custom houses, it must be mentioned that many differences in data between custom houses and port authorities exist, because port authorities collect data about traffic not only of import or export but also of internal needs, whereas custom houses collect data only about traffic related to movements abroad.

The traffic of passengers is strongly related to that of cars. Looking closer to the combined graph below it can be seen that there is the same annual trend, although more passengers and cars seem to be coming in than going out. There is no certain explanation of this imbalance. Passenger imbalance might be due to some passengers leaving Greece via other gateways (including air transport). Car imbalance might be explained by an underlying steady "immigration" of cars into Greece.

From the Greek side the main port is Patras. Patras may be losing part of its share, but it remains the most significant port as far as passenger traffic is concerned. Until 1991 Patras was serving 62.5% of the passenger traffic (coming to Greece) and 60.0% (travelling to Italy) annually. Corfu has a steady flow in and out of less than 200,000 passengers and an average of 25,000 cars during the 1990's. Igoumenitsa's shares were 18.7% and 15.5% respectively. But during the war period Igoumenitsa's shares increased reaching the percentages of 35.1% (incoming) and 34% (out coming) and the shares of Patras decreased to 47.4% and 47.5% respectively. A very interesting notice about car traffic is that Patras served 57%, Igoumenitsa served 26% and Corfu 17% during the pre war era but from 1992 Patras's shares fall to 41% and Igoumenitsa gets 45%. As far as it concerns passenger traffic in the ports of Italy, Brindisi had an average of 60%
Section I - Maritime Networks and Modal Split

annually, Ancona 31% (in and out), and Bari only 8% (in and out). A remarkable change during the period 1992 and 1994 is the increase of passenger traffic in Bari, where the percentages become 19.7% (in) and 18.8% (out), in the same time where Ancona had a steady flow of total traffic of 32.6% and Brindisi gets a 48% annually. But from the Italian side things became more interesting and complicated. Brindisi is until the main port serving most of the traffic. Brindisi and Ancona share also 80% of the car traffic. As the passenger traffic was split in Italy during the pre war period, so does also and the car traffic. Brindisi and Ancona serve 46% and 43% respectively. During the war their shares decrease to 37% and 41% revailing an increase of the importance of Bari as a port.

Things are looking different concerning the shares of truck traffic in Italy and in Greece. The main port not only of destination but also of orientation is Patras during the decade, although Igoumenitsa increases its shares from 1992 continuously. More specifically Patras served 88% and Igoumenitsa 8%. For the period of 92-94 Patras served 78% and Igoumenitsa 17%. But generally speaking things are different in Italy. Until 1991 the main ports were Brindisi and Ancona; in the period 85-91 a mean annual share of the total traffic is 42% for Brindisi, 40% for Ancona and the rest 18% for Bari. As happened for the car / passenger traffic Bari increases its share in favour of Brindisi during the war era achieving the percentages of 25%, where in the same period Brindisi gets 37% and Ancona 37%. An interesting observation is that all Greek ports are receiving more traffic than they send, except in 1987 and 1988 in Patras and in 1990 in Igoumenitsa where the figures were marginal equal.

Seasonality is observed mainly in the car/passenger traffic. From the provided data (not attached here) is obvious that the main stream of traffic flow (65% of the total) is served during the third quarter, summer season. In the second quarter 20% of the traffic is served and the other two quarters get an equal share of 7.5%. The seasoning is exactly the same, as obviously expected, in Italy and in Greece. Truck traffic was stable during the decade, where the second, the third and fourth quarter got a percentage of 27%. Remarkably is that the first quarter in Greece has a 19% and in Italy has 27%, but the rest quarters have a stable seasoning of 24%.

3 Technical Aspects of the Modes

Having a brief look at the existing fleet operating in the Adriatic Sea network until May 1994 some interesting remarks can be made. The first is that mean fleet age is about 24.55 years. This old-aged fleet is operating with an average speed of 18.89 knots. The above observations concern ships of 1,000 GRT and more. The fleet has an average GRT of 8,865 and a mean number of crew of 98. The average ship has a capability of transporting 1,113 passengers, 328 cars and 37.3 trucks. The sample is not poor; it represents 52 of 57 ships totally, and the result of the above statistical analysis is characterised as sufficient. The only extracted result that can be disputed is the transport capability of the typical ship.

Two more interesting remarks are that 48 of the 57 vessels are under Greek or Cypriot flag (generally Greek owned) and they are occupied 5.46 months annually.
in the routes of the Adriatic. Another remark is that almost all ships are second hand. This means that the operating companies generally do not invest (or have not invested until now) in newbuildings. The above remark is not surprising and already explained in \{2\}. In 1994 some companies announced the routing of some newbuildings in the Adriatic Sea network and actually they are operating since the beginning of the summer of 1995. These ships are conventionally designed, but they are fast enough to serve users with high value of time.

From a Naval Architecture point of view it is very interesting that these ships are conventionally designed. "New technology" designs, such as SWATH or CATs are not operating yet. Three conventionally designed car/passenger ships which can make about 26.5 knots and can cover the distance between Patras and Ancona within 20 hours are already routed. Representatives of the companies said that at the beginning the idea of routing "new technology" fast ferries was tested, but due to technical and financial problems the idea was rejected. After successful routings in the Adriatic Sea in summer of 1995 the companies seem to be satisfied. Unfortunately however, there are no statistical data provided yet in order to understand the shares gained by these ships. It is very important to remark that these ships are newbuildings, specifically designed for this link and operating under the Greek flag and law. This is indeed a new trend. Shipping companies and operators are expecting a lot from these investments.

Still, what will likely affect this transport system the most is the possible routing of "new technology" fast ships in this trade (called from now on High Speed Craft -HSC). Based on a previous paper \{2\} any sea vessel exceeding 20 meters in length and having a cruising speed over 30 knots can be characterised as fast. In trying to classify HSC some criteria have been set; and the comparison among the designs is very subjective. From an engineering point of view the criteria are typically the following: speed, ride quality and comfort, capacity, reliability, strength, and energy savings \{3\}.

Nobody knows exactly how the market will react upon appearance of HSCs in this trade. In fact, passengers are not used to sit in a comfortable seat for 6 or 8 hours in order to cross the Adriatic. Also it cannot be accurately predicted if they are willing to pay more than the usual fare, or if a calculated Value Of Time (VOT) extracted from a regression model reflects the real intentions of customers. On the other hand, it is known that transport companies demand faster crossing of the Adriatic.

Table VII lists a limited number of HSC types and their main characteristics. The data is provided by several magazines focusing on developments in Naval Architecture. The selection of these specific ships among a much wider sample of HSCs is based mainly on their technical data and scope of this rough analysis is to ascertain if their economic future is promising in one of the existing lines.

Table VII shows the required fares these types of HSC must charge to break even for some specific routes, in comparison with two existing conventional designs, "old" and "new" ("new" being the equivalent of the fast newbuildings recently purchased). The model of predicting the required fares is presented and extensively used in \{5\}.
Section I - Maritime Networks and Modal Split

<table>
<thead>
<tr>
<th>Design or Name</th>
<th>Type</th>
<th>Speed (kn)</th>
<th>Passenger</th>
<th>Cars</th>
</tr>
</thead>
<tbody>
<tr>
<td>SEAJET 250</td>
<td>Semi-SWATH</td>
<td>40.8</td>
<td>450</td>
<td>120</td>
</tr>
<tr>
<td>STENA SEA LYNX 2</td>
<td>Catamaran-Wave Piercer</td>
<td>37</td>
<td>600</td>
<td>240</td>
</tr>
<tr>
<td>M&amp;K FERRY</td>
<td>Monohull</td>
<td>33</td>
<td>600</td>
<td>160</td>
</tr>
<tr>
<td>ALBAYZIN</td>
<td>Monohull</td>
<td>38</td>
<td>450</td>
<td>84</td>
</tr>
</tbody>
</table>

Table VII

<table>
<thead>
<tr>
<th>Sea miles</th>
<th>130</th>
<th>210</th>
<th>290</th>
<th>500</th>
<th>600</th>
</tr>
</thead>
<tbody>
<tr>
<td>Required</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passenger</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fare in</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GRD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SEAJET 250</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>STENA SEA LYNX</td>
<td></td>
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<td></td>
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<tr>
<td>M&amp;K FERRY</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>ALBAYZIN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;OLD&quot; CONV/NAL</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>&quot;NEW&quot; CONV/NAL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Required  |     |     |     |     |     |
| Passenger |     |     |     |     |     |
| Fare in   |     |     |     |     |     |
| the cheapest fare | | | | | |
| SEAJET 250|     |     |     |     |     |
| STENA SEA LYNX |     |     |     |     |     |
| M&K FERRY  |     |     |     |     |     |
| ALBAYZIN  |     |     |     |     |     |
| "OLD" CONV/NAL |     |     |     |     |     |
| "NEW" CONV/NAL |     |     |     |     |     |

4 Modal Split Analysis

It is obvious that all new designs require higher fares than the conventional designs, except only in the case of the link between Igoumenitsa and Brindisi. This may explain why new conventional design were preferred to enter the network in this link.

4.1 Modal Split Analysis

Given the data on traffic and by making some additional assumptions there is a possible way to forecast what is expected to happen in case HSCs enter this trade in the near future. We do this here by adapting the "revealed preference" method.
used in \{4\} (for a modal split analysis within the Aegean Sea in order to assess the possible impact of HSCs in 2004, the year of market deregulation). As in \{4\}, the first step in this method is to choose a workable and relevant subset of the network. A subset has to be chosen because the entire network would be unworkable because of its complexity (at least two origins in Greece such as the two major Greek cities of Athens and Thessaloniki and several major European destination cities such Munich, Paris etc). What is of interest to our study is the sub-network of the Adriatic Sea. This sub-network schematically looks as shown in Figure 2.

Figure 2

In spite of a 3-port configuration at each side, notice that there is a fundamental asymmetry in this configuration: Greek nodes are effectively disconnected from each other, whereas Italian nodes are connected. Indeed, whereas Italian "autostrade" effectively link Brindisi with Bari and then Ancona, nothing similar exists at the Greek side. In fact, nobody in Patras would consider going to Igoumenitsa to take the ferry to Italy, because the road connection (which actually involves a ferry crossing) is too cumbersome. The same argument applies for Corfu, which is an island.

So the main assumption is that the Greek origin or destination places are not linked together and all the traffic to Italy is heading to the northern part of the Italian coast. This means that all traffic to Italy essentially has the same intermediate destination point, Ancona, before continuing further north to destinations in Central EU. Obviously this assumption omits any traffic connecting Greece to Rome and other southern parts of Italy, or traffic directly going to Venice or Trieste. However, these flows are much smaller than the ones in the network examined. Also the model does not consider "new" prospective ports such as Rimini or Ravenna for example (although such new nodes could be included).

The model will thus compare the routes Patras \(\rightarrow\) Ancona, Igoumenitsa \(\rightarrow\) Ancona and Corfu \(\rightarrow\) Ancona and for each case the three possible ways to get to Ancona: directly by ship, via Bari by ship and then by road, and via Brindisi by ship and then by road.

In \{4,5\}, the Value of Time (VOT) was calculated using a multinomial logit model and the "revealed preference" method. A similar approach has been used here,
the preferences revealed being determined by how traffic is split along the network examined. For the needs of this analysis the following "modes" are set: mode1 is referring to the direct sea link from Patras or Igoumenitsa or Corfu to Ancona, mode2 is referring to the link from Patras or Igoumenitsa or Corfu to Ancona via Bari and mode3 via Brindisi. To calculate VOT (calibration of the logit model) all "modes" refer to conventional ships, since this is the only data available.

The results of the analysis ([4] provides more details as to how the logit model was formulated and solved) are shown in the three tables below, for passengers, cars, and trucks separately. Each row in each table refers to a specific route, with a separate row for each direction. Notation used in the tables is as follows:

<table>
<thead>
<tr>
<th>i</th>
<th>% share of mode i (i = 1: directly, i = 2: via Brindisi, i = 3: via Bari)</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>total fare (GRD) by mode i (i as above)</td>
</tr>
<tr>
<td>t</td>
<td>time (hrs) by mode i (i as above)</td>
</tr>
<tr>
<td>VOT</td>
<td>value of time (GRD/hr)</td>
</tr>
<tr>
<td>P</td>
<td>total fare, mode x (HSC) (GRD)</td>
</tr>
<tr>
<td>t</td>
<td>time (hrs) by mode x</td>
</tr>
<tr>
<td>s</td>
<td>% share of mode x</td>
</tr>
<tr>
<td>s</td>
<td>% new share of mode i (i as above)</td>
</tr>
<tr>
<td>P</td>
<td>Patras</td>
</tr>
<tr>
<td>A</td>
<td>Ancona</td>
</tr>
<tr>
<td>I</td>
<td>Igoumenitsa</td>
</tr>
<tr>
<td>C</td>
<td>Corfu</td>
</tr>
</tbody>
</table>

The results are shown in Table IX.

The fares that are used are calculated through an approximation of all normal possible costs, and the main difference among prices of inbound and outbound traffic is due to the different fuel cost in Italy and Greece. Also some time data is different in the two directions because delays are also calculated. The delays are personal experiences of people working in the ships, but the difference is an hour or a half hour. The cost for trucks is based on an approximating model developed in [1]. The cost for cars is a summation of fuel costs and the the fares, and for the passengers is the summation of the fares, a standard spending onboard, and a split of the cost of car by 2.5, because a car contains 2.5 people in average (an estimate of travel agencies in Patras).

It is very interesting to see that routing a new HSC vessel may have different results on passenger and vessel traffic. For example a new fast mode routed from Patras to Ancona and vice versa will get about 50% of the passenger traffic and only 5-15% of the car traffic. Also trucks from Ancona to Patras will prefer this vessel, but from Patras to Ancona the vessel may be empty of trucks, because Bari attracts the most. Another interesting observation is that routing a fast vessel from or to Corfu will guide the traffic to the southern Italian destination. So before the investment on any vessel, it has to predict the separate shares in a relevant way with the future of other routes after the routing of this new vessel. Some other useful remarks are that passengers are willing to pay more in order to get at their destination sooner, but that is not valid for car traffic, which will
Table IX

mainly use the existing modes. Time may be the critical factor for the decision among routes and modes, because more people will use southern ports as already happens (except the case of Corfu). The observed significant "spread" in the estimated VOT for passengers and cars can only be explained by the speculation that there are probably more factors affecting passenger preference for a specific route than fare and trip time alone. In fact, the pleasure of a journey onboard a luxurious ferry may outweigh the preference for a faster crossing in many cases. However, it is interesting to note that such a spread in VOT is not observed for truck traffic, meaning that for a truck driver fare and trip time are far more important factors than they are for a passenger with or without a car.

As far as truck traffic is concerned, one can see that the routing of a new HSC vessel may dramatically change the status and diminish some routes. For movements from Italy to Greece a new fast vessel will dominate the route of Patras, carve almost the same niche as Brindisi and Bari for the route of Igoumenitsa and lead all traffic from or to Corfu to routes of Brindisi. The higher VOT of the links from Italy to Greece prove also that time costs more in imports, and it is obvious that the link from Patras to Ancona (the longest movement) serves exports of smaller VOT than any other port.
5 Recommendations

To the best of our knowledge, this is the first time such an analysis (economic feasibility and modal split) has been performed to investigate the potential of HSCs for the Adriatic Sea link. This analysis can lead to some interesting conclusions.

It is obvious that there are some malfunctions and discontinuities of the transport chain. Sometimes it seems that there is no chain at all. There was and there will be problems in linking Greece with the rest EU-States via the Balkan roads; before the war in Bosnia there were not enough trespassing licences, during the war road connections through Bulgaria and Romania do not provide safety and low cost, so the future does not seem very prosperous. On the other hand the Adriatic Sea link does not provide proper services; the ports of Patras and Igoumentisa are not properly connected to the major trade regions of eastern Greece and there is an absolute lack of rail services. In addition, the operating ships are relatively slow so there is a time handicap of approximately a day long, depending on the destination point. The link via the Balkan States leads to Austria and Germany, where special environmental laws will be gradually effective -if they are not already effective- due to the principle of territoriality, prohibiting the trespassing of the majority of Greek trucks, so the transport cost will be increased.

The Adriatic link will not be the same in the years ahead. New fast conventionally designed ships are already operating and serving the northern Italian ports. It is sure that these new ships will attract more trucks, especially during the winter. Unfortunately, these ships entered the route between Patras and Ancona in the summer of 1995 and there is not any available traffic data or statistics.

The last objective of this paper is to propose some recommendations. All recommendations are derived from the above conclusions and follow the principles:

- Removal of any exclusiveness and restraint;
- Improvement of the efficiency of the network, nodes, modes and of specific branches -ways;
- Application of new technology;
- Immediate planning of new Greek national transport policy within the frames and needs of EU

The first proposal is the creation of new tracks of transportation, exploiting in the best way the willingness of EU to get cargoes from the road to the sea. Greece can develop new lines connecting significant trade regions, such Creta directly to major European ports. This is not only applicable to isolated regions but also to regions confronting problems of road congestion such as Epirus or the Pelopon-nese. Small multipurpose ships can collect cargoes and direct them to ports such as Marseille, Trieste or Barcelona. Ships with holds capable to keep adequate temperatures for the expensive fresh vegetables and fruit, ro/ro facilities and high cruising speeds will require less time for the movement from Greek coasts not only to northern Italian ports, but also to the new dynamic markets and future significant nodes such as Marseille. Thus requires a sophisticated management with an aggressive marketing, which will persuade all user to change the way of
The Intermodal Link Between Greece and the Rest of the EU Countries

transport, collect and handle cargoes in large storehouses and operate fast, accurately and safely.

The existing system suffers from inadequate links and congestion in several roads, ports and custom places. This problem is mainly a Greek one; the port of Patras can hardly get more traffic unless it is reorganised and the port of Igoumenitsa is not properly linked to Athens and Salonika, the two major trade regions of Greece. A substructural problem like this can be solved by the Greek government through EU fundings and will permit trucks to use the existing fleet of the Adriatic Sea. But it is wise to follow international practices; the lack of rail connections makes it impossible to move large, cheap cargoes with the relevant cost abroad. So Patras can become a rail port, connecting Italy's rail lines with Greece, permitting the existence of many today relatively slow ships if only the handling of cargoes is adequately fast. At this point the RoadRail technology can be applied. Other applications of new technologies are the use of highly sophisticated telecommunication facilities and packaging, improving the efficiency of nodes.

In other words it may be useful to create port pairs, because there is no other obvious way to keep the demand high enough for the supply to act. It is also the only way to exploit all new institutional and technical changes of the recent years.

References

{1} O.D. Schinas, "The Transportation of Goods between Greece and the rest of Europe; Status, Prospects and Recommendations" (in Greek), Diploma Thesis submitted to the Department of Naval Architecture and Marine Engineering in September 1994; Thesis Supervisor Professor H.N. Psaraftis.


{5} H.N. Psaraftis, "Greek Coastal Shipping: Status, Prospects, and Investment Opportunities", Final Report to ETBA (in Greek), Athens, 1993
THE MARKET POTENTIAL FOR SHORT SEA SHIPPING: A CASE STUDY

1 The market

In order to find out the market potential for short sea shipping it is essential to know the market situation today and what factors that affect the market and its development.

The Swedish transport market is special as the majority of cargo can be carried by all transport modes along the tall narrow country. The major industry in the most remote areas is situated along the coast. The type of transport mode used and what preferences to use the different transport modes can be found from the shippers.

The shippers can be divided into categories as well as the present market of different forms of transportation. The market and the major user of each transport mode can be described as follows:

<table>
<thead>
<tr>
<th>Transport mode</th>
<th>Shipper</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Short Sea Shipping</strong></td>
<td>The shippers capable of closing sea transportation contracts has already done so. A few potential contracts has been taken by the railroad.</td>
</tr>
<tr>
<td></td>
<td>The large shippers can balance the utilisation between transport modes. Smaller industries do not have the same possibility.</td>
</tr>
<tr>
<td></td>
<td>Today shipper looks for alternatives where they do not have to take on a contract of a vessel to be able to use sea transportation. A regular sea transportation service where instant booking can be done in liner shipments should be able to solve this. However, the shippers demand a high frequency of their shipments, preferably one per day, and will not contract the service unless it can prove reliability.</td>
</tr>
</tbody>
</table>

Traditionally all sea transportation has been an arrangement between a shipper and a ship owner. The potential of increasing the number of contracts for whole shipping systems must be considered as minimal. Sea transportation must offer other types of services to be able to cover a larger variety of goods.

A few shippers are able to provide liner service in a limited operation. This is a liner service aggressively marketed by the operators who takes care of the total transport from door to door.

Similar type of services should be possible to be offered in a variety of transport systems along the coast.

The shipowners are not prepared to take the risk of investing in the number of ships required to give a high frequency service and not filling their ships.
Section I - Maritime Networks and Modal Split

Road transports
Road transports offers the most flexible transportation service. Numerous forwarders are eager to please the shippers demand for transportation of any type of cargo. In Sweden there is an oligopolistic market situation of large forwarders also being the truckers. The two major companies provide complete services from exclusive transport contracts in a door to door operation or over terminals in groupage traffic.

The cost of the transportation is also very low. The road regulations in Sweden permits 24 m long vehicles having a maximum weight of 60 tons which makes the transport very efficient.

The transportation cost over a 1 000 km distance is contracted at the level of 0.20 SEK/tonkm (1 SEK ~ 0.12 ECU). The transport can also be contracted as an overnight transport guaranteeing that goods loaded before 16.30 hrs will be delivered before 7.00 hrs next morning. This gives roughly an average speed of 67 km/hr.

The flexibility of the truck is unique. It reaches everywhere and gives a minimum of diversions from the straight transport between the pick up and the delivery station.

The truck stands alone with a number of advantages and has taken market shares in goods transportation over the last decades.

What is not acceptable in the long run is the demand on the state to develop and maintain the roads for extensive trucking. In addition to this it is a political issue to try to reduce the use of trucking in favour of transport modes having better environmental performance.

The trucking faces also an extensive internal competition which will keep the costs down. The cost of transportation is greatly influenced by the cost of trucking.

Road transports are needed for the transportation of all types of cargo that cannot be picked up and delivered by another transport mode. This is the essential issue in the competition as we must introduce a transfer system and its cost in the total figure of competition. The transfer cost itself rules the competition from one transport having low underway cost to trucking. Trucking is also unique in its capacity of handling small portions of cargoes a speciality that hardly can be challenged by other transport modes.

For these reasons trucks will always be the prime mover of goods but the development of transport modes will limit the extension of its exclusiveness. By developing other transport modes the trucking will be pushed back in competition and the distance at which it can compete will decrease.

There are special type of industries that requires trucking. Most of the cargo going in a JIT-process with smaller shipments will depend on trucking. Even though a certain “abuse” of transportation capacities can be seen using exclusive trucking in a JIT-process.

The development of transportation will not allow for transports that is not utilised at a fair rate in the future. This has been foreseen by the industry and a certain relocation of contractors close to the assembly industry can be seen in progress.

However a certain category of cargo will never be in question for anything else but road transport.
The railroad

In Sweden like in most of the European countries the railroad is heavily subsidised by the state. As special conditions for the railroad started to apply when the infrastructure and the operation were split up in two separate organisations it should be clarified that the subsidies refer to the total balance of the transport mode towards the state. The figures of today show a total income from railroad traffic of about 750 MSEK while the annual cost for the traffic includes maintenance of about 4 GSEK and newbuilding of the same magnitude.

The railroad undergoes a substantial updating as concerns traffic and marketing. Being forced to prove profitability in operation the railroad tries to rationalise the traffic by cutting out transports that gives high marginal costs. For this reason smaller shipments have been priced out and the railroad advises the shippers to deliver the products to the intermodal railway terminal for the loading instead of presenting a railcar at the industrial site to be loaded. The effect will be that a road haulier/forwarder will be introduced who will decide how the transportation will be done, direct on truck or by rail.

The marketing of rail transports focus on large shipments from the major industry. This means a direct competition to cargo that traditionally is sea transported.

The railroad faces also problem with increased speed differences between freight trains and public transports. Heavy investments in new fast trains to a spread number of destinations lowers the service level for goods and as freight trains has lower priority it will reduce their speed as they have to stop more often to let the fast trains pass.

The shipper uses the railroad for full trainloads which is the only way of using train in a productive way. We can see examples of rail shipment contract of a level that can not be justified by cost from competitors but is just a way of getting the transport. This is a way of dumping transport prices by a system that does not cover its cost towards its owner that rightly must be questioned. One problem is however that the shipper must buy the rail vehicles himself. This gives two results, the capital cost of the rolling equipment will only be distributed on the transport done for the shipper and that the shipper will be more reluctant to use any other transport mode as he has invested in the rolling equipment.

The over pricing of railcar shipments has stroke a number of smaller industries hard who has built up their infrastructure to fit the railcar operation. It gives also a substantial cost increase transporting the cargo to terminals for the reloading onto railcars. This cost increase cannot be compensated by the rail shipment why the goods will be transported directly by truck instead.

Rail transports are until now not facing internal competition. For this reason the railways will give prices of transportation that eliminates other competition. There are examples where a rail transport is quoted at the same price for a 1 000 km transport by direct rail as for a distribution transport of 150 km rail where a sea transportation system did the rest of the 1 000 kms. A quotation that only can be presented by a monopolistic transport operator as there has been no alternatives from other rail transport companies.

The competition between the transport modes can be described by the following figure. Today the cargo categories in competition between sea transportation and the other transport modes are very limited. Studies made in the end of 1980-ties show this to be 1% of the cargo shipped according to statistics. What is happening is a shifting of the railroad categories up to right into the area of sea transportation while we claim that new technology should move the sea transport down to left to cover more categories that are advised to road transports only today.

Newbuildings of railroads in Sweden brings special focus to the competition between the transport modes influenced by the state. As of today there are no investments in railroad infrastructure that will:
Figure 1: Principle of cargo distribution between transport modes

- Pay back investment;
- Cover for the maintenance cost.

Although projects are in the pipe for newbuildings of railroads that will mainly affect sea transportation. This is a remarkable situation as the annual deficit of the railroads mainly is motivated by its environmental friendliness and at the same time it is the railway, that by it struggle to be profitable, that is creating most of the transfer of cargo from rail to road in these days.

The question is whether there is a market for sea transportation that can be covered by new technology and improved frequency? Will such a market be large enough for a shipping service and engage enough of ships to give the frequency?

2 The case study

During the 1990-ties some studies have been made in the possibility of increasing the utilisation of sea transportation as a complement to rail and road transports. This would give a most cost-effective and economic way for the state to provide for low costs transports instead of the need for additional investments in transport infrastructure on land. One of the crucial questions is whether the industry would accept such an arrangement and what effects it would have.

In the 1990-ties MariTerm AB made three studies regarding the potential development of sea transportation to become an alternative to land transports in coastal
The Market Potential for Short Sea Shipping: A Case Study

and short sea shipping services. The studies show an economic and technical potential to develop sea transportation to become more competitive. Furthermore a strong political reaction towards utilisation of sea transportation as an alternative transport resource has been noted both domestically in Sweden and in the EU.

In addition to the discussions of a potential short sea shipping system and its technique, the potential demand of transport capacity has not yet been determined. Coastal services have almost ceased to exist and the short sea shipping services do not flourish today.

However, the traditional sea transports available today differ to the service offered by a high-frequency shipping system. Today the service level of short sea shipping liners is very low, maximum one call a week, normally 14 - 21 days service. The number of destinations are few but have grown in the last few years as there is a certain growth of services along the coast. The growth comes in relations which connect to transport centres in Europe.

We have done this study as an analysis of the potential demand of shipping capacity along the Swedish east coast connecting to the Continent to find out if a high-frequency sea transport system can be offered.

Today the liner-shipping services to/from the north Swedish coast covers some 7 million tons annually and consists mostly of forest products. These products are shipped from Sweden to terminals decided by the shipper. Most of the transports are by this connected to special terminals for forest products which may not suit other types of commodities because of its location etc. The shipping systems are mainly built on contracts between a shipper and a ship owner.

The total transports by sea on the north-east coast of Sweden was in 1994 17.5 million tons. About 60% of this quantity is bulk-material which hardly can be handled in any other way than it is today. The rest of the cargo is distributed as shown in Table I.

The table shows that a majority is forest products. About 3 million tons are shipped today in regular long term sea transport systems from the region concerned to the Continent and UK and the capacity and quantity will grow in the coming years. The forest industry systems are almost 100% dedicated forest product transports leaving no room for external cargo in the outbound service. On the northbound leg external cargo and raw-material as well as returned wastepaper is carried. There is also a regular shipment of new cars between North Germany and the mid of Sweden carried onboard the northbound forest systems ships. Otherwise the northbound cargo is bound for local industries in the region of the terminal. Few shipping liners have progressively tried to fill the return leg with cargo. The most successful shipping line was the Iggesund linked Uni-shipping. This system was built up to a certain extent on semi-trailers for both distribu-

1Source: "Swedish Maritime Gazette", No 22, 1995
Section I - Maritime Networks and Modal Split

Table I

<table>
<thead>
<tr>
<th>Arrivals, ton</th>
<th>Luleå</th>
<th>Piteå</th>
<th>Umeå</th>
<th>Skellefte</th>
<th>Örnsköldsvik and Husum</th>
<th>Sundsvall</th>
<th>Hudiksvall and Iggesund</th>
<th>Gävle</th>
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Table I

tion of cargo as well as return cargo. The operation attracted return cargo transports to Iggesund in a wide range around the port. The system was however abandoned when the new integrated MoDo-SCA shipping system was formed demanding more specialised handling.

From previous studies it has been shown that sea transportation can be performed in a way that provides for a very cost effective and environmental friendly transport alternative. It can clearly be said that it cannot measure with road transport by time of transport or flexibility or with exhaust emission in comparison to transport modes using non carbon fuels such as nuclear- or hydro-power. The strength of the sea transportation (and also in some respect its handicap) is that the major investment costs for the service is the vehicle and not the road. All states provide for the road infrastructure at very high costs both for trucks and rail. The road is free and of no cost when it comes to sea transports. The sea transport mode carries its costs in full towards the state. In Sweden it covers not only the actual costs of all infrastructure and administration but also the cost of the regional environmental support such as icebreakers which is normally subsidised by the State.

Investment in infrastructure on land and along the Swedish coast is an investment to reduce time for transports and to increase safety. Sea transport can provide for and ensure high safety of transports partly by the high safety of sea transports and partly by removing cargo from roads. In comparison to road transport the additional transport capacity is only provided by an investment in transport equip-
ment. The ambition from the state has been to reduce the demand for road transports in order to save the environment. The same ambition would apply to the saving of environment and nature as concerns the newbuilding of roads and railways by using sea transportation where it is possible.

Sea transports are very cost effective. Previous reports and this report show that an open sea transport system can cover for its own costs in a commercial way without subsidies. If this is compared to other transport means where the state has to put up the capital, not only for the full construction of the infrastructures but also for all the maintenance of the same, the ambition from the state should be to encourage the development of sea transportation to be used more extensively.

For this reason it is of interest for the European states to look into the feasibility of an increased utilisation of sea transports in a wide sense and in open integrated transport systems. This type of studies has been encouraged by the EU. The Swedish East coast is a very suitable area for the trial of an open sea transport system running parallel to the land transport facilities.

This study covers in a market analysis the interest from the industry to have such a system and what requirements the market puts on a system.

2.1 How the study was done

In the late autumn of 1994 we presented a project for some of the major industries in the north of Sweden and asked if they would support a market study regarding an open high-frequency sea transport system along the Swedish coast to the continent. The Provincial governments had at previous occasions announced their interest in such a study. The Provincial governments can be seen as representatives of the smaller industry of the region. They are also responsible for the planning of a complete and efficient infrastructure of the province and its development.

The research was accomplished by personal interviews of representatives for the industry. The interviewed were policy makers who decided what type of transport modes the industry used and the development of transports.

The industries covered by the study are located in the area from Luleå to Gävle with some additional information from Oskarshamn and Cell-pap terminal in Kiel. Some forwarders have also been approached and they have provided some information both as regards the market situation and in general terms about own potential interest in the use of sea transports.

The total quantities that are said to be of interest for a short sea shipping system was nearly 1.7 Mtons annually. From this quantity we have extracted 1.48 Mtons to be of interest for the testing of costs of a high-frequency shipping service. The cargo chosen for the analysis is shown in Table II.
Table II: Total quantity used in the shipping analysis

The study shows a remarkable high percentage of southbound cargo. This was expected due to the fact that the industries contacted distribute products in bulk from Sweden while the imported goods normally is high value cargo. The supplies to the industries come from other countries and in other forms of transportation than the studied. The major potential users are manufacturers of products that come from natural resources in Sweden and/or products that requires inputs shipped in bulk quantities and mainly by sea transports. What is imported to the large industries is supplies to the machines for maintenance and running. The assembly industry imports semi-manufactured parts for its production. These products come in smaller volumes and are often unitised or transported by road.

The study cannot claim to cover the whole market. It should be regarded as a scanning of the interest from the big actors in the market who do the main part of all transports and uses all types of transport modes. It should also be noted that the lack of official statistics, and the need for them clearly is shown, when working with the study. Only one province has made a summary of transports as a special draft of the existing official statistics. This statistics gives information of where the products are manufactured and how it left the province but it does not give its final destination. The total potential market is by this still unknown but the study shows a large interest from the part of the shippers.

As can be seen from the result of the study the density of industries and consequently the potential volumes grow from north to south. As anticipated the difficult part of the market study has been to find the potential of northbound cargo. The big industries having extensive exports do not have imports suitable for unitised cargo of any dignity. Most of the imports are trade commodities, foodstuff and industrial supplies.
The Market Potential for Short Sea Shipping: A Case Study

The sea transport system is calculated for the cargo quantities which is given as a result of the market study. The cargo is assumed to be unitised in one way or another. Three different principles and systems have been set up:

- Exclusive container system based on 20 and 40' containers transported by Lo/Lo ships;
- Exclusive semi-trailer system based on all rolling road trailers transported in Ro/Ro ships;
- Swap-body/container system based on the previous projected port hopper concept called a HUC-ship.

The ships are picked out from the market and the costs of the ships are based on a time charter rate for a 5 year contract of 1996 year level. The Lo/Lo and Ro/Ro ships are chosen by size as typical of its category and are not further optimised for the service. The HUC (High Tech Unit-carrier) was originally purpose designed for the trade and is used as such.

The shipping systems are built on certain criteria:

- Each ship type will operate in a unique system with the ambition to minimise the costs of passing a port;
- The ship will load and discharge in the ports at any time of the day;
- The crew in the port is optimised for the specific operation.

2.2 The tested systems

We have made a priority to use costs and capacity figures of known vessels instead of doing a project for each type of ship. This would imply that the costs of an optimised Lo/Lo and Ro/Ro system should be lower if the ships system was specially designed for the service. The different systems are then simulated in a time simulation program where all activities from all ships in the system are followed and calculated in time steps over a months period.

Here follows a brief presentation of each system.

2.2.1 The Lo/Lo system

The Lo/Lo vessel is characterised by the lifting operation of all cargo on and off the vessel. In our system all of these units are calculated to be 40' containers. The ship carries two cranes to be able to perform the operation. She is not dependent on any special service from the port with exemption of a normal berth along a quay side and the service from the stevedores to man the cranes and feed the
quay side with semi-trailer carrying the containers. The system is considered to be a trailer-borne container system, i.e. all containers are standing arrest on a semi-trailer during the full stay ashore (compare a SEA-LAND operation). The capital costs of the trailers are for this reason included in the total costs of the operation and is added to the capital costs of a complete container fleet. The system assumes that the land transport is covered by the hauliers who pick up and deliver the units to a specific parking area in the port terminal. No reception/delivery operation involving manual operation from the terminal will be needed by this.

2.2.2 The Ro/Ro system

The Ro/Ro ship system is based on an exclusive semi-trailer operation. The system covers for all costs of a complete system, which is all semi-trailers involved in the service by means of capital costs and running costs for the keeping of the units. The operation performed by the stevedores is to arrange the securing of the units onboard the ship and to haul the units on and off the ship to/from the parking area. To simplify the calculation three terminal tractors have been regarded to perform the operation. These are manned by drivers. To each tractor 2 men are operating in the ship to secure and release the trailers during the operation.

The shipping system will only require a berth which allows for a Ro/Ro ship to put down its ramp.

2.2.3 The HUC system

In previous reports the advanced self loading/unloading ship system has been presented {11}. The ship system is designed for a completely unmanned port operation. This means that the system will be highly mechanised with a handling device that allows for the reception and accommodation of the units in the terminal and the handling of the units during the ships stay is controlled by the ship. The load carrier is regarded to be swap-bodies. They are handled in the distribution operation by roller frame vehicles.

The handling system onboard the ship is fully mechanised and allows for an average of 60 units per hour turnover of units to be loaded and discharged at a time. If the handling capacity can be used for only discharging or loading it can then be performed at about 120 units per hour. The ship and handling system features the capability to handle 20' ISO base standard units with a maximum length of 8 m, height of 3.2 m and width of 2.6 m.

The fleet of Swap-bodies employed in the system is covered by its capital costs as a fixed cost of the system.
3 Conclusions

The industry shows an interest for a development of a short sea shipping system calling at high-frequency to the port. One of the ports Gävle has over the last few years lost cargo to the west coast of Sweden mainly due to the high-frequency service offered there.

To cover for the demand six ships are needed in the operation. The frequency to each port will come out of the demand for transports and consequently the amount of cargo in each port.

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Table III: Weekly schedule of the ships in service

The cost of sea transportation in this case will include all port and terminal costs and also the cargo duties. It also includes the sea transportation cost and should be compared to Free On Vehicle - Free on Vehicle delivery of goods. The cost will also cover for the supply of the load-carrier for the trip and the use of the load-carrier from door to door. What is not included is the hauling cost to/from the terminal in either end.

Table IV shows the totals in a short sea shipping activity covering the said system.

The costs per tonkm are the total transportation costs for the short sea shipping system. This value can be compared to other transport alternatives.

The HUC can fulfil a complete round trip at an average of 5.3 days. If the net round trip time of a week is used instead, the output increases and the transportation costs decreases to 0.20 SEK/tonkm.

If more northbound cargo can be attracted the system will be more efficient. A rough calculation based on the market study show that the output cost will decrease with approximately 0.01 SEK/tonkm for every additional 100 000 tons of northbound goods. For 600 000 additional tons of northbound goods the cost will drop to about 0.13 SEK/tonkm.
Section I - Maritime Networks and Modal Split

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<tr>
<td>Cargo carriers</td>
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Unit: million SEK/year

Giving a cost per transport work of:

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<td>Sek-tonkm</td>
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Table IV: Summary of results

The total cost for using the system per ton can be seen in Table V

Table V: Transport cost SEK-ton for different relations

However, a short sea shipping system will never be as cost efficient as a two port system. In a two port operation the whole capacity of the ships can be utilised as no shifting has to be done and extra time for multi-port operation will not be required.

It should be noted that these costs will include some safety margins. First of all they are not built out of an optimised system but for existing ships. Some of the cost aspects are very conservative. The way the cost of the load carriers is handled can be said to include double safety. The market can offer units at a very competitive price. So will probably a number of units be transported in transit to overseas destinations. The probability of getting more return cargo is also quite high. This return cargo will give direct cost benefits to the outbound cargo.

It shall also be noted the potentially high quality of transportation offered by the described systems. The products loaded in one end will go untouched to the
receiver of the products. This is a quality that will appeal to every quality certified producer.

Finally some calculated costs for comparable truck transports:

- International trucking from Piteå to Lübeck is estimated at 817 SEK/ton;
- Domestic trucking from Piteå to Kapellskär is estimated at 193 SEK/ton.

The conclusion of this is that the sea transport system is very cost efficient. The summary of a complete system will give the same result as in previous studies. The total annual cost of the system is in the region of 350 - 500 MSEK all costs included (men, ships, fuel, load-carriers, terminals, handling etc.). This is the total cost for a transport capacity of about 3 million additional tons to existing transport capacity.

If we play around with figures this cost could be compared with the long term annual yield from a certain capital. If this yield is set to 10% the required capital will be in the region of 3,5 - 5 billion SEK. Let's just imagine that the state will set of 3 billion SEK in a infrastructure fund, this would allow for almost free transports to a region where transportation is very expensive and a substantial handicap in competition with industries located closer to the consumption areas.

Another comparison is that this fund will then be of the same level as the total cost of the Högakusten bridge to take one example not to mention new investments of railroads in the northern regions.

This is of course just a playing around with figures but what can be added is that there is no maintenance cost to be added to the figures and that it, as shown in the report, has a potential to be an infrastructure that is cost efficient enough to be fully commercial if other transport modes will not be subsidised in manner that will make it impossible to be commercial. A guarantee to make a new coastal short sea shipping system start off will probably only require a small portion of subsidising.

As a conclusion this type of resources deserves much more attention from the state when planning for transport capacity and resources to provide for an environmental friendly and safe infrastructure for goods transports of the future.

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HINTERLAND TRANSPORT MANAGEMENT INFORMATION SYSTEM

By J. van der Linden, S.J.H. Veldman and M.J. van der Flier

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1 Introduction

Fast available, accurate information concerning hinterland connections within Western Europe is of eminent importance for the operational and policy planning of overseas container shipments as well as for the overseas shipping of special purpose cargo. This concerns on the one side hinterland connections by road and combined transport like rail/road, river/road and sea/road. On the other side especially the sea transport between main ports and port of origin/destiny is also of importance. During decision making about hinterland connections transportation costs, transit time, frequency and reliability play an important role in.

Within a research and development project, called Hinterland Transport Management Information System, funded by the Foundation of Intermodal Transport (SIT), the feasibility of an automatized system presenting such information within shipping companies was investigated. SIT aims to strengthen the application of intermodal transportation by means of education, studies and initiating action programmes. During the project, that was carried out partly in 1994 and partly in 1995, several activities were conducted:

1. Research on the actual situation within a number of shipping companies concerning the presence of hinterland transport systems in general;
2. Investigate whether shipping companies were interested in the development of a hinterland information system, and if so what requirements could be formulated by the shipping companies;
3. The design and building of a prototype of the information system.

Fifteen shipping companies, actively involved in short sea, deep sea, line transport, tramp transport, specialized and not specialized markets were asked to participate in an pre-interview round. Seven shipping companies made clear not being interested in a hinterland transport system, generally because their companies were not interested in or did not provide for hinterland transport.

The remaining eight shipping companies were interested in a second interview. From these interviews it appeared that shipping companies showed not only interest as a user, but also as supplier of (complementary) transport services. This also applies to the other suppliers of hinterland transport like the railway companies, road transporters and suppliers of storage and transfer services. Because the interests of a Hinterland Connections Management Information System (MIS) reach beyond the maritime sector, it would be useful to let other interested parties participate.
Of the remaining eight companies four showed great interest in an hinterland transport system. None of these companies appeared to have such an information system. One of them had a planning system concerning the transport of empty containers by land. A second aimed at the development of such a hinterland transport system.

There was full agreement on the purpose of the system. First of all it would be of use for operational planning. Eventually it could be used for policy planning. As a consequence the hinterland transport system should be integrated within the operational planning of a company as a whole. Of course operational planning varies strongly according to the different markets of the shipping companies, like short sea, deep sea, line shipping, tramp and industrial shipping, charter market and so on. Of course this made it difficult to design a general information system that could be implemented within all mentioned shipping companies.

As appeared during the interviews, the hinterland transport system should, from an ideal point of view, comply with:

1. A full coverage of all relevant modalities;
2. Taking into account the most important attributes like costs, transit time, frequency and reliability determining the choice of a modality;
3. A simple integration into company specific information systems;
4. Good maintainability;
5. A delivered prototype to be extended by the shipping companies themselves.

Though several information systems exist on the market that cover parts of requirement 1 and 2, like TCM InGrid (rail/road annex costs), CCS Database System (road/river annex costs) and Combiplanner (multi-modal transfer) these systems would have to be combined and extended to meet further requirements. The design and development would require a long term project, where research on an European level would be necessary. As a consequence substantial financial means would be needed.

Because of the restricted financial means of the present project it was not possible to accomplish this goal. Therefore it was chosen to design and develop a prototype of an interactive reference system for the supply and conveyance of intercontinental (oceangoing) in- and outgoing containers. The prototype concerns the container feeder transport by sea, is named CoFeeder and has been worked out in cooperation with Nedlloyd.

In Chapter 2 the content of the prototype will be described in terms of vessel schemes and costs. Chapter 3 deals with the modules of the prototype from the perspective of the user. Chapter 4 ends with a review.
Section I - Maritime Networks and Modal Split

2 Model description

2.1 In general

The model supplies information for the settlement of container feeder transport in connection with the intercontinental sea routes. This information is made up of the supply of optimal feeder connections between Western European ports (main ports) and Scandinavian ports, as well as ports of the Baltic states (ports of origin and destiny). The model selects for each port of origin or destiny those feeder connections that offer the best connections with the main line concerning costs and time. Two options are offered with this selection: one whereby the main port has been specified in advance and one whereby the model selects the optimal main port. For the implementation of the model the above stated shipping area has been chosen, with the reason that it concerns a controllable setting. The model can be extended with every possible course of navigation.

2.2 Sailing schedules

Only the relevant shipping area of the main lines has been included in CoFeeder. This means that for every route for solely one trip the Western European ports (main ports) with the accompanying arrival respectively depart dates have been selected. The known frequency of the service enables the computation of every possible desired trip of a main vessel by the model.

All possible direct connections between a main port and a port of origin or destiny of the feeder services are included. Since the frequency and depart- and arrival date of each connection is known, the model can compute each desired departure. After the model has determined a departure or arrival of a main vessel within the specified time window, the model selects the relevant feeder connections. In case of import, this means the first feeder departure sequencing the date and time of arrival of the main vessel. In case of export, this means the latest arriving feedership before the main vessel will depart.

2.3 Costs

The costs of the feeder transport entails all activities from the transfer out of the main vessel to the transfer onto the truck in the port of destiny or all activities in reverse sequence. These costs are build up from the following components (see Figure 1):

1. Transfer main vessel - stack;
2. Transfer stack - truck;
3. Transport to other terminal;
4. Transfer truck - stack;
5. Transfer stack - feeder vessel;
6. Transport feeder vessel;
7. Transfer feeder vessel - stack;
8. Transfer stack - truck;
9. Cargo dues.

Figure 1: Cost component

The activities 2 until 4 only take place when the terminal of the main vessel is not directly reached by the feeder service. In this case the container has to be shipped to another terminal.

The activities to be charged by the feeder operator to the main line, depends on the transportation condition the main line and the feeder have agreed upon. The main line is directly charged for the costs of the other activities. The total costs of all activities are weighted in comparison between the alternative shippings possibilities.

Within the presentation of the cost data a distinction is made between the costs that the main line of the feeder operator is charged for and the costs that the main line is directly charged for.

3 System components

3.1 Input module

Before CoFeeder can offer the user options for the desired feeder connection, first basic data have to be entered. This is done in the input screen (see Figure 2). A user has to enter subsequently:

1. The kind of trade flow: container world flows to Western Europe (import) or container world flows from Western Europe (export);
2. The time window: in what period the main line in a Western European main port is expected, or will depart;
3. The container type: what type of container will be transported, 20 feet (1 teu), 40 feet (2 teu), fridging container, loaded or unloaded or a combination of these;
4. The main line trade: the main line trade that will ship the containers from or to Western Europe.

Figure 2: The input screen

In each of the mentioned cases, only one choice can be made at a time. Just click the left mouse button on the desired option once. When there is more information available than can be displayed at once in the window, there is the possibility to see the remaining information in the window by means of a vertical liftbar. In these windows it is possible to click on an arbitrary text sentence. When all these choices have been entered, the status bar at the top of the screen will be complete. The choices made can be changed. The status bar automatically adjusts to the most recent choice. This status bar also comprises the frequency of the main line.

In the lower right corner of the screen three action buttons are available. By clicking these buttons the current screen disappears. The upper button "about..." shows a screen with information on the prototype. By clicking the "exit" button
the user ends CoFeeder and returns to the operating system. The button "Options" opens the Feeder options module.

3.2 Options module

At the top of the module "Feeder Options" (see Figure 3) the same status bar from the previous screen appears. Two of the six windows have already been filled with information.

![Figure 3: Feeder options](image)

In the window "Main Line Port Arrivals" the relevant part of the vessel scheme is being comprised of one of the container vessels belonging to the selected main line. The date of the first called port is in the selected time window by definition. The arrival date and time, respectively departure date and time are displayed per port (main port). In case of export from a main port the departure dates and times are also being provided with "closing dates" between brackets. These closing dates show, when known, the number of hours that a container should be present in the main port before departure.

The right window "Feeder Ports" shows the feeder ports from which can be chosen. With the exception of some English, French, Dutch and German ports, it mainly concerns Scandinavian and Baltic ports. With the vertical liftbar these ports can be made visible. For reasons of clearliness the international three digit port
code has been comprised in this window. When a code that is being displayed in the left "Main Line Port" window causes confusion, it is possible to look up the translation of this code in the right window.

Now the user is expected to make a choice out of the presented main ports. In these main ports a container is being offered to a potential feeder operator in case of import and in case of export to the already chosen main line. The user is free in choosing one or several ports to get the desired comparison data. In contrast with the previous screen, the user has to click twice in this case. After each choice, the potential main port appears in the window beneath. When date and time deviate from more recent vessel schemes, this data can be corrected by clicking the "Date & Time" button.

Right at the top a quarter window called "Change Date & Time" appears (see Figure 4).

![Figure 4: Change date and time](image)

In the upper window the chosen main ports are being presented. Before entering adjustments, first the user has to select a port. The desired port is selected in the window "Main Port option". Next, select the right day, month, year and time in the four windows beneath. One click will be enough. By clicking the "Save" button the adjusted date and time appear in the window "Port - Date - ETA" of the underlying window. On error it is possible to enter a correction in the same way or make a replacement of the original data. In the latter case, the port should be clicked another time in the window "Main Port Option", followed by a click on "save". When the desired correction has been made, click on "Back", after which the screen "Change Date & Time" disappears and the "Feeder Options" screen is presented again.

At this moment, the right data concerning arrival and/or departure date and time of a main vessel in a potential transhipment port is presented. Now, the user can
make a definite choice on the port of origin or port of destiny according to the export or import of containers.

In the window "Feeder Ports" the desired port should be clicked twice. The selected port appears in the "Destination" or "Origin" window. When the button "Connections" is clicked upon, CoFeeder will select all possible next connections due between main port and feeder port. The result of this selection process will be displayed in two upperlying windows. The upper window is sorted on costs (from the port of origin till transferred to the main vessel, or reversed) and is expressed in German Marks (DEM). The feeder connection with the lowest cost is displayed at the top, those with the highest cost is displayed at the bottom. When more than three options are chosen, a vertical liftbar appears in the window to be enable to see the remaining options.

The window beneath is sorted on time. In case of import of containers the feeder connection with the fastest arrival time in the port of origin, irrespective of the accompanying cost, is displayed on top. In case of export of containers, the connection from the feeder port with the latest departure time is displayed on top.

Both windows show from left to right the name of the "Feeder Operator", the frequency of the maintained connection, two port codes of respectively origin and destiny (read: port of origin - main port of main port - port of destiny), the accompanying departure and arrival dates in these ports, as well as the "Lead Time". This is the number of days and hours lying between the moment of arrival of the main vessel and the departure of the feeder vessel in the chosen transhipment port. In some cases, this time window can be extremely short and even negative. In the latter case both the vessel of the main line and the vessel of the feeder operator are in the transhipment port on the same day, but with the difference that the departure time of the leaving vessel was earlier than the arrival time of the other vessel. In that case the frequency of the feeder operator tells when an earlier or later arrival will take place. Finally, the costs are displayed in the utmost right column, expressed in German Marks (DM). When the costs are unknown, a zero is displayed.

When the user is not interested in further details of the selected feeder connections, it is possible to leave the screen by clicking the "Back" button. The input screen appears again with the current choice settings. It is possible to adress a new selection, or to leave CoFeeder and return to the operating system.

However, when the user is interested in further detailed information concerning the feeder connections, then the desired connection in the upper one of the two windows has to be clicked on twice. The current screen will then disappear and the output screen will appear.

The output screen, called "Feeder Details" (see Figure 5) is made up from one large window, accompagnied with two buttons, i.e. "Back" and "Currency".
Section I - Maritime Networks and Modal Split

The window first repeats some already known information, like the name of the feeder operator, the route or the connection expressed in port codes and the selected type of container (coded).

New information concerns the type of contract that has been agreed upon between the main line and the feeder operator regarding the concerned connection. This contract information is being displayed behind the title "Terms". In the next three columns the following information is presented:

1. The different activities necessary to ship the container from the main vessel to place of destiny or reversed;
2. The accompanying costs for the feeder operator;
3. The accompanying costs for the main line.

Since the currency and exchange rates can differ per activity an overview is given in separate columns. Beneath these columns the total costs are displayed, for feeder operator and main line together. These costs are presented default in DEM. Another currency, for example the total costs expressed in Dutch Guilders (NLG), can be realized by clicking the "Currency" button.

Right at the top appears now a small new screen, called "Currency" (see Figure 6). By clicking on the desired currency and next clicking on "OK" the "Currency" screen will disappear and the "Feeder Details" screen will return, accompanied with the total costs expressed in the chosen currency.

Figure 5: Feeder details
Finally some text (if known) with further information on name of the terminal, details on the contract with the feeder operator, the possibility of direct arrival at the terminal, etc. is displayed (see "Remarks").

It is possible for a main line and a feeder operator to make several agreements on the same connection. In such a case a second and third contract is presented underneath the dotted line in the "Handling and Feeder Costs" window. The eventual price differences between these contracts are explained by the type of contract (see "Terms") and by eventual further information.

The "Back" button brings the user back in the options screen. By again clicking "Back" in this screen and clicking "Exit" in the input screen, the user will return to the operating system.

4 Review

The results of the present project indicate that an Hinterland Transport Management Information System is interesting for the shipping companies that do provide or are related to hinterland transport. Though a couple of shipping companies have taken initial steps in the direction of such an information system, an information system that meets the requirements mentioned in the introduction could not be
found at the shipping companies interviewed. Of course the 'ideal' system can be realized on the long term, but would need a substantial research and development effort.

The proposed planning system will be of primarily use on the operational level within an organisation. Both from the perspective of the client, the main line arriving in or departing from main a port like Rotterdam, and of the operator of the shipping company offering transport services to feeder ports the system forms a optimalisation in the door-to-door transport chain. As a matter of fact one contact between the client and the operator is enough to know for what price and within which time window a container can be transported from Rotterdam to Riga. Of course the planning system must also include information about the actual space on the selected feeder.

Though, talking about door-to-door transport, pricing and timing of the various links within the transport chain are very important elements also aspects like transit time, frequency and reliability of the several links can influence the decision making. The actual values of the mentioned attributes will be determined partly by the modal split opportunities of the relevant ports (a possible future rail connection between the main port of Rotterdam and the important hinterland Germany can for example generate new cargo flows). During the judgement of the most optimal mode the attributes can be weighed. Trade-offs will have to made between costs and transit time, costs and frequency and so on.

Of course the prototype CoFeeder, developed in the present project, is only a small link concerning the whole chain of door-to-door transport. Nevertheless CoFeeder is used by operators within Nedlloyd. The actual activities of the operator are facilitated rather substantially by using CoFeeder. The process of dealing with wishes of clients by the operator will elapse more efficiently. Some extensions, like changing time schedules, frequency schedules, cost (elements), new shipping areas can be implemented by Nedlloyd itself, by changing integrated datafiles outside CoFeeder. In future it is possible to extent CoFeeder to an information system with greater geographical coverage, concerning the full hinterland transport in Europe, take into account all modes and all attributes.

A more general problem related to door-to-door transport concerns the management of the information flows between and the operations of all related parties. On the one hand interfaces between mutual information systems within company walls should be as transparent as possible. On the other hand door-to-door transport involves activities of several parties at each link so transparency requirements yield also for groups of related parties. Though technical infrastructure is available, like physical networking by cable and electronic data interchange it is estimated that information management and logistics aspects will play a major role in future transport markets.
# Perspective of Shortsea Navigation in the Black Sea Basin

## PERSPECTIVE OF SHORTSEA NAVIGATION IN THE BLACK SEA BASSIN

By R. Ciorton

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Section I - Maritime Networks and Modal Split

PERSPECTIVE OF SHORTSEA NAVIGATION IN THE BLACK SEA BASIN

Abstract

The European concept on the development of transport infrastructure forecasts the realisation of transport corridors having a port at their extremities. This concept pays special attention to watertransport, especially to short sea shipping. This type of navigation has real and viable chances to develop in the Black Sea Basin, connecting efficiently, the ports of the countries in this area. These countries organized the Black Sea Economic Co-operation (BSEC) in order to achieve quicker economic development.

The Port of Constantza is the biggest port in the Black Sea; as it has road, rail and river connections it may be used as a "port feeder" and as a main storage and distribution centre for the European countries as well as for the countries in the Middle and Far East.

1 The european approach on transport corridors

A series of aspects concerning the need of a new infrastructure in Eastern Europe, the Black Sea Region and the Balkans included, is analyzed at present, on CEE/ONU level, alongside with the possibilities or realizing the transport corridors, settled at the Conference in Crete, 14 - 16 03.1994, for road and rail corridors, which are to meet the transport and multi-modal transport needs on local, regional or national level, as well as on pan-European level.

Concerning the prior corridors in Central and Eastern Europe thanks to the expert contribution in the interested in countries, a number of nin prior corridors (Figure 1) resulted as possible, namely:

I. Tallin - Riga - Kaunas - Warsaw + Branch I.A : Riga - Kaliningrad - Gdansk
II. Berlin - Warsaw - Minsk - Moscova
III. Berlin - Wroclaw - Katovice - Lvov - Kiev + Branch III.A: Dresda - Wroclaw
IV. Dresda - Prague - Bratislava - Gyor - Budapest - Arad - Craiova - Sofia - Thesaloniki/Plovdiv - Istambul; + Branch IV.A: Nuremberg - Prague; + Branch IV.B: Viena - Gyor; + Branch IV.C: Arad - Bucarest - Constantza.
V. Trieste/Koper - Postojna - Liubljana - Budapest - Uzgorod - Liov; + Branch V.A: Bratislava - Zilina - Kosice - Uzgorod; + Branch V.B: Rejeka - Postojna;
VI. Gdansk - Katovice - Zilina; + Branch VI.A: Torun - Poznan
VII. The Danube, all the ports located along its axis included, in Central and East European countries.
Perspective of Shortsea Navigation in the Black Sea Bassin

Figure 1: Priority corridors in Central and Eastern Europe

VIII. Durres - Tirana - Skopje - Sofia - Plovdiv - Burgas - Vama
IX. Plovdiv - Bucarest - Chisinau - Lyubasivka - Kiev - Vitebsk - Pskov - St. Petersburg - Helsinki; + Branch IX.A: Odessa - Lyubasivka; + Branch IX.B: Kiev - Minsk - Vilnius - Kaunas - Klaipeda; + Branch IX.C: Kiev - Moscow; + Branch IX.D: Kaunas - Kaliningrad;

The selection of these corridors for the second stage was based on TEM and TER networks, as well as on three main reasons: each participating country, within Central and Eastern Europe has to be reached by, at least, one corridor; only the economically viable corridors, having real perspectives for their funding and execution up to 2010 are to be included, mentioning that the parallel corridors must be avoided, as they may mutually diminish their economic viability; the selected corridors must be compatible with their integration within a networks, strengthening this way, their individual viability. Certainly, within a shortterm period there is not enough traffic to justify construction or modernization works for all the corridors. That's why a selection of the "prior corridors" established in Crete is necessary; the choice made is, indeed, a matter of economic constructive, environmental and financial analysis.

As far as the waterbom transport is concerned, the Declaration in Crete, stipulates that development of inland waterway network's efficient form the energetic consumption point of view, having a less impact on the environment. The inland
waterway network must be integrated into the intermodal traffic systems. The actions for the further development of the waterbom transport on short sea shipping must be also put into force.

2 The role of the waterborn transport in the general system of the transport corridors

There are 9 prior corridors, among which the Corridor No. VH represents, in fact, the waterway of the Danube. Nevertheless, it is mentioned that other corridors cross the Danube: Corridor No. IV; Corridor No. V; Corridor No. IX. The sections towards Sofia of corridor no. IV have an outstanding importance as they are part of the corridor No VIII, too, on East-West direction from the Black Sea to the Adriatic Sea.

These new routes enlarge, considerably, the Danube hinterland, this river representing, this way, an impressive connection for the many kind of traffic. It has been also ascertained that as a matter of fact, all the corridors have a port as extreme point, such as Constantza in Romania, Vama and Burgas in Bulgaria, Istambul in Turkey and Odessa in Ukraine. This fact will contribute to the promotion of the sea short shipping to connect the corridors on waterways.

3 The geography of the black sea

The Black Sea has an area of 411540 sq.km and together with the Azov Sea, the area amounts to 461540 sq.km. The maximum distance between coasts is 1125 km on the East-West direction and 600 km on the North-South direction.

As a matter of fact, navigation is possible all the year round, except the Northern part of the Azov Sea, where, during some winters, icebreakers are needed for about two months. Three important navigable rivers flow into The Black Sea, the Danube, the Niper, the Don thus extending, considerably, the hinterland of the sea (Figure 2).

Together with the Rhine - Main - Danube Canal the Danube forms a navigable corridor which crosses Central and Western Europe and makes the connection with the North Sea.

The Volga - Don Canal allows the navigation of ships up to the Caspian Sea and then, on the inland waterways in Russia, up to the White Sea, passing by the Moscow area and St. Petersburg, the latter being one of the biggest ports on Baltic Sea. The Black Sea is connected to the Mediterranean Sea through the Bosphorus and Dardanelles and then, to the Atlantic basin through Gibraltar, while the navigation to the Asia - Pacific region is realized through Suez Canal (Figure 3).

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Figure 2: The extension of the Black Sea hinterland

Figure 3: The Black Sea connection with other geographical zones
Section I - Maritime Networks and Modal Split

The Black Sea is part of the border in 6 countries: Romania, Ukraine, Russia, Georgia, Turkey and Bulgaria. The six countries together with Greece and Albania created a zone of economic co-operation in the Black Sea (BSEC), where the development of transport is a major focus, being periodically analyzed by a working group. There are more than 35 ports on The Black Sea and Azov Sea coast (Table I and II).

About one third of this number is accessible to middle and large capacity ships. Such ports are: Constantza, Odessa, Novorosiisk, Poti, Samsun, Istanbul etc., as well as the ports situated on the maritime Danube, such as Sulina, Tulcea, Galati, Braila in Romania and Reni, Ismail in Ukraine. (Figure 4). The future port of Giurgiulesti in the Republic of Moldavia, which is directly be added to the above mentioned orts.

<table>
<thead>
<tr>
<th>Port</th>
<th>Constantza</th>
<th>Odessa</th>
<th>Novorosiisk</th>
<th>Poti</th>
<th>Samsun</th>
<th>Istanbul</th>
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<td>Distance</td>
<td>371</td>
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Table I: Distances between Black Sea ports

4  The coastal navigation perspectives in the black sea basin

The important social-political and economic changes, which occurred during the last years in Europe and the former Soviet Union, justify our consideration of an international transport market. Integration and co-operation often represent a desideratum and if there is any way to fulfil it, it is by transportation.
### Table II: Ports in the Black Sea and Azov Sea

Favourable conditions were created to promote the extension of European and intercontinental exchanges, as well as to integrate the regional transport network into the continental network. Thus, by creating the logistic zone of the Black Sea, the efficient connection of the European flows with the Asian flows can be realized. International companies consider the Black Sea region a significant business
The new political, economic and commercial conditions have generated an attractive and favourable context for business. The coherence of regional systems may be facilitated by activating the intermodal transport, by creating appropriate networks and by applying transport and transfer specific technologies.

At the Meeting of The BSEC Working Group for transport - organized in Anapa (Russia) on October 18th - 19th, 1995, the following recommendations were made to the participating countries:

- To study the extension possibilities of Ro-Ro and rail-ferry systems among the ports in the Black Sea and Azov Sea, in addition to the Ro-Ro lines operating between the Bulgarian ports of Varna and Burgas and the Port of Poti in Georgia, and between the port of Constantza in Romania and Istanbul in Turkey, as well as in addition to the rail-ferry line between Constantza (Romania) and Samsun (Turkey) which will be soon open to traffic;
- To integrate the navigable way Moscow - Rostov/Don - Novorosiisk into the European corridor No 9;
- To create and develop container terminals;
- To realize an appropriate road-rail network to connect the ports;

Thus, a preliminary study on the development of a transport line between Constantza (Romania) and Poti (Georgia), using the Black Sea, indicates the following possible benefits:
Perspective of Shortsea Navigation in the Black Sea Bassin

- A reduction of the distance from 2600 km (on the Russian and Ukrainian railway), to 1815 km via Batumi - Tbilisi and to 2208 km via Samsun - Kars - Dogukapi;
- A reduction of the time from 8-10 days to 4-5 days;
- A decrease in the transport expenses and the elimination of the discontinuity when passing from a normal way to a larger way;
- An alternative transport way from Europe to Iran, Asia, China;
- A better usage of the means of transport: ships, wagons, road vehicles, containers and other units of the intermodal transport;
- The attraction of international transit on the route;
- The intensification of the co-operation in the respective zone;
- The continuity of rail, road and river transport is achieved by the ports situated at the extremities of the line;
- The introduction of new transport systems based on multimodal transport which uses specialized transport units: containers, semitrailers, autotrails etc.

A traffic of a minimum 250 thousand t/year is estimated to be realized on this navigation line. According to the data provided by the Institute of Transpolis in Ukraine, a traffic of about 651 mill. tonnes was realized in 1990, among the countries around the Black Sea and Europe. A traffic of 1628 mill. tonnes is estimated for the year 2010, in same area (Table III). Total traffic of the Romania in 1993 with the countries in the influence Black Sea area is 14,35 mill. tonnes, from which 2,75 mill. tonnes export and 11,6 mill. tonnes import (Figure 5)

Will be developed new cargo traffic flow for oil products including from Caspian Sea, cereals, GPL, GNL, ore and coal.

5 The port of constantza - a main storage and distribution centre

There are three ports along the Romanian shore of the Black Sea, namely Constantza, Mangalia (about 22 n.miles southward) and Midia (about 10 n.miles northward). The most important among them is the Constantza Port located about 182 n.miles from Bosphorus.

The Constantza Port covers about 10 sq.kilometres of shore and includes on its premises the outlet to sea of the Danube-Black Sea Canal, the port enclosure of 32 sq.kilometres advanced seaward with about 5.5 kilometres (Figure 6).

The development of the Constantza Port has been achieved during several stages. The first one started in 1888 with a unitary outlook on the construction of the harbour, with breakwaters closing a 1.99 sq.kilometres basin and vertical quays having 8.28 metres docking depth.

The second stage realized between 1958 - 1965 meant a fulfilment of the port constructions located inside the area sheltered during the first stage, with new quays having 9-10 metres docking depths.
### Table III: Estimated O-D of trade between BSEC countries

During the third stage, from 1962 up to 1982, new port operating capacities have been realized in order to support an increased traffic and to accommodate greater capacity sea ships. During this stage a new port area covering about 5.23 sq.kilometres, equipped with modern facilities and including suited wharfs to operate oil products, ore, cereals, containers, metallurgical products, warehouses for general merchandise and storage lands for other different goods has been realized. Operating capacities dedicated to Ro-Ro traffic and other suited quays to accommodate up to 80,000 tdw oil tankers and up to 65,000 tdw bulk carriers, have also been realized.

The daily throughput marks 100,000 tonnes of dry cargoes and up to 60 ships simultaneous by operated. The present Constantza Port enlargement marked in 1976 the beginning of works for the South Constantza Port, southward the existing one, planned to accommodate ships with capacities up to 250,000 tonnes.
Perspective of Shortsea Navigation in the Black Sea Bassin

Figure 5: The traffic between Romania and countries in the Black Sea area

Figure 6: The port of Constantza
Section I - Maritime Networks and Modal Split

The present Constantza Port consist of a couple of great basins: the North and South port able to practically operate any kind of merchandise. The main characteristics of the Constantza Port are shown in Table IV.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Measuring unit</th>
<th>North Constantza</th>
<th>South Constantza (final stage)</th>
<th>Total (Final stage)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total area sq kilometres</td>
<td>sq kilometres</td>
<td>7.22</td>
<td>25</td>
<td>32.22</td>
</tr>
<tr>
<td>- Land sq kilometres</td>
<td>4.04</td>
<td>13</td>
<td>17.04</td>
<td></td>
</tr>
<tr>
<td>- Sea sp kilometres</td>
<td>3.18</td>
<td>12</td>
<td>15.18</td>
<td></td>
</tr>
<tr>
<td>Breakwaters kilometres</td>
<td>6.77</td>
<td>11.45</td>
<td>17.77</td>
<td></td>
</tr>
<tr>
<td>Quays length kilometres</td>
<td>13.4</td>
<td>50</td>
<td>63.4</td>
<td></td>
</tr>
<tr>
<td>No. of berths no.</td>
<td>78</td>
<td>200</td>
<td>278</td>
<td></td>
</tr>
<tr>
<td>Basins depth metres</td>
<td>7.2 - 14.5</td>
<td>7.0-22.5</td>
<td>7.0-22.5</td>
<td></td>
</tr>
<tr>
<td>Traffic capacity mill. tonnes/year</td>
<td>67</td>
<td>180</td>
<td>240</td>
<td></td>
</tr>
<tr>
<td>Ships capacity 10^3 dwt</td>
<td>80</td>
<td>250</td>
<td>250</td>
<td></td>
</tr>
</tbody>
</table>

Table IV: Main characteristics of Constantza port

The new Port of Constantza South will be built in a series of stages, according to the traffic requirements. Thus, the following steps have been planned:

- The multipurpose terminal, in pier I, of about 0.2 sq.km with a total docking length of 2,000 m, accommodating ships up to 65,000 dwt;
- The RO-RO terminal of 25,000 sqm;
- The rail ferry terminal, for the route between Romania Turkey (Samsun) and then to Iran, Iraq and Syria;
- The accommodation of the Free Zone in Constantza which will have at the beginning, two enclosures, totalizing about 0.3 sq.km; these areas will be destined to processing activities, trade, services etc.
- The activity concerning port operations is directed by 12 companies which ensure the operation of 3,500 - 4,000 ships/year. The average operating time of a ship is 3.5 days.

The sheltered storage areas amount 39,000 sq.m and the storage platforms reach 172,300 sq.m. The port has a 190 km long network and a road system 100 km long. There are 12,000 people employed in port activities.

The transport infrastructure developed a lot. The port concentrates all systems of transport, the multimodal transport being highly efficient.

Owing to the Rhine - Main - Danube Canal, a corridor for the traffic between the Black Sea and the North Sea has been created. It will generate both significant economic relations and the increase of port activities. The Port of Constantza is located at one extremity of this corridor, this position influencing the future development of the port.
Perspective of Shortsea Navigation in the Black Sea Bassin

The sea trade connections can be intensified worldwide, as the Port of Constantza is able to accommodate any type of ships entering the Bosphorus and crossing the Suez Canal. Consequently, a very wide geographic area in Europe, Middle and Far Orient will benefit from this navigable waterway. These aspects may stimulate the port activity along a double direction, one concerning the transport and the other regarding the industry. By specialising the port complementary suitable services, with competitive costs, improved performance indicators will be obtained. At the same time, the land merchandise added value will increase. Applying a global and interconnected dealing with the strictly speaking port activities and the logistic services maximum benefits can be offered to users, the port incomes will increase and the infrastructure will be more efficiently accounted.

The Constantza Port, as the greatest trade port in the Black Sea area, has the greatest chance to develop along four directions:

- As a main transit port, including RO-RO services, between the Black Sea and the Western Europe;
- As a middle collection in merchandise traffic between the CSI and Europe;
- A port for the operation of great ships considering the trade relations between the markets in the vicinity.

Due to its location and dimensions this port, holding a strategic position in the crossing of the ways between Europe and Asia, has genuine perspectives in attracting new traffic figures and in the development of economic activity of partners in other countries, both for national requirements and for transit activity. The development of the Port of Constantza is planned according to a modern concept. Due worldwide connections an increased volume of merchandise will be transported through this port.

6 Types of ships suitable for short sea shipping on the black sea

The types of ships proposed for Short Sea Shipping in the Black Sea Basin consider the following transport routes:

- Central Europe - Ukraine, Russia;
- Central Europe - Turkey (Georgia) - the Middle and Far East;
- Between the ports in the Black Sea Basin.
6.1 The route Middle Europe - Ukraine, Russia

Two of the biggest European rivers, Danube and Dnepr, represent the natural waterway connection between these two regions. The distance between Danube mouth by Sulina and Dnepr mouth by Kherson is less than 300 km. Both on Danube and Dnepr a vivid traffic exists. According to the political and economical changes in Ukraine and countries along the river Danube, both parties have a lot of concern to use this natural waterways and problems of shipping of this section become very attractive. Therefore, this route must be treated together with its fluvial prolongations.

The development and diversification of commercial relations between Romania and the neighbour countries imposed the finding of new solutions for the cargo transport between the West ports of the Black Sea and those on the inland adjacent rivers.

A rapid and efficient transport system is by means of specialized ships - barges carriers - which transport floating barges. Besides other specialized ships (self-propeller barges, floating docks) ICEPRONAV S.A. from Romania projected a special ship, having the characteristics of a floating dock and of a self-propelled barge, capable to load and transport barges (Figure 7). Such a ship is provided, in the space between the bottom and the double bottom top, with 48 wells through which water enters the holds. Water level is regulated by ballasting depending on the barges draught, thus, that between the barges bottom and the ship's double bottom to remain a permanent space of 300 mm. This way more types of barges (LASH, BAKAT I, floating containers) loaded with general cargo, oil products or chemical products can be transported. The transport can be performed according to barges categories or combined. This way of transport offers a series of important advantages:

- Reduction of the stay in port of the barges carrier both during loading and during unloading;
- Lifting devices for the loading - unloading process (cranes) are not necessary;
- Utilization of ports with reduced facilities;

Figure 7: The Bakat type ships
Perspective of Shortsea Navigation in the Black Sea Bassin

- The possibility of barges, after unloading from the ship, to be coupled in convoys and transported in zones with rivers, having a smaller depth;
- The use of barges, after the unloading in ports, for a certain period of time, as storing spaces.

The main characteristics of the this transport system are the following:

- **The ship:**
  - Length overall: 118.5 m
  - Breadth moulded: 18.00 m
  - Depth moulded: 6.00 m
  - Draught max.: 3.80 m
  - Crew: 10 persons
  - Speed: 10 knots

- **Loading capacity**
  - 15 BAKAT -I type barges + the maneuvering module, or
  - 4 LASH type barges + 5 BAKAT -I type barges + 2 floating containers + the manoeuvring module, or:
  - 4 LASH type containers + the manoeuvring module, or
  - Other combinations with BAKAT -I type barges and floating containers + the manoeuvring module.

- **The manoeuvring module:**
  - Length overall: 5.70 m
  - Breadth moulded: 4.20 m
  - Depth moulded: 163/1.10 m
  - Installed power: 125 kW

The after entrance section is limited in each board by an engine room. The ships propulsion is assured by two DEUTZ type TBD 604 8 (700 kW, 1500 rpm) Diesel engine which operate two propellers. This fact assures a good manoeuvrability of the ship.

An extension of this concept reffers to the ships transporting river barges in FO-FO (float-on (float/off) system. Thus, the floating dock type ship was designed to transport barges with a individual capacity of up to 3000 t. This type of ship uses a maritime articule pusher 2000 Hp. Such a ship will be capable to transport three barges but two port-barges ships with a total length of about 180 m are necessary for a train of six barges. Considering the easy draught, it is difficult to build such a port barge ship, with such a length, but it is possible to lash two ships 90 m long each, thus reducing considerably, the hogging stress (Mr.Yamaguci - Taisei Corporation)(Figure 8).

Another type of ship efficiently used for the sea and river transport is Volgo - Balt type, of the Russian and Ukrainian fleet (Figure 9). Their main characteristics are:

- Gross registered tonnage, reg.t: 3086
- Net registered tonnage, reg.t: 1925
6.2 The route: Central Europe - Turkey/Georgia - The Middle and Far East

Three types of ships have been proposed for this route:

- The RO-RO fast ship;
- Port container 400-500 TEU;
- The multipurpose ship;
- Rail ferryboat ship.

6.2.1 Fast RO-RO ship

Fast Ro-Ro Ships are necessary for Black Sea area, following the intense traffic. On the Black Sea, the transport corridor no. IV, VII, VIII and IX, can be prolonged.
Distances between harbours are relatively short: Constantza - Istambul 192 n.m; Constantza - Samsun 390 n.m; Constantza - Trabzon 530 n.m. In this case service speed must be about 22-23 knots. Naturally a lot problems could occurred in financial field because of the high price of such vessel, about 50-55 mil.USD, but taking into consideration that all money can be repaid in about 4-5 years the investment is very attractive. The main characteristics proposed are:

- Length between perpendiculars 160.0 m;
- Breadth, moulded 24.0 m;
- Depth to the continuous deck 8.5 m;
- Depth to the second continuous deck 14.3 m;
- Draught, design 6.0 m;
- Corresponding deadweight 6,500 t;
- Ro-Ro line capacity (12.5 m slots) abt. 2,000 m;
- Trailers 150 pcs.;
- Drivers 100-110.

6.2.2 Portcontainer 400-500 TEU (Figure 10)

The great development of the containerized sea transport, the diversification of the transport means, the intensification of the present and future commercial relations drew and continue to draw the attention of ship designers, specially for Black Sea area. It is therefore necessary to elaborate complex projects for the so-called ships of the future, which must meet halfway and satisfy the more and more exacting requirements of the shipowners and ship builders, requirements
Section I - Maritime Networks and Modal Split

centre especially the container transport capacity, the speed, the fuel oil consumption, automation, crew and life conditions a shipboard, decreasing of the loading/unloading period in ports, etc.

Figure 10: Port container, 400-500 TEU

The manoeuvring qualities of the ships are completed by a bow thruster, abt. 500 kW, 4 blades propeller, diameter of abt. 1.6 m, which can produce a nominal thrust up to 8 t at abt. 340 rpm.

Main characteristics (preliminary) are:

- Length o.a. abt. 115.00 m
- Length b.p. 106.20 m
- Breadth moulded 18.60 m
- Depth moulded 9.10 m
- Draught (max) 7.20 m
- Draught (design) 6.50 m
- Deadweight (max) 6,200 t
- Service speed (at design draught) Abt. 15 Nā
- Stowage capacity TEU 484
  - abt 144 TEU in holds
  - abt. 340 TEU on deck, from which 50 reefer TEU
- Holds 3
- Hatches 3
- Deck cranes 2 x 30 t SWL
- Crew 15 persons
6.2.3 Multipurpose cargo ship

The powerful development of the marine transports of cargo, performed by container type ships, did not exclude the future use of traditional transport technologies, performed by means of general cargo ships. The traditional container lines are not sufficiently equipped with handling means of a large cargo range, including general cargo, dangerous cargo, steel products, pipes, equipments, bulk cargo, timber and pallets. For this reason, a high percentage of the volume of cargo, transported by sea should be unitized also in the future (packets, pallets) or carrier in bulk, bags etc. The studies of regional and global prognosis show that the "multi-purpose" type ships (5000 - 10000 dwt) will be also intensely required in the future (Figure 11).

![Multipurpose cargo ship](image)

Figure 11: Multipurpose cargo ship

6.2.4 Rail Ferry-boat

In this year will be append the rail ferry route between Constantza - Samsun. This navigation line ensure a 30-50 % quicker and shorter connection between Romania and Iraq, Iran, Syria Zone, against the exclusively rail transport on the same route (Figure 12). The situation is resented into the Table V.

This line will serve many Central and Western European countries (Figure 13). The average duration of a transport, to and from, (2x390 Mm) is 4,5 days, loading time - 8 h, unloading time - 8 h and number of voyages per year can be 72. The transport capacity for one ship is 200,000 t/year.

The ships built to be used on this line are capable of caring 108 vagons or 70 and 34 tracks at a time (Figure 14). The main characteristics are:
Section I - Maritime Networks and Modal Split

Figure 12: Rail transport between Romania and Iran, Irak, Siria

Figure 13: Ferryboat line, Constantza - Samsun
### Perspective of Shortsea Navigation in the Black Sea Basin

<table>
<thead>
<tr>
<th>Rail connection from Romania</th>
<th>Route</th>
<th>Duration (days)</th>
<th>Distance (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iran through CSI</td>
<td>Romania (Socola) - Moldova - Ungheni, Ukraine, Russia - Iran (Djulfa)</td>
<td>12</td>
<td>2,988</td>
</tr>
<tr>
<td>through Bulgaria</td>
<td>Romania (Giurgiu) - Bulgaria (Rusesvilengrad) - Turkey (Kapicule - Kapakoy)</td>
<td>16</td>
<td>2,949</td>
</tr>
<tr>
<td>Rail ferry</td>
<td>Romania (Constanza) - Turkey (Samsun-Kapokoy) - Iran (Razi)</td>
<td>8</td>
<td>1,938</td>
</tr>
<tr>
<td>Iraq through Bulgaria</td>
<td>Romania (Giurgiu) - Bulgaria (Rusesvilengrad) - Turkey (Kapicule-Nusaybin) - Syria (Eqamichliye-Yaroubiech) - Iraq (Uglat)</td>
<td>15</td>
<td>2,843</td>
</tr>
<tr>
<td>rail ferry</td>
<td>Romania (Giurgiu) - Bulgaria (Rusesvilengrad) - Turkey (Kapicule-Maydan) - Syria (Ekez)</td>
<td>8</td>
<td>2,114</td>
</tr>
<tr>
<td>Syria through Bulgaria</td>
<td>Romania (Constantza) - Turkey (Samsun-Maydan) - Syria (Ekez)</td>
<td>12</td>
<td>2,227</td>
</tr>
<tr>
<td>Rail ferry</td>
<td></td>
<td>6</td>
<td>1,542</td>
</tr>
</tbody>
</table>

#### Table V

- Maximum length: 184.2 m;
- Maximum breadth: 26.76 m;
- Maximum draft: 7.4 m;
- Speed: 18.5 KN;
- Crew: 45 persons.

### 6.3 The routes between ports in the Black Sea Basin

For these routes there will be considered same kind of vessels that were previously mentioned. Due to rather short distances between ports, the related crossing time is also short, no more than 1-2 days long. To optimim run of ships, the port traffic times are impelled to be as short as possible. In this purpose there are foreseen the development of containerised cargo, RO-RO traffic and ferry one, to ensure a quick loading/unloading of goods and also the setting of specialised terminals inside Ports fitted with high efficiency operating equipment.
7 Conclusions

The economic development of the countries in the Black Sea Zone, the liberalization of exchanges, as well as the free access to the transport market will determine a considerable increased quantity of goods to be transported both among the countries. An economic way to activate the transport in the Black Sea Basin is the Short Sea Shipping system, using ships appropriate for this type of navigation. The Port of Constantza, in Romania, is the biggest port in the Black Sea Basin and benefits by road, rail and river connections with Europe. Consequently, it will be possible to use this port as an efficient "port feeder" for the storage and distribution of goods to Central and Western European countries as well as to the Middle and Far East countries.
PRESENTING THE "CPT - CONTAINER PALLET TRANSFER" - AN AUTOMATIC, HIGH CAPACITY SHIP/SHORE LOADING SYSTEM

By B.O. Hansen

Presentation

The TTS Group is a thirty year old international technology company with headquarters in Norway. The core business is the developing of technology and design of systems for production process and heavy load handling mainly for the international shipbuilding industry and other related steel industry. The experience also includes analysis and logistics.

TTS Drøbak AS has through the last two decades designed and delivered a number of heavy load handling systems for moving ship-/off - shore sections, and complete ships in the range of 100 - 16,000 ton.

Based upon long experience within Transport and Handling technology, TTS took the opportunity of a challenge and participated in the "VOLVO" project four years ago.

Since than a number of high speed designed ships have been presented and most of them without a reliable container handling solution.

This problem triggered interest for TTS and commenced development of our new concept for loading and unloading vessels, which at the same time opened for automatic terminal operations.

Requirements

As we have seen from former reports regarding short sea transport systems the following critical success factors have been emphasised:

- Transport time; Regular and fast transport;
- Transport cost; Capital and running cost;
- Frequency and flexibility;
- Reliability; Good performance under all weather conditions;
- Customer satisfaction; Complete door to door transport;
- Environmental impact; Reduce or avoid growing truck traffic on the roads;
- Politically acceptable.

A high capacity ship/shore loading system will be an important part in the total intermodal transport chain for short sea operation. Regular line traffic between two hubs is the basis for our evaluations.
From the analysis of the critical success factors, the following requirements are of great importance:

- **Port facilities**
  - Automatic operation;
  - Safe operation under all weather conditions;
  - Effective terminal operation/planning;
  - Accept different loads (containers and swap bodies);
  - Accept incoming goods from rail and road;
  - Accept late incoming goods;
  - Planned maintenance (port based handling equipment);
  - Well known and proven technology.

- **Ship-/shore transfer**
  - Automatic mooring;
  - Automatic high speed loading and unloading (discharging);
  - Accept tide variation;
  - Avoid/reduce stevedores and seafastening work in the ship (automatic lashing);
  - Minimise mechanical equipment on board the ship.

- **Cargo units**
  - Be standardised;
  - Allow on-going intermodal transport;
  - Flexible in accepting different kinds of cargo;
  - Accept automatic handling.

### Introducing CPT

To meet the requirement in high speed shipping TTS has designed the CPT concept.

The Container Pallet Transfer System (CPT) has been built up around the idea of pre-loading containers and trailers on mega-pallets capable of carrying up to 20 * 20 ft containers with a total weight of 400 tons.

The pre-loading of the mega-pallets will take place prior to, and after the ship has arrived. The containers are locked to each other and to the mega-pallet with standard twist-locks. Cargos, for example trailers, are also secured to the mega-pallets. All sea-fastening to the mega-pallets will take place in the terminal area before entering the vessel.

The main idea behind the CPT system is to handle a block load on mega-pallets in the port area. Optimal capacity of up to 900 TEU/hour is achieved by stacking standard containers two height. The system is to a certain extent module based and will be tailored to the actual vessel specification.
Presenting the "CPT - Container Pallet Transfer"

Figure 1: Trailers on mega-pallet/Block load of containers on mega-pallet

The TTS solution is based on well-proven technics that we have used for Heavy Load tasks in the shipyard industry throughout the last 20 years.

Main items

A complete system is comprised of the following main items:

- CPT cars;
- Mega-pallets;
- Standard container cranes;
- Lifting tower with platform and ramp;
- Ship mooring and docking support;
- Automatic pallet locks (in the vessel).

General description of the system

The handling system is in this presentation designed to be installed in two specific ports (Hubs) with regular turn-around service from fast vessels.

All equipment is shore based, except the rails on the cargo deck and the automatic locks for the mega-pallets in the vessel.

Each terminal will be furnished with lanes of mega-pallets in the magnitude of two times the vessel capacity - one half for outbound cargo and the other half for inbound cargo.

A number of container cranes straddling the mega-pallets and the rail or truck way are used to stack and unstack the mega-pallets.
Section II - Ships and terminals

The loaded mega-pallets are transferred between the vessel and the quay by diesel-electrically driven transfer trolleys (CPT-cars) running on rails on the terminal ground and the ship. The transfer trolleys are equipped with their own hydraulic power pack, hydraulic motors and lifting cylinders. The mega-pallet is designed in such a way that the CPT cars can be driven under the pallets from all sides. Independent of the terminal layout it is therefore possible for the total loading or unloading cycle to be broken down into a number of separate cycles operating simultaneously.

The shore based lifting tower is equipped with an entrance ramp and a lifting platform. The ramp has an automatic leveling device to keep it horizontal and at the correct height to the deck independent of tide and draft conditions. After the vessel stern door has been opened the ramp aligns to the predestinated deck level.

The lifting platform is designed for safe vertical transport block loads between the ramp level and the quay, based on the well known Ro-Ro technique.

Landside CPT cars run into the vessel hold on rails corresponding with the terminal rails, positioning themselves under the first mega-pallets, lift the pallets out of their locks and transfers the mega-pallet to the lifting platform. The transfer cars then return to pick up the next pair of mega-pallets. The elevator platforms are lowered and allow new transfer cars to come in and pick up the mega-pallets and...
take them to a crossing point. The pallet positioned in the crossing point is picked up by a crossing transfer car and moved to the next crossing point or the first available storage position.

As soon as the vessel is fully unloaded, the loading of outbound cargo can start in reverse order.

For larger vessels the cargo hold can accommodate two or more lanes of mega-pallets and in this case two or more pallets will be transferred parallel with each other to avoid listing of the ship.

The positions of the mega-pallets in the cargo hold have been predefined and all the positions are equipped with automatic operated pallet locks.

The control system can be developed in steps, from automatic ship/shore transfer system with communication between the vessel and the terminal, to a complete integrated container tracking system.

Another important facility is the submerged docking beam designed to touch the aft section of the ship after mooring. The suspended beam has motion compensation and supports the ship while the huge block loads pass through the stern door. The support beam also reduces the trim capacity requirements for the ship.

Main features

- All vital equipment is shore based. This enables preventive maintenance when the ship is not in port;

- Automatic lock arrangement of the mega pallets in the ship cargo hold. Containers and trucks are secured to the mega pallets during the shore operation;
The system can operate independent of tide and draft conditions;

The system is well proven, and the technique has been used by TTS throughout many years in shipbuilding and repair industry;

The only installation onboard the vessels are rails on the cargo deck and the locking arrangements for the mega-pallets. This allows the ship also to be used for conventional Ro-Ro traffic;

The system and the mega-pallets can be tailor made to suit most high speed vessels and is designed to meet different cargo types like containers, trucks, cars and general cargo;

The system accepts incoming goods around the clock. Late incoming goods will also be accepted to the terminal during discharging of the ship;

The control system can be integrated to an overall container tracking control system.

**Status of the cpt today**

Stress analysis, weight calculations and technical design have been made.

Most of the components are in regular use in other applications.

A port/ship module has been established in a simulation program to calculate capacity figures and analyse bottlenecks.

We have received positive market response from both specific projects and general presentations.

The whole system is presented on a 3D animated video tape illustrating the most interesting sequences in action.

In combination with Fast cargo ships, we see our CPT concept as an interesting niche for the high value goods with fast turnaround time.

TTS hopes to see the CPT concept, installed in future port terminals, as a flexible system for inter modal services with high speed operation.
THE IMPACT OF LOGISTICS ON THE TECHNICAL PERFORMANCE OF SHIPS: A CASE STUDY

By J. Igielska

ABSTRACT

Following the paper "An Alternative System for Shortsea Shipment of Road Vehicles" published for the Second European Research Roundtable Conference on Shortsea Shipping, 2-3 June 1994 in Athens/Vouliagmeni, a comparison of technical and economic performance of the Roll-on/Roll-off vessel and Lift-on/Lift-off carrier for transport of trailers is presented here. The initial designs of these vessels have been developed by a group of students at Chalmers University of Technology, Department of Naval Architecture and Ocean Engineering, Gothenburg, Sweden, as part of an obligatory course for a degree in naval architecture, under the guidance of the author of this paper. The sea trade between the Scandinavian countries and the Continent has been chosen for this study. The vessels are intended to be employed in a fast service between Gothenburg and Zeebrugge, to fulfill the market requirements for effective, regular, frequent, and reliable transport of cargo on road trailers. The frequency and round voyage schedules are arranged for daily arrivals and departures in such a way that factory production is transported by the vessel the same day and delivered to a spot after 24 hours. Such logistics have influenced the technical parameters of ships, especially service speed (of 29 knots), which was carefully analysed, as a cost-effective factor, taking into account both investment and operational expenses. In order to offer a reliable transport system for regular arrival and departure times of ships, regardless of weather conditions and other unforeseeable circumstances, on top of a sea margin, an allowance for shallow water for the main propulsions has been added. The type of propulsion plant has been considered to be different for each ship, in order to make the study more comprehensive. Cargo volume per shipment of about 160 road trailers was assumed for an estimated daily need for the industry located in western Sweden. The paper covers an analysis of the impact of logistics on required overall vessel technical and economic performance.

1. General

Requirements on transport systems are increasing steadily. Today's inland transport infrastructure hardly satisfies the need for cargo flow growth. Road and railway congestion in many industrial regions of Europe is already a problem. Marine transport systems might open new possibilities for the market and provide fast connections for shortsea shipping. To shippers, the main advantages of using such system are short transit time, high frequency, high reliability, high safety, and high efficiency at low costs, and the fact that they take environmental aspects into account.
Many traffic routes in Europe are dominated by roll-on/roll-off freight services, with lorries and trailers being transferred by sea to their markets. The European Community market can only be reached from Sweden by sea. A huge volume of cargo flows is considered here, and therefore air connections are neglected.

Two types of ships, a roll-on/roll-off vessel and a lift-on/lift-off carrier, both intended for transport of road vehicles have been designed, and a comparison of technical and economic performance has been carried out.

The existing ships, with slow service speed, require four days for a round trip on the route between Sweden and Belgium or the Netherlands, where the sea distance for a return trip is about 1100 Nm. A ship with an average speed of 16 knots, serving this trade, spends more than 68 hours at sea in a return voyage, and 8-10 hours in each port. Daily service thus demands four vessels. In order to reduce number of ships engaged in this service, and offer attractive transit time, vessel service speed in range of 30 knots has been considered. An eventual investment in high speed ships for transport of road vehicles was broadly discussed in shipping circles in Sweden, as well as in European Community research programmes, and stimulated the basic features of the project presented in this paper.

2. Trade choice

The aim of this study was to give some alternatives for transport of high value products for the industrial plants situated in western Sweden, especially for Volvo factory production flows to/from the Continent. Therefore, the trade between Gothenburg and Belgium or the Netherlands has been considered, as it is one of the most important areas for Swedish industry, which requires short transit times, and high frequencies.

The ports in Zeebrugge, Gent and Rotterdam have been considered in order to choose the most suitable terminal for handling of the intended ships. Access to Gent and Rotterdam terminals requires passing canals and locks. The ship fitted with a high power propulsion plant should have as short a sailing time at low speed as possible. Zeebrugge terminal, which is situated near the open basin of the North Sea, has been chosen for this trade. Distribution of cargo on the Continent by road vehicles has not been analysed. It is worth mentioning that Volvo products, which make up about 25-30% of the total ship cargo capacity, have to be moved by road transport 66 km to Gent, and vice versa.

3. Type of cargo units, type of vessel and ship capacity

Disadvantages and needs for improvements of road vehicle transport by roll-on/roll-off type vessel have been analysed in my paper presented at "The Second European Research Roundtable Conference on Shortsea Shipping", 2-3 June 1994. An alternative system to roll-on/roll-off for shortsea shipment of road vehicles, which allows for transport of trailers stowed on cassettes by cellular carrier, has been suggested. Thus, these two systems have been analysed, assuming the same ship capacity of about 160 trailers, estimated as a suitable volume for daily transport of Swedish industry products from/to this region.
The frequency and return voyage schedules are arranged for daily arrival and departure in such a way that factory production is transported by the vessel the same day and delivered to a consignee after about 24 hours. In order to improve shipping service economy, an innovation with standard liner service (regular arrival and departure times) has been made, resulting in shifting of ship schedule time by about 1.5 hours every day, as can be seen in Table I. Cargo handling time has been limited to 4 hours for both types of ships. This might be considered too optimistic, and should also be regarded as a goal for an improved cargo handling system, especially for Roll-on/Roll-off vessels, where trailer securing for sea voyage is to be done on board.

Table I: Ship departure Gothenburg

<table>
<thead>
<tr>
<th>Latest time for cargo delivery to terminal gate</th>
<th>Ship departure time</th>
<th>Earliest time for cargo collection at terminal</th>
</tr>
</thead>
<tbody>
<tr>
<td>22.30 Monday</td>
<td>23.00</td>
<td>22.30 Tuesday</td>
</tr>
<tr>
<td>24.00 Tuesday</td>
<td>00.30</td>
<td>24.00 Wednesday</td>
</tr>
<tr>
<td>01.30 Thursday</td>
<td>02.00</td>
<td>01.30 Friday</td>
</tr>
<tr>
<td>03.00 Friday</td>
<td>03.30</td>
<td>03.00 Saturday</td>
</tr>
<tr>
<td>04.30 Saturday</td>
<td>05.00</td>
<td>04.30 Sunday</td>
</tr>
<tr>
<td>06.00 Sunday</td>
<td>06.30</td>
<td>06.00 Monday</td>
</tr>
</tbody>
</table>

Ship departure times from Zeebrugge are similar. It has to be observed, that there are six return voyages per week, and ship departure and arrival times take into account the shortest possible transit time for factory production. Factory products manufactured on Monday in Sweden may be delivered to Gothenburg terminal as late as 30 minutes before ship departure, and after 25.5 hours can be collected at Zeebrugge terminal. A trip on Sunday can be cancelled, if no factory products are delivered to terminal. This time might be utilized for ship maintenance and minor repairs. This makes it possible to put the ship back on schedule after unforeseen delays. Such logistics have influenced ships' technical parameters, especially service speed, which was analysed in detail, as a decisive cost factor, taking into account both investment and operational expenses. Allowing for a return voyage of 51 hours instead of 48 hours, permits some reduction of propulsion power. Higher speed than 29-30 knots requires substantially increased output, as can be seen in the diagram, which explains why a ship service speed of 29 knots has been chosen. In order to offer a reliable transport system for regular arrival and departure time of ships, regardless of weather conditions and other unforeseeable circumstances, a sea margin for the main propulsions of 15% has been added. Shallow water influence on ship resistance is an important factor, which should be taken into account when considering ship logistics scenarios. Speed loss owing to shallow water effects is shown in Figure 1.
It is of great importance for short sea shipping to analyse distances with limited depths of water on a given trade, as this influences the logistics schedule, and the ship technical performance. Ship voyages are often coastal, and speed has to be limited because of resistance effects and risks for grounding. Extra power in the main propulsion engines, required to maintain high service speed in shallow water, necessitates higher investment and operating costs. A selection of sea route has been carried out, in order to estimate the required time for sea passage, and to analyse fuel consumption. A comparison of seven investigated sea routes is shown in Table II.

The maximum time difference between these routes is about an hour, and the fuel consumption difference is 16 t per single trip, and 5000 t per year, which is an important proportion of the total operating costs. It should be emphasised, that the more favourable route might not be the shortest one, taking into account the overall economy.

5. Main dimensions of the vessels

The main dimensions of the ships have been determined taking into account the required cargo capacity for 160 trailers, as well as the possibility to pass the lock at Immingham. This last assumption might give an operational advantage for future service, as this port is one of the most important terminals in Great Britain for Swedish industry. Various alternatives of trailer stowage patterns abreast and along ship have been considered, taking into account vessel fullness (block coefficient), resistance, stability performance, required displacement, etc. After an
The Impact of Logistics on the Technical Performance of Ships: A Case Study

### Route Distance

<table>
<thead>
<tr>
<th>Route</th>
<th>Distance (Nm)</th>
<th>0-10 (m)</th>
<th>10-20 (m)</th>
<th>20-30 (m)</th>
<th>30-40 (m)</th>
<th>40-50 (m)</th>
<th>50- (m)</th>
<th>Total time at service speed (hr)</th>
<th>Fuel consumption (t)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>511</td>
<td>3.3</td>
<td>22</td>
<td>31</td>
<td>19</td>
<td>21</td>
<td>3</td>
<td>20.21</td>
<td>253.2</td>
</tr>
<tr>
<td>2</td>
<td>522</td>
<td>2.7</td>
<td>3</td>
<td>22</td>
<td>37</td>
<td>28</td>
<td>6.8</td>
<td>19.27</td>
<td>240.2</td>
</tr>
<tr>
<td>3</td>
<td>534</td>
<td>1.6</td>
<td>3.3</td>
<td>16</td>
<td>47</td>
<td>25</td>
<td>6.6</td>
<td>19.46</td>
<td>248.0</td>
</tr>
<tr>
<td>4</td>
<td>552</td>
<td>2.5</td>
<td>2.8</td>
<td>19</td>
<td>13</td>
<td>17</td>
<td>47</td>
<td>20.18</td>
<td>251.3</td>
</tr>
<tr>
<td>5</td>
<td>551</td>
<td>1.5</td>
<td>1.9</td>
<td>8.9</td>
<td>52</td>
<td>28</td>
<td>6.4</td>
<td>19.67</td>
<td>251.8</td>
</tr>
<tr>
<td>6</td>
<td>560</td>
<td>1.5</td>
<td>3.2</td>
<td>14</td>
<td>22</td>
<td>14</td>
<td>45</td>
<td>19.96</td>
<td>252.7</td>
</tr>
<tr>
<td>7</td>
<td>569</td>
<td>1.5</td>
<td>19</td>
<td>75</td>
<td>28</td>
<td>16</td>
<td>45</td>
<td>20.10</td>
<td>256.1</td>
</tr>
</tbody>
</table>

**Table II:** Percentage of time for passing various water depths and fuel consumption

In the optimisation process, the vessel main particulars have been selected as shown in Table III.

### Main particulars of the vessels

<table>
<thead>
<tr>
<th></th>
<th>Roll-on/Roll-off vessel</th>
<th>Lift-on/Lift-off vessel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length o.a.</td>
<td>m</td>
<td>190</td>
</tr>
<tr>
<td>Length b.p.</td>
<td>m</td>
<td>186</td>
</tr>
<tr>
<td>Breadth moulded</td>
<td>m</td>
<td>25.5</td>
</tr>
<tr>
<td>Depth moulded</td>
<td>m</td>
<td>20.5</td>
</tr>
<tr>
<td>Draught service</td>
<td>m</td>
<td>7.0</td>
</tr>
<tr>
<td>Block coefficient at service draught</td>
<td></td>
<td>0.44</td>
</tr>
<tr>
<td>Displacement at service draught</td>
<td></td>
<td>14700</td>
</tr>
<tr>
<td>Deadweight at service draught</td>
<td>t</td>
<td>7400</td>
</tr>
<tr>
<td>Draught scantling</td>
<td>m</td>
<td>7.9</td>
</tr>
<tr>
<td>Displacement at scantling draught</td>
<td>t</td>
<td>18000</td>
</tr>
<tr>
<td>Deadweight at scantling draught</td>
<td>t</td>
<td>10700</td>
</tr>
<tr>
<td>Cargo capacity</td>
<td></td>
<td>2260 lane m, 1330 t (54 FEU) on W.Deck</td>
</tr>
</tbody>
</table>

**Table III:** Main particulars of the vessels
6. Main propulsion

The type of propulsion is different for each ship, in order to make a more comprehensive study. The Roll-on/Roll-off vessel is fitted with gas turbines and diesel engines, and the Lift-on/Lift-off ship with diesel engines only.

<table>
<thead>
<tr>
<th>Roll-on/Roll-off vessel</th>
<th>Lift-on/Lift-off vessel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main propulsion</td>
<td></td>
</tr>
<tr>
<td>2 ABB GT35 &amp; 16400 KW 4</td>
<td>6 Stork-Wärtsilä 16V38 &amp;</td>
</tr>
<tr>
<td>Ruston 20RK270 a 6875</td>
<td>10560 KW</td>
</tr>
<tr>
<td>KW1 Ruston 8RK215 with</td>
<td></td>
</tr>
<tr>
<td>ABB generator, 1245 KW,</td>
<td></td>
</tr>
<tr>
<td>60 Hz</td>
<td></td>
</tr>
<tr>
<td>Total output of main propulsion</td>
<td>60300 KW</td>
</tr>
<tr>
<td></td>
<td>63360 KW</td>
</tr>
</tbody>
</table>

| Propeller number         |                         |
| 2 CP + 1 Solid           | 2 CP                    |

| Service speed            |                         |
| 29 knots                 | 29 knots                |

**Table IV: Main propulsion of the vessels**

The main propulsion was optimised for a service speed of 29 knots at the respective service draughts for both type of vessels. High power of main propulsion and limited draught have been decisive factors for two and three propeller arrangements.

Generally, the gas turbine propulsion system has low efficiency when partly loaded (lower speed), and therefore the arrangement is combined with diesel engines. For passage at maximum speed, even in shallow water, the Roll-on/Roll-off vessel is driven at full machinery capacity coupled to three propellers. Two side propellers are used for lower speed when approaching the port and when passing shallow water areas. For Lift-on/Lift-off vessels, diesel engines have been chosen for their relatively lower fuel consumption. Higher weight of the diesel propulsion plant, compared with the gas turbine, was not a critical factor in this case.

7. Steel structure

In order to decrease weight of the ship's structure High Tensile Steel has been used to a large extent. It is obvious that steel structure of the Roll-on/Roll-off vessel weights more than Lift-on/Lift-off carrier, owing to the weight of strong fixed decks. Estimated weights are as follows:

- Steel structure weight of **Roll-on/Roll-off carrier** 6600 t
- Steel structure weight of **Lift-on/Lift-off carrier** (5350 t) with cassettes (860 t) 6210 t
As can be observed, the cellular vessel together with cassettes is lighter by about 400 t. Other advantages of this ship type are better stability performances due to a lower centre of gravity, and a generally simpler structure.

8. Vessel layout and cargo handling system

The Roll-on/Roll-off carrier, as shown in Figure 2, is fitted with three fixed decks. Access to the main deck and upper deck, which are for stowage of vehicles, is through a two-storey link-span. The weather deck is aimed for transport of containers and their handling to be done by shore cranes. Thus, loading and discharging of road vehicles may be simultaneously performed on/to two ro-ro decks. Containers may also be stowed on the weather deck, which requires parallel mooring of the ship to the quay. It is assume, that the link-spans will be part of the terminal investment in Gothenburg and Zeebrugge.

The Lift-on/Lift-off carrier, as in Figure 3, is divided into nine cellular holds, fitted with a guide system. Road vehicles are stowed on cassettes, and secured to them in the port terminal, prior to ship arrival. Loaded cassettes form cargo units, as shown in Figure 4, which are stowed in the cellular holds by shore cranes.

Figure 2: General arrangement of roll-on/roll-off carrier
This system eliminates stevedoring work on board, because the units are secured by cell guide structure for sea voyage. Two or three shore cranes can be engaged to load and discharge cassettes simultaneously; one in the aft part of the carrier, another at the front of the superstructure, and a third one in the forward part of the vessel, leaving a distance of about 30 m (two holds) between cranes for movement of the cassettes on the quay.
9. Economical evaluation and comparison

In order to estimate costs for a transported cargo unit, and to make a comparison between the two carriers, capital and operating costs have been calculated. The capital cost of a ship is always difficult to estimate, because it depends on shipyard, financial conditions, delivery time, etc. Cost of the steel structure has been calculated at 25 SEK/kg, and the cost of main propulsion plants and equipment have been estimated separately. The result is as below:

- Roll-on/Roll-off: 380 M SEK
- Lift-on/Lift-off: 375 M SEK

A comparison of trailer transport costs from the terminal gate in Gothenburg to the gate in Zeebrugge, depending on ship capacity utilisation, is shown in Figure 5.

![Figure 5: Trailer transport cost (on a 'break-even' basis)](image)

Freight of a trailer transported on road by Swedish carrier from Gothenburg to Belgium is on a level which corresponds to calculated break-even costs of sea transport of a similar cargo unit, if vessel capacity utilisation is about 50%. Any allowance for agency expenses are not added. It must be pointed out that sea transport might offer shorter transit time, as the average speed for a road system is 30-40 km/hr, on European high ways. Trailer transport costs are lower on the cellular ship, because this ship has a higher capacity and lower operating costs (lower fuel consumption).

However, owing to uncertainty of ship capital cost estimations, a scenario of various prices has been assumed for each vessel and trailer transport cost calcu-
lated, as shown in Figure 6 and Figure 7. The analysis has been carried out on the assumption that freight income is equal to total operating costs.

Figure 6: Trailer transport cost on roll-on/roll off vessel

Figure 7: Trailer transport cost on lift-on/lift-off vessel
9. Conclusions

The initial designs of Roll-on/Roll-off and Lift-on/Lift-off vessels have been used for comparison of ships' economic performance. The project aimed at similar capacity and the same trade, providing six sailings per week. Alternative main propulsion systems have been studied. Generally, the cellular carrier is lighter, even when the weight of cassettes is included, has a higher capacity, simpler construction, and consequently a lower investment cost.

Cargo handling time has been assumed to be four hours for both vessels, regardless of volume of cargo transported. This assumption was suggested by an existing shipping company, working to achieve an improvement in their conventional cargo handling system, by adding a double level of stern ramp, a new lashing system, etc. Such short time in port is realistic when the volume of handled cargo is about 80% of ship capacity, but this port time could be sufficient for a cellular carrier if three cranes were simultaneously engaged, each of them with a handling capacity of about 30 units/hour.

Generally, cargo handling systems still need improvements, in order to make shortsea shipping more attractive. Time at sea may be increased when port time is reduced. Consequently, ship speed could be lower, which would substantially decrease capital and operating costs.

Shallow water is a decisive factor for installed main engine power, and therefore optimisation of routes should be performed, especially for shortsea shipping with long coastal distances. Carefully analysed logistics might have an influence on ship technical performances, and much improve total economy of sea transport.

As can be seen, trailer transport by vessels is an attractive alternative. Even for low ship utilisation of about 50%, the costs for trailer transport by sea are competitive with road systems. The cellular carrier might be more attractive than the Roll-on/Roll-off alternative, until some dramatic development in horizontal cargo handling and cargo securing take place.

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*Gustavsson M.
*Röök J.
*Johansson H.

European Shortsea Shipping
# SEALYNX - PRESENTATION OF A NEW CONCEPT OF SHORTSEA BULK TRANSPORT SYSTEM

## By M. Svendsen

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European Shortsea Shipping
SEALYNX - PRESENTATION OF A NEW CONCEPT OF SHORTSEA BULK TRANSPORT SYSTEM

1 Introduction

The purpose of the paper is to describe and evaluate the economic rationale for an innovative new concept in ship design and shortsea operating mode - the bulk transport system by a barge-carrying catamaran "Sealynx". The design is primarily intended to meet the changing requirements in shortsea shipping industry for more efficient, secure and environmentally friendly bulk transport.

2 Major trends in the seaborne dry bulk trade within the Baltic Sea

The market for seaborne bulk transport in the Baltic is of such complexity that it is impossible to assess all aspects of the market in this paper. Also the difficulty of getting comparable commodity trade statistics imposes limitations to the study. Therefore, this part of the study concerning cargo movements in the Baltic, is especially focused on a few fundamental factors which exert strong influences on the Baltic shortsea shipping market.

2.1 The demand for dry bulk shipping within the Baltic Sea region

The European short sea trade totalled 774 mill. tons in 1994, of which 54% was non-fuel bulk\(^1\). The main dry bulk commodities within the Baltic region comprise mineral commodities, logs, primary metals and iron ore, coal and wood chips, fertilisers and grain. Four important factors largely influence the Baltic dry bulk shipping market:

- Growth and development of the Finnish and Swedish primary process industry (and particularly the wood- and paper industry, steel, mineral, fertiliser, chemical industries);
- Prospects for the use of energy coal in power plants in Finland, Sweden and Denmark;
- Economic development and export activities in the former Soviet republics of Russia, Estonia, Latvia and Lithuania which border on the Baltic Sea;
- Changes in the global regional balance of grain production and consumption.

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The industries around the Baltic Sea rely heavily on shortsea maritime transport and they have a pronounced need for serious and reliable bulk as well as general cargo transports to and from the continent. Since 1992 we have seen a rapid growth in cargo movements within the Baltic Sea. The Eastern Baltic republics are showing an upward trend in cargo turnover in their main bulk ports and at the same time Finnish and Swedish exports have been record high, partly due to a depreciation of currencies. The total Finnish seaborne trade increased from 58.9 mill. tons in 1991 to 74.3 mill. tons in 1994 (26%) and at the same time the import of raw materials increased by 23% from 15.5 mill. tons to 19.1 mill. tons. The total trade through Swedish ports increased from 99.1 mill. tons in 1991 to 113.7 mill. tons in 1994, and the import of dry bulk increased from 12.6 mill. tons to 17.3 mill. tons (37%).

Reliable statistic showing the recent trade in dry bulk commodities in the ports of the Eastern Baltic region are not available. However, individual port data collected by the Baltic Port Organisation (BPO 1992-93) as well as other Baltic port references indicate an upturn in shipping volumes. After a sharp decline in exports in 1990-91, following the democratic revolutions in Eastern Europe, the Eastern European countries are currently experiencing very high export growth. Russia's exports to the OECD area increased 20% in 1994, and the export volumes through Russian sea ports increased by 30% in 1994, of which fertilisers and metals are important product groups.

2.2 Structure of the shortsea dry bulk tonnage within the Baltic Sea region

With the prospect of increasing economic development in the eastern Baltic region, many of the principal Baltic dry bulk ports are anticipating an increase in trading activity. Several Nordic dry bulk ports are establishing the facilities and infrastructure to cater for additional tonnage. However it is recognised that there has not been much development on the short sea bulk tonnage, although evidence of strong upturns for shipping volumes of simpler bulk products as been recorded.

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4 OECD Economic Outlook 1992 and 1994


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A recent study\(^1\) concludes that ships used in this trade are of a standard type for conventional cargo handling, slow speed and high average age (see Figure 1 and Table I)

<table>
<thead>
<tr>
<th>Age (yrs)</th>
<th>0-4</th>
<th>5-9</th>
<th>10-14</th>
<th>15-19</th>
<th>20-24</th>
<th>25+</th>
<th>Total dwt</th>
</tr>
</thead>
<tbody>
<tr>
<td>LMIS</td>
<td>856,089</td>
<td>1,124,348</td>
<td>893,880</td>
<td>1,023,766</td>
<td>746,988</td>
<td>315,666</td>
<td>4,959,847</td>
</tr>
<tr>
<td>RusBaltic</td>
<td>37,472</td>
<td>154,491</td>
<td>121,753</td>
<td>105,604</td>
<td>182,573</td>
<td>249,523</td>
<td>851,416</td>
</tr>
<tr>
<td>Total Baltic</td>
<td>893,561</td>
<td>1,278,839</td>
<td>1,015,733</td>
<td>1,129,370</td>
<td>928,571</td>
<td>565,189</td>
<td>5,811,263</td>
</tr>
</tbody>
</table>

Table I: Deadweight and age profile of the Baltic shortsea dry bulk fleet, end 1993

The size distribution of the 5.8 million dwt under study is:

- 1000-3900 DWT, totalled 2.7 million Dwt among 1200 vessels;
- 4000-12000 DWT, totalled 3.2 million Dwt among 400 vessels.

Sealynx - Presentation of a New Concept of Shortsea Bulk Transport System

This average age of the fleet is about 14 years, but as much as 46% of the fleet is over 15 years. A continuous removal of vessels, particularly from the Russian fleet, is observed, but there is little newbuilding activity at current construction prices.¹

3 Introduction of a new concept of short sea bulk transport system - Sealynx

An increasing awareness of total cargo-handling economy combined with even stricter quality, safety and environmental requirements, will change the demand for bulk transport. In the future more emphasis will be given to the economics of total logistic chains, a topic that has received relatively little attention as regards dry bulk transport, in contrast to the vast literature related to containers and ro-ro systems.

The basic idea behind the Sealynx concept is to combine the idea of an inexpensive mobile bulk warehouse with an efficient use of the expensive propulsion segment, to obtain high frequency, efficient use of existing port facilities and a cargo lot size matching logistics requirements. The design idea is to use a semi-submersible cargo catamaran designed to carry a number of barges (floating containers) to and from coastal loading and discharging centres. The barge carrier should not enter ports, but sail with high frequency on fixed routes between assembly areas located outside the entrances of coastal or inland waterways ports. The barges are left for discharging or loading and are swopped with already loaded or unloaded units. The semi-submersible Sealynx serves as a docking platform for the transfer of the bulk containers (the barges).

Design tactics and methodology

The design phase is a challenging task in marine engineering. Especially when the challenge is to find a compromise between cargo capacity, speed, fullness and size for a none existent vessel, for which there is no familial comparison.

Modern ship design could be described as an industrial product development process based on the application of naval architecture and knowledge of hydrodynamics. Combine this with skill in marine engineering, spice it with creativity, add experience and the ability to meet a specific market demand, and you may have a ship adapted to fulfil the newest rules, regulations and requirements. Ultimately the process has to be carried out with a close look at costs and economics in the hope of future profit.

¹Hall Erik, Åland Shipping & Commerce 6/95 (original: Morskoj Flot 7-8, 1995)
Section II - Ships and Terminals

The design process is an iterative one, where the designs are checked against the market requirements and adjustments are made until the final design emerges. The Sealynx' dimensions, hull shape, powering and general layout have been changed many times during this process. The final design is illustrated in figure 2. However, the basic concept is still much the same as when the first vague idea of using a semi-submersible catamaran for barge transport took shape.

Figure 2: The Sealynx barge carrier loaded with five 3,000 dwt barges

4 Feasibility study of the Sealynx-system in industrial shipping within the Baltic Sea

As a pilot case the Sealynx bulk transport system has been tested on the requirements of the Nordic cement and lime industry. The primary bulk shipping activities of the industry involve the lifting of more than 3 mill. tons of bulk material among 23 Baltic ports, corresponding to some 861 mill. ton miles.

4.1 Restrictions of ship's physical dimensions in ports and fairways

One of the great problems in the Baltic Sea is insufficient water depths, not only in the ports themselves, but also along the coastal line. Although the vessel design will eliminate draught constraints in many fairways and ports, the wide beam of the Sealynx catamaran and the required docking draught put restrictions

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on the barge carriers' port access through narrow and shallow waterways. According to preliminary design studies of the barge carrier, the docking operations requires a minimum draught of 16m. The transit draught of Sealynx is about 6.7m fully loaded with 15,000 tonnes cargo plus the weight of the barges.

The collected port data indicated water depths at the anchorage places sufficient for barge docking operations usually within 5 miles of the port facilities. Hence, it is assumed that finding a docking place in the approach channels or in the port basins of the actual destinations will not be a significant bottleneck. In some shallow ports included in the study, the maximum allowed berthing draught is 5 metres. This limitation has been taken into consideration in the barge design.

4.2 Restrictions due to environmental conditions

The principles applied to the design of a shipping system for the Baltic Sea are generally the same as those for other shortsea regions. However, ice and low temperatures add a further and crucial factor. This is discussed at length in the main studies, but will not be dwelled upon here.¹ ²

4.3 Determination of the parcel-size

By analysing the structure of the transport demand it has been possible to create a picture of the parcel-size restrictions. Focusing on the ports, the first step involves the analysis of the stock ratio and the maximum acceptable stock size in the discharging port. After designating parcel-size categories, throughputs are summed in the appropriate categories to give a breakdown by parcel-size (Figure 3.). The result of this analysis shows that 88 % of the shipments should be delivered in parcels under 4200 tonnes and the majority of this is in the range of 4000-4200 tons per consignment. The rest should be shipped in consignments of maximum 6000 tonnes.

Given the very substantial economies of scale in seaborne bulk haulage and the generally proportional increase in handling costs with scale, it might appear that the optimal vessel size is the largest that can be used on a given trade. However, the more time the ship spends on loading and discharging the less will a relative change in cargo capacity influence the relative change of transport capacity. This is one of the reasons why the optimum capacity is relatively small on short sailing routes as within the Baltic Sea. This should outweigh economic benefits of large consignments. In this respect one needs to consider technical limitations of design

¹"Technological and cost economical considerations in design of Sealynx - seafreight system by cargo catamaran", Magnar Svendsen's final thesis for in the MSM-Programme: MBA in Shipping, NHH, NTU May 1995.

and operational aspects of the total transport system. The existence of technical limitations and the problem of non-matching parcel sizes make the problem very complex. It will be very difficult to have barges of different sizes, particularly with respect to the repositioning of empty barges. The overall assessment is, therefore that the system requires uniform sizes of barges, and it is our estimate that a barge size of 3000 dwt will match the demand and the operational requirements best.

4.4 Preliminary determination of barge and barge carrier dimensions and dead-weight

The major factors in the choice of physical dimensions for the barge carriers and the barges are the technical maritime restrictions, the transport volume and the parcel size demand.

The preliminary design idea, sketches and control calculations indicate a maximum dead-weight capacity of Sealynx of about 18000 tonnes. This size is determined by two main factors, the need to navigate in narrow coastal waters and the maximum permissible breadth due to fairway restrictions, which is about 43 meters.

Due to shallow water constraints in many of the docking stations in the planned traffic route, the Sealynx submerged draught is designed not to exceed 16m during docking. The length has been increased to get a length/breadth ratio according to standard rules of ship design.

A barge size of 3000 dwt gives a good match with the physical dimensions of the barge carrier. Furthermore, the barges can be given length/breadth/depth ratios that permits a normal design shape for the barges, both in relation to stability and seagoing capabilities, as well as for draught limitations in ports.
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The main particulars for the barge carriers, as illustrated in Figure 1, are as follows:

- Dwt cargo capacity 17900 tonnes
- Transit draught max. 6.7 metre
- Draught submerged = 15.75 metre
- Submerged draught main-deck = abt. 5.75 (sufficient for barge docking)
- \( L_{oa} \) = abt. 137 metre, \( L_{pp} \) = 129 metre, breadth moulded = max. 43.2 metre
- Baltic ice class min. ICE - 1 C
- Transit service speed 15-16 knots
- Diesel-electric propulsion with two propellers
- Bow and stern thrusters sufficient for good manoeuvring and positioning keeping
- Ballast system that permits efficient and fast docking operations

The barge design will be side-ramp deck-load type with cargo coaming on deck. Volume space within the coamings enough to permit loading of 3000 m³ cargo, as showed in Figure 4, and with the following main dimensions and principal specifications.

![Figure 4](image)

- Dwt cargo capacity 3000 tonnes
- Draught fully loaded 5 metre
- \( L_{oa} \) = 41.5 metre, breadth moulded 20 metre
- Flat bottom shape suitable for docking and storing on barge carrier's main deck
- Baltic ice class ICE - 1

4.5 The Sealynx barge-carrier and barge-fleet size problem for liner operations

In this section the problem of minimising the number of barges and barge-carriers required to transport the given quantity of bulk cargoes in a short sea liner system
Section II - Ships and Terminals

within the Baltic Sea is considered. The fleet size planning is a key issue in the design of a transportation system. This strategic decision is aimed at determining how many barges to acquire in order to satisfy the demand requirements of a set of ports through which the barges must be routed and scheduled over an extended planning horizon. To determine which is more attractive, a barge-carrier system or conventional ships, the influence of the number of barge-carriers and barges in the system must be realistically measured.

With a barge size of 3000 dwt and a breadth restriction of 43m for the barge carrier, the maximum number of barges to be carried is 5. With 23 ports with a varying demand combined with the problem of repositioning of empty containers, it is very difficult to find a solution to the optimum size of the system (i.e. the number of barge-carriers and barges). No standard linear programming model will be able to handle all parameters of the problem. We have been using a spreadsheet model and by manual adjustments, we have tried to optimize the problem. The problem is divided in three:

1. Design a route network and allocate demands to these routes;
2. Allocate frequencies to the given routes so that all demands are fulfilled;
3. Test of the possible route to obtain the required capacity for the transportation of the given bulk cargoes, as well as the allocation of empty barges.

The following constraints are taken into consideration:

- The utilisation problem is to allocate regularly a number of barges to the system so that the total time should be minimised and all demands have to be fulfilled, with the following assumptions:
  - The network of ports congregated into seven regions to be served is as shown in the map in Figure 5;
  - The barge-carrier follows the same route, i.e., the same sequence of port visits during the planning horizon of one year;
  - It may not be necessary to visit all the ports, if there is no cargo units available at a port;
  - The cargo capacity of one barge is 3000 tonnes and the barge carrier capacity is five barges (15000 tonnes);
  - The speed of the barge carrier is fixed to 15 knots and the time for connection and disconnection of barges is fixed at 9 hours;
  - The maximum distance between docking place and port is 5 nautical miles;
  - The average total time for feeding the barges to the port, cargo handling time and time for feeding of barges out to the docking stations is fixed at 36 hours.

The network, from which the routes and regions are chosen, consists of 23 ports, and the network of ports is for convenience divided into six regions to be served as indicated on the map in Figure 5. The barge carrier will follow the same route, i.e. the same sequence of ports is kept throughout the year, but some ports may be skipped if no cargo units are available or required. The centre of the network is the island of Gotland with the two ports Storungs and Slite. The network can
further be divided into two main regions, the lower Baltic ports and the Northern Baltic ports.

In this system Gotland will be visited two times per round-trip. The important traffic between Finland and Estonia can be managed as a separate round-trip, which is important for the allocation of excess capacity of barges from one port to another.

The routing system is divided into eight legs and the total distance from the first leg to the last one is 1455 nautical miles, as can be seen from the Table II. The barge-carrier can manage one round-trip per week, so yearly demand can be divided into weekly programmes to estimate the required capacity.

Based on data for the demand for bulk transportation capacity, Table III shows the yearly demand in terms of number of required barges. The next problem is to decide on frequency. Assuming that cargo is available at a uniform rate at each port over the entire time-period, the number of barges required every week for every link is given in Table IV.

The logistical requirements as given in Table III and IV can be served by a system of two Sealynx barge carriers and 30-32 barges as summarized in Table V.

The results of changes in speed is not simulated in this case. On short routes, as in our case, the relative improvement in total performance by increasing the cruising speed is of minor importance. In the basic calculations the cruising speed is fifteen knots and the round-trip is 1455 Nm, which gives a total sea time of four days per round-trip. The time used for the docking and undocking operations
Section II - Ships and Terminals

### Table II: Time used for the round-trip

<table>
<thead>
<tr>
<th>From region</th>
<th>To region</th>
<th>Leg</th>
<th>Average haul (nm)</th>
<th>Ultimo round-trip</th>
<th>Hours/days port</th>
<th>Days sea</th>
<th>Days/round-trip</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>1</td>
<td>106</td>
<td>106</td>
<td>9</td>
<td>0.3</td>
<td>3.0</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>2</td>
<td>348</td>
<td>454</td>
<td>9</td>
<td>1.0</td>
<td>4.0</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>3</td>
<td>295</td>
<td>749</td>
<td>9</td>
<td>0.8</td>
<td>7.0</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>4</td>
<td>170</td>
<td>919</td>
<td>9</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>5</td>
<td>5</td>
<td>215</td>
<td>1134</td>
<td>9</td>
<td>0.6</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>6</td>
<td>6</td>
<td>53</td>
<td>1187</td>
<td>9</td>
<td>0.1</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>5</td>
<td>7</td>
<td>53</td>
<td>1240</td>
<td>9</td>
<td>0.1</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>8</td>
<td>215</td>
<td>1455</td>
<td>9</td>
<td>0.6</td>
<td></td>
</tr>
</tbody>
</table>

### Table III: Allocated demands measured in number of barges (3000 tonnes)

<table>
<thead>
<tr>
<th>Region to</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>from</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
<td>346</td>
</tr>
<tr>
<td>2</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
<td>100</td>
</tr>
<tr>
<td>3</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
<td>20</td>
</tr>
<tr>
<td>4</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
<td>100</td>
</tr>
<tr>
<td>5</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
<td>177</td>
</tr>
<tr>
<td>6</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
<td>275</td>
</tr>
<tr>
<td>Total</td>
<td>130</td>
<td>243</td>
<td>132</td>
<td>72</td>
<td>374</td>
<td>67</td>
<td>1018</td>
</tr>
</tbody>
</table>

### Table V: The Sealynx barge carrier concept

is three days per round-trip. By increasing the speed for example to twenty knots the sea-time decreases by one day, which is equal to eight round-trips more per year. However, the system can utilise higher cruising speed only within the con-
strains of the minimum time for the operation of the barges in the ports. At the utmost the amount of barges could be decreased by 1-3 barges. On the other hand there is also other requirements to be considered. Increasing the cruising speed is expensive due to the physical laws of propulsion, according to which the power requirements rise sharply with the cruising speed. In addition to the investment in bigger engines, this causes higher fuel consumption.

5 Cost economical considerations in design of Sealynx

In our study we have tried to estimate all the relevant cost elements:

- Building costs (design and construction costs);
- Capital costs;
- Operating and voyage costs;
- Bulkhandling costs at vessel- and port interface.

5.1 Construction costs

The Sealynx barge-carrier is a new ship type that involves a certain degree of new technology. Therefore there is a greater uncertainty regarding calculations of building and capital costs than when dealing with more conventional vessels.

First the construction costs are calculated by empirical methods for thereafter to be compared with other and similar newbuilding projects. In addition the costs are checked by a rough item by item calculation. The prices are to be regarded as first indications and therefore the total price could be changed if more detailed negotiations were to be undertaken.
The final building cost estimates are presented in Table VI, and the numbers are adjusted for cost savings as a result of serial ship building.

<table>
<thead>
<tr>
<th>Vessel</th>
<th>Price (1,000 US$)</th>
<th>Number</th>
<th>Total price (1,000 US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barge carrier</td>
<td>26,000</td>
<td>2</td>
<td>52,000</td>
</tr>
<tr>
<td>Barge</td>
<td>1,100</td>
<td>30</td>
<td>33,000</td>
</tr>
<tr>
<td>Total investment</td>
<td></td>
<td></td>
<td>85,000</td>
</tr>
</tbody>
</table>

**Table VI: Construction costs**

Even though the revolutionary Sealynx design makes it a little difficult to draw direct lines of comparison based on dimensions, measurements and weights alone, it still seems rational to check the viability of the estimated building costs by looking closely at newbuilding prices for other cargo ships, and trying to make a comparison with these ships. **Figure 6** indicates the differences in building costs based on data from a main broker. The prices refer to the situation as per the first quarter of 1996.

![Figure 6: The transport system selected for the analysis](image)

The estimate of 26 mill. $ for Sealynx places it on level with a 10% larger tanker or container vessel, which seems reasonable.
5.2 Operating costs

In the operation of ships the manning costs represent a considerable share of the total operating cost of a vessel. These costs will be dependent on flag, crewing policy, mandatory number of positions on the vessel etc. The manning cost for the Sealynx system are based on Finnish crewing and flag.

After manning, repair and maintenance is the second important cost component. The annual expenses attributed to repairs and maintenance are more difficult to evaluate and quantify. Class and certificates are also a considerable item of expenditure.

The third major cost component of operating costs is insurance. There are many risks involved in shipping, not only from the "perils of the sea" but also other liabilities such as damage, pollution, civil commotion, etc., for which the shipowner will seek cover by insurance agreements.

Administration costs in operation of the Sealynx fleet will also require its share of the total operational costs. The estimated yearly costs are assumed to cover wages and social cost of three fully employed workers, including travelling and overheads connected to operation of the Sealynx vessels.

The total operating costs for the entire Sealynx fleet, consisting of two barge carriers and 30 barges, is estimated to: US$ 5,380,000 a year, and correspondingly $15,040 per day as showed in Table VII.

5.3 Voyage costs

Voyage costs are all costs incurred by the actual trips of the vessel and mainly include the cost of fuel, port and fairway charges and other service charges.

Fuel costs are normally the main variable cost component faced by the shipowner. As a result of the trade pattern of Sealynx, with short sea voyages and frequent ballast/deballasting operations, a diesel-electric power station is chosen to handle the power requirement. Based on a diesel-electric power station consisting of 4 * 3000kW = 12000kW diesel engines, the following power profile for the Sealynx barge carrier is computed as illustrated in Figure 7.

Total fuel consumption per round-trip is calculated to 258 tons gasoil which is equal to 51600 USD per round-trip based on a price of gasoil of 200 $ per ton as per March 1996. The yearly fuel costs for two barge-carriers is estimated to 5,366,400 $, which is equal to 1,76 $ per cargo ton.

Port charges represent a major component in voyage costs and include a wide range of fees levied against the vessel for the use of the port and fairway. Charging systems vary considerably from one country to the other and even from one port to the other, but they are mainly of two types - harbour dues and fairway dues. Harbour dues are levied on the vessel for the general use of port facilities,
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Table a

<table>
<thead>
<tr>
<th>Sealynx carrier</th>
<th>Day</th>
<th>Year</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crew costs</td>
<td>2,793</td>
<td>1,000,000</td>
<td>Finnish manning</td>
</tr>
<tr>
<td>Provision, storage &amp; lub. oil</td>
<td>140</td>
<td>50,000</td>
<td></td>
</tr>
<tr>
<td>R&amp;M, incl spare parts</td>
<td>908</td>
<td>325,000</td>
<td>200,000 US$ every second year</td>
</tr>
<tr>
<td>Docking</td>
<td>279</td>
<td>100,000</td>
<td>Excl. main class every fifth year</td>
</tr>
<tr>
<td>Class &amp; survey costs</td>
<td>28</td>
<td>10,000</td>
<td>Hull &amp; machinery + P&amp;I</td>
</tr>
<tr>
<td>Insurance</td>
<td>503</td>
<td>180,000</td>
<td>Estimate same for 1 as for 2 ships</td>
</tr>
<tr>
<td>Administration</td>
<td>698</td>
<td>250,000</td>
<td></td>
</tr>
<tr>
<td><strong>US$</strong></td>
<td>5,349</td>
<td>1,915,000</td>
<td>Each barge carrier</td>
</tr>
<tr>
<td>* 2 = US$</td>
<td></td>
<td></td>
<td>For both barge carriers</td>
</tr>
</tbody>
</table>

Table b

<table>
<thead>
<tr>
<th>Sealyynx barges</th>
<th>Day</th>
<th>Year</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>R&amp;R, incl spare parts</td>
<td>30,000</td>
<td>5,000</td>
<td>Every third year (30,000)</td>
</tr>
<tr>
<td>Lub. oil &amp; fuel</td>
<td>10,000</td>
<td>5,000</td>
<td></td>
</tr>
<tr>
<td>Docking</td>
<td>10,000</td>
<td>5,000</td>
<td></td>
</tr>
<tr>
<td>Class &amp; survy costs</td>
<td>140</td>
<td>50,000</td>
<td>Sea comments with reference</td>
</tr>
<tr>
<td>Insurance</td>
<td>28</td>
<td>10,000</td>
<td>Hull &amp; Machinery</td>
</tr>
<tr>
<td>Administration</td>
<td>168</td>
<td>60,000</td>
<td>Incl. in budget estimate above</td>
</tr>
<tr>
<td><strong>US$</strong></td>
<td>168</td>
<td>60,000</td>
<td>Each barge</td>
</tr>
<tr>
<td>* 30 = US$</td>
<td>5040</td>
<td>1,800,000</td>
<td>Total for all 30 barges</td>
</tr>
</tbody>
</table>

Table c

| Total operating cost budget US$ | 14,040 | 5,380,000 | For the entire Sealynx fleet                  |

Table VII

including wharfage dues and the provision of the basic port. The barge-carrier will not enter ports and consequently it has been assumed for the Finnish ports, that no fairway dues is paid for the barge-carrier, only for the barges.

Service charges cover various services that the vessel uses in the port, including pilotage, towage and agency services. Normally these costs are a minor part of the total port costs. In the Sealynx case the expenses for tugboat assistance for the barges between the docking place and the port, will represent a major component in voyage costs (see Table VII.). The concept is based on a system where the barge-carrier is not sailing into ports, but arrives outside of the port area to load and unload barges at a suitable anchoring place. It is assumed that one tugboat is required for the towing of one barge and two tugboats are needed for the towing of two to four barges. Since the system will use tugboats on a large scale, it is assumed that long term contracts will give tugboats costs at 75% of
Sealynx - Presentation of a New Concept of Shortsea Bulk Transport System

![Sealynx Power Load Distribution](image)

**Figure 7: Sealynx power Load distribution**

the current market rates.

For the purpose of this study, representative data is gathered from port agents in the appropriate regions. All costs have been converted to $ and Table VIII summarizes the port costs.

<table>
<thead>
<tr>
<th>Port costs</th>
<th>US$</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harbour dues</td>
<td>838,444</td>
<td>14</td>
</tr>
<tr>
<td>Light and fairway dues</td>
<td>959,529</td>
<td>16</td>
</tr>
<tr>
<td>Pilotage</td>
<td>319,300</td>
<td>5</td>
</tr>
<tr>
<td>Boatmen</td>
<td>164,240</td>
<td>3</td>
</tr>
<tr>
<td>Agency</td>
<td>968,227</td>
<td>16</td>
</tr>
<tr>
<td>Tug expenses</td>
<td>2,677,028</td>
<td>45</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>5,926,769</td>
<td>100</td>
</tr>
</tbody>
</table>

**Table VIII: Sealynx yearly port costs**
Section II - Ships and Terminals

5.4 Economic evaluation of Sealynx

The standard way of measuring the profitability of an investment project is to calculate the net present value of the cashflow. To do so one needs to know the entire flow of income and costs and one needs to specify an appropriate discount factor. We have used the equity capital model to estimate the profitability of the project, so the appropriate discount factor should reflect the alternative cost of equity.

Assuming rational capital markets, the discount factor (R) can be found as the expected return on equity:

\[ R = RF + \beta (RM - RF) \]

where RF is equal to the risk free interest rate. RM is the estimated average market return on investments and \( \beta \) is the beta of the project measuring how closely correlated the project is to the average portfolio. By assuming RF to be 8% based on the Finnish Government Bond rate, RM to be 15% reflecting average stock return on the Helsinki Stock Exchange and the beta of the project to be 1, the discount factor will be 15% for the equity cashflow.

One problem is that we do not know the income levels, only the cost components. We have, therefore, calculated the total income necessary to give the project a net present value of 0, assuming a 60% loan to be paid in equal installments over 12 years to a fixed 7% interest rate.

The result is given in Table IX, where the cost figures refer to the first year of operation.

<table>
<thead>
<tr>
<th></th>
<th>1,000 US$</th>
<th>US$ per ton</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total required income (NPV = 0)</td>
<td>21,651</td>
<td>7.98</td>
<td>100.0%</td>
</tr>
<tr>
<td>Fuel cost per year</td>
<td>2,580</td>
<td>0.85</td>
<td>10.6%</td>
</tr>
<tr>
<td>Other voyage costs per year</td>
<td>5,927</td>
<td>1.95</td>
<td>24.4%</td>
</tr>
<tr>
<td>Operational costs per year</td>
<td>5,428</td>
<td>1.78</td>
<td>22.0%</td>
</tr>
<tr>
<td>Implicit capital costs per year</td>
<td>7,716</td>
<td>3.40</td>
<td>43.0%</td>
</tr>
</tbody>
</table>

Table IX: Estimate cost structure of Sealynx - 15% return on equity

The break-even-analysis determines the rate that must be earned in order to cover operating costs and the required 15% return on equity, and is rounded upwards to 8$ per ton.
5.5 Cargo handling costs and port interface

The use of barges equipped with a sideramp and wheel-loaders for the loading and discharging operations are the basic elements in barge "Ro-Ro" bulk handling, and such barges are today in use by Finnish and Swedish push-barge operators within the Baltic Sea. These barges offers operational flexibility and versatility and can serve rather primitive loading and unloading ports around the Baltic Sea.

In addition to lower cargo handling costs, the barge system will also lower the total terminal costs, as they and can be used for floating storage and thus lower the storage costs. It is difficult to estimate the implicit cost savings involved, but it seems reasonable to assume that the Sealynx system could give cost savings of order of magnitude 3 $/ton, which is not included in the figures in Table IX.

6 Economic feasibility of the Sealynx transport system in relation to the market assessment

When comparing traditional shipping methods with new technological innovations, it becomes essential for a true analytic argumentation to choose an approach which reflects the results of the comparison under different costs conditions. Discussions of economic feasibility solely based on comparison of shipping costs of same size bulk ships as Sealynx barge-carrier would lead to misconception. Therefore the costs comparing of the Sealynx concept has three different approaches. First it focuses on the possible time charter rate and bunker costs in comparison to current rate levels within the Baltic Sea. Secondly, the Sealynx seafreight costs for some specific trades in the bulk cargo system are studied by comparing the rates with current freight rates paid in the market. The influence of port handling costs for the two different bulk shipping methods is also considered in the same comparisons.

For the purpose of the study one can compare the Sealynx transport solution with operation of conventional 3000 tons bulk vessels for solving of the transport task in the case study.

Assuming that a vessel of 3000 tonnes cargo capacity makes in average 75 voyages per year in a typical Baltic Sea trading pattern, based on the assumption that each voyage takes five days including loading and unloading. Thus the yearly capacity per vessel will be 225.000 tonnes, which corresponds to 14 vessels in the bulk trade in relation to the cargo volume focused in this study. The current time charter rate for such vessels built 1990-95, with a transit speed of abt. 12-13 knots (1700 kW) is around 4200 USD per day. Taking into account that 14 vessels of each 3000 tonnes cargo capacity are needed, it adds up to a daily total time charter rate of 58.800 USD (see Table X).

---

1 Interview with broker J. Arppe, Oy Finnshipping Ltd, Helsinki.
Table X: Comparison of time charter rates and fuel costs (exc. port expenses)

The fuel consumption is based on a vessel type with engine power of 1700 kW and hence daily fuel consumption of 7.5 tonnes. The Sealynx time charter rate is based on the capital and operational costs as well as the tugboat costs in the respective ports. This is of course a static approach at current market level. It gives priority to the Sealynx alternative - a conclusion that would be valid if the freight market remained constant all the time and all other assumptions of the future become true.

A second approach showed in Table XI, compares the Sealynx costs with current freight rates paid within the bulk trade evaluated in this study by use of an calculated average market rate. In this approach the Sealynx system looks somewhat more expensive than the current market rates, but that is before the savings of reduced cargo handling and terminal costs are brought into consideration. So also here, the Sealynx solution seems to be most favourable.

Table XI

The comparison of economic feasibility between the Sealynx system and other available systems is of course difficult, as the systems are not directly comparable. On the other hand these methods give an indication of the possibilities of the Sealynx system.
7 Alternative utilisation of the Sealynx vessel

Although the Sealynx vessel was conceived as a result of a search for new methods to increase the efficiency of shortsea bulk transport, other ideas have emerged for application of the concept as a spin-off effect of this study. Some of the known alternatives can be mentioned:

- Short Sea trade areas where combined barge/barge carrier transport of dry bulk cargoes is in similar or related trade patterns to the bulk trade which is the focus of this study. For example the Mediterranean could very well be an alternative to the Baltic Sea trade area for the purpose of a broader evaluation of possible utilisation of the Sealynx system design.

- Overseas transport of barges using Sealynx vessels could perhaps be a good alternative to the LASH type of barge carriers, in deep sea trade between ports and mouths of rivers. This alternative should also be considered in light of debate in recent years among maritime experts, and the many proposals of increasing the emphasis on development of inland waterways in order to increase exploitation of the freight opportunities of rivers and canals. This is applicable not only to European shipping, but also to other parts of the world, including the Far East rivers, and particularly China.

- Transport of liquid cargoes, such as chemicals, using specially-made tanker barges. For this particular alternative, where the hull of chemical tankers are divided into a large number of tanks, partly to cater for the shipment of different chemicals, the Sealynx alternative could be rather interesting for several reasons. There is an improvement in security against pollution in case of leakage caused by collision or grounding, and also improved flexibility and the possibility of cost savings.

- Improved type and new generation of semi-submersible heavy weight deck-cargo vessel. At first glance this may seems to be the most straightforward and obvious alternative. Perhaps it also really is. The market for sea transport of heavy weight constructions and modules is very visible, not least in Northern European waters such as in the off-shore oil industry. Even if the market segment is limited, it is at the same time clearly defined with few operators.

By taking Sealynx’s attractive stability characteristics and plentiful reserve buoyancy, the excellent manoeuvring capability of the vessel, and the large deck area with a huge beam in relation to the deck length, into account when comparing with the standard of the greater part of the vessels servicing this market at the present, technically it is rational to believe in the Sealynx design if entering this market segment. But of course, it is also a question of freight rates, obtainable income volume and market opportunities in relation to the investment.
The Sealynx container liner. From the very conception of the Sealynx idea, and at an early stage in this study, the expression floating containers - floating warehouses was utilised. The concept behind the Sealynx Transport System as a whole has been explained with reference to liner shipping and container transport. So since the relationship between the fundamental idea of the Sealynx concept and container liner shipping seems present already, it could be of interest to look at the Sealynx carriers capability and possibilities as a container liner. Based on this, a few calculations have been carried out:

Container capacity - a calculation based on the physical dimensions of TEUs - Twenty-foot Equivalent Unit - containers gives the following result: The TEU measures of 20 * 8 * 8 foot requires a net volume demand for each container of 35 m³ or equivalent 14.5 m² deck space per container. The deck of the project vessel offers space of stowing 270 TEUs on deck. The stowing height and number of containers in tiers seems to be a practical rather than a stability matter. A stability check through a calculation indicates that the stability is good enough for stowing the containers in five tiers on deck. A glance at existing container vessels supports the fact that stowing of containers in up to four tiers height above deck is customary, and vessels carrying five tiers of TEUs on top of the hatch covers also exist. Hence one can conclude that the Sealynx carriers container vol. cap. is 270 * 5 = 1350 TEUs. A comparison with existing container ships indicates that the container capacity of Sealynx places her at the upper end of medium sized container vessels. The project vessel's Lw, Dwt and GT also seem to fit relatively in comparison to other container vessels with approximately the same container capacity. This observation should at least indicate that the building costs may not differ too much from existing container vessels in about the same size range.

Another aspect of the Sealynx design as a container liner is the shore terminal aspect. A short evaluation of these questions rapidly discovers both an advantage as well as a drawback. An advantage could be the possibility of fast loading and unloading of containers - by RoRo and purpose built vehicles for the task. The project vessel can easily be kept steady - and in same vertical position along quay and in relation to drive ramps during loading and unloading of containers. Further it is difficult to see any reason for stowing containers in cargo holds on ships except for the design solution of the traditional cargo and container vessels, and in relation to the historical background of shipping. One can also observe that today's container liners store and transport between 30 and 50% of their container cargo on deck or on top of hatch covers.

Technical advantages of the vessel design

The Sealynx vessel are designed for the loading and unloading of heavy cargoes (barges) over the ship's sides on and off the main deck, in a docking operation where the vessel is in a semi-submerged position and the main deck is submerged several meters below the surface.
Sealynx - Presentation of a New Concept of Shortsea Bulk Transport System

Proportionally, the Sealynx design seems to offer higher freeboard and less draft loaded during transit than the existing semi-submersible heavy load vessels. Also the draft when submerged is less than that of other semi-submersibles. Minimum draft is a matter of necessity for the purpose of the Sealynx vessel and the sketched trade pattern.

The relatively high stern castle above the main deck, below the wheel house, combined with a corresponding high forecastle included in the vessel's design flotational structure, gives a better weight and buoyancy distribution for the Sealynx vessel in submerged position, compared to other vessels. Therefore the ship will have a more secure and steady longitudinal trim characteristic. For the same reasons, and according to the basic stability qualities of catamaran vessel design in general, also the transverse stability of Sealynx are better than for the mono hull vessels, both submerged and in transit.

It would seem that there will be a larger part of the Sealynx's hull remaining above the water when the vessel is semi-submerged (lasting freeboard) compared with the other vessels. This gives better reserve and redundancy buoyancy for the Sealynx design.

The twin hull design offers an enlarged transversal moment of inertia due to the Steiner link, which gives a large metacentric height. The twin hull is therefore a much more stable design for a semi-submersible vessel built to carry heavy deck loads. The transversal stability plays an important role in the safety during docking operations as well as in transit mode with a heavy deck load onboard.

The twin hull design also allows for a large, strong main deck area of some 4400m\(^2\), which adds considerably to the range of opportunities for utilisation of the vessel.

The hull design combined with the planned ballast tank division offers several valuable advantages in terms of increased flotation safety and damage stability in the event of grounding or collision. The design also offers the possibility of high built-in fire safety and maximum security against the spread of fire. The location of the machinery plant and main power station on the main deck and with no bunkers tanks below the main deck contributes greatly to diminishing the risk of environmental pollution as result of leakage caused by grounding, collision or other hazard.

Improved manoeuvrability ratio gained by the large distance between the rudder/propeller installations in each hull should also be taken into account.

8 Prospects

Short sea bulk shipping is not static, but continually undergoes a process of evolution, in order to keep pace with changes in basic factors such as growth and the relative importance of trades, environment, new technology, new regulations,
etc. These changes create new business opportunities at different levels in the service chain of short sea bulk shipping.

The potential for improving traditional dry bulk systems has neared the point of exhaustion. Further progress of any magnitude in short sea dry bulk shipping will have to incorporate new thinking and innovation in the rationalisation of ship/port functions. With the development of industry in new areas of the Baltic Sea presently without modern ports, the number of smaller ports will increase. Most of these ports will handle substantially lower volumes than the major bulk ports around the Baltic Sea. In order to keep low freight costs for these modest volumes, it will be imperative to employ shipping systems with simple ship/port functions and small requirements of port investments. The Sealynx bulk transport concept is an obvious answer to such requirements, and a natural basis for further evolution in the short sea dry bulk sector. Most important for introduction of the new shipping system would be that it serve the interest of major cargo owners. Because of the ability to reach ports of all sizes economically, added to the high frequency of the barge-carrier, the Sealynx concept should be particularly suited for distributing raw materials in a industrial shipping system.

In conclusion the Sealynx system holds important merits and opportunities for further improvements in short sea dry bulk shipping, and should be given serious attention by everybody dependent on, or concerned with, future developments in short sea dry bulk shipping.
# A NEW CONCEPT FOR CONTAINER RELOADING ON INLAND WATERWAYS VESSELS

By B. Zigic and V. Renner

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A NEW CONCEPT FOR CONTAINER RELOADING ON INLAND WATERWAYS VESSELS

Summary

The paper deals with one new concept for deep-sea container terminals with a considerable share of inland waterway feeder service, respectively inland waterway container terminal. It contains the brief description of technical ideas and operational parameters and compares them with conventional solutions with container bridges as key components of the reloading system. The kernel point is the consideration of applicability of such and similar ship reloading systems on river Rhine concerning various points of view and the definition of conditions where and when the system could be applied successfully.

1 Introduction

The recent trends of building large deep sea container vessels with capacity of 4000 to 6000 TEU, as well as the design development of even bigger (up to 8000 TEU) or moderate size super fast units (2000 TEU, 40 knots) will probably cause the following consequences:

- Reducing the number of main hub container terminals;
- Increasing demands for terminal efficiency.

That means that following the development of new concepts for future container transport systems {1}, also the feeder service has to be improved. Considering the fact that many of the existing main hub terminals in Europe are located on the estuaries of navigable rivers (Rotterdam, Hamburg, Antwerpen, Bremen/Bremerhaven, Le Havre), a substantial role in waterborne feeder service has to be assigned to inland navigation. In order to match the overall future concept in container transportation (that is the always shorter time of door-to-door delivery at lower cost), the improvements of feeder service have to be looked at in those areas where the weak points of waterborne mode are, simultaneously keeping in mind the tiny equilibrium of advantages and disadvantages that makes this mode still competitive.

It is well known that waterborne transport on the routes where land mode alternatives exist (inland navigation and in many cases short sea shipping) is most economical and ecological at low speeds {10}. Increasing the speed in technically feasible limits and introducing highly sophisticated reloading systems bear the danger of loosing some of these advantages {1} - at least low transport cost.
A new Concept for Container Reloading on Inland Waterways Vessels

The leading barging operators on the Rhine have identified the extended times for barge reloading activities in main hub ports, particularly the Port of Rotterdam, as one of the main difficulties. On average, barges stay 36 hours in the port \(4\). On the other side, the transit time between Rotterdam and e.g. Mannheim (about 580 km upstream) is only 30 hours. Not only the reloading times represent a limiting factor for further development of this transport sector. At the moment, the reloading action and terminal services make 3/4 of the overall transport costs in inland navigation mode on the Rhine \(5\).

This paper deals with one possible concept for improvement of the performances of container transhipment between terminal and inland waterway barge. The idea is basically not new (horizontal reloading of container package), but includes some additional components (also already known and technically feasible) and gives certain hints for further development.

2 Existing reloading systems

In ship reloading procedure, the shifting of load unit (container, palette) can be presented as the sum of linear motions along x, y and z axis in three-dimensional space. Sometimes, the rotation of cargo is also required, but here will be not considered. Two basically different reloading principles are to be mutually distinguished - "vertical" (Load-on/Load-off) and "horizontal" (Roll-on/Roll-off) system.

The problem of ship reloading must be considered through the fact that the ship floats, i.e. the waterline alters following any change of loading condition and/or load distribution. Besides the draught alteration (parallel positive or negative sinkage), trim and heel angles are also subjects of change, as well as transverse stability. Moreover, the water level itself changes its altitude too (tide, high and low water periods on rivers), and thus the height difference between plane of reference (pier) and loading deck of the ship is never constant.

2.1 Vertical ship reloading system

The procedure (loading or unloading) consists of the following steps:

1. Lifting the cargo (container) in z-axis direction;
2. Shifting the cargo in y-axis direction;
3. Shifting the cargo in x-axis direction;
4. Sinking the cargo in z-axis direction;
5. Shifting the crane in initial position (over the next container).

Some of the above actions can be done simultaneously (usually No. 2 & 3). So-called container bridge (Containerbrücke) is the special device mostly used for such container ship-to-pier and v.v. reloading system. The all motions are mostly provided by electrically driven motors and the action No. 4, (cargo lowering) doesn't bring back any energy savings. The limiting element is the weight of cargo.
to be lifted. The lifting speed is proportional to the installed power of the crane. The ability to lift at all is on the other side restricted by structural elements of the crane and their strength. Therefore, the lifting capacity of a standard container bridge rarely exceeds 40 tons.

2.2 Horizontal ship reloading system

This system (also called Roll-on/Roll-off) is performed over the sloped surface (ramp) that connects pier and loading deck. Due to the change of the waterline during reloading, the ramp must be hinged on one side (ship or pier) and freely supported on the other end. The vertical shifting exists here too, but this time influenced by the alterations of waterline only. That means that vertical shifting is minimised as far as possible. This system is usually applied for reloading of heavy cargoes and trailers. Sometimes, the containers are being reloaded on this way using the so-called Roll-trailers or Roll-flats - special low platforms equipped with small wheels or rollers.

In general, the reloading process can be subdivided in following phases:

1. horizontal approach over the pier;
2. rolling along the sloped surface 1 (ramp);
3. rolling along the sloped surface 2 (deck).

The slope angles in actions No. 2 & 3 alter themselves during the whole procedure, and the drawing vehicle must be able to match them, either performing drawing or braking force. A particular restrictive element is the angle between matching point of two adjacent surfaces (pier-ramp joint and ramp-ship joint respectively). That means that the length of ramp is the function of vertical distance between pier and loading deck. Since this distance depends on plenty of factors (water level, ships loading condition (waterline), ships size, stability characteristics, weight of rolling cargo) the ramp is sometimes very long and thus expensive. Even then the reloading ability can not be always guaranteed. As an example the Ro-Ro ramp in Port of Duisburg with an overall length of 42 m and elevation in scope of 4.9 m (maximal slope of 11.4%) can be mentioned. Having in mind that water level variations of more than 5 metres are not the rarity, it can be concluded that even the most modern existing Ro-Ro facilities do not offer 100% reliable performance. Besides, the change of trim determinates the limitation of single cargo weight.

3 Concept description

The general intention is to decrease the reloading duration and to achieve cost and energy savings. In each cargo shifting procedure, some "void" steps appear that are necessary due to applied reloading technology, but are in fact non-effective. To load one Rhine E II barge with 120 TEUs (Twenty feet Equivalent Unit), it is necessary to repeat exactly 120 times the same sequence of steps. That means
that if the group of containers could be shifted together, the sum of void actions duration, involved energy and as a consequence cost itself, should be decreased. In addition, as mentioned before, certain increase of performance could be achieved if the sum of lifting actions would be minimised. A concrete idea for river container barge is shown in Figure 1.

The whole system consists of:

- Flat top river barge (pos. 1);
- Lifting platform (pos. 2);
- Container palette (pos. 3);
- Undercarriage assembly (pos. 5);
- Track system (pos. 6).

The procedure sequence is as follows (see Figure 2):
Section II - Ships and Terminals

Figure 2: Reloading procedure

1. Barge is positioned on pier;
2. Lifting platform elevates the barge to align levels of deck and pier;
3. The pair of undercarriage assemblies take position under the container palette;
4. Hydraulic cylinders in undercarriage assemblies elevate the palette;
5. Palette is transferred to the pier and released;
6. System of rectangular tracks and appropriate carriages enables further transfer of palette over the terminal area.

In Figure 3 the same system is designed for longitudinal reloading. The choice between side and longitudinal version depends on available terminal layout. The combination of transverse and longitudinal reloading system is possible too.

Each component of the system shall be further described separately.

Figure 3: Longitudinal reloading system for containers
A new Concept for Container Reloading on Inland Waterways Vessels

3.1 Lifting platform

The lifting platform consists of rigid horizontal structure (docking berthl, three pairs of hydraulic cylinders and pump with corresponding piping system and armature. The rough order of magnitude for technical particulars is estimated below:

3.1.1 Input data and performance demands

<table>
<thead>
<tr>
<th>Platform weight</th>
<th>5000  kN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight of empty barge</td>
<td>4000  kN</td>
</tr>
<tr>
<td>Weight of container palettes (5 pcs.)</td>
<td>2000 kN</td>
</tr>
<tr>
<td>Weight of load (80 TEU, 125 kN each)</td>
<td>10000 kN</td>
</tr>
<tr>
<td>Total weight to be lifted</td>
<td>21000  kN</td>
</tr>
<tr>
<td>Lifting height</td>
<td>5      metres</td>
</tr>
<tr>
<td>Lifting rate</td>
<td>0.6    metres/minute</td>
</tr>
<tr>
<td>Number of hydraulic cylinders</td>
<td>6</td>
</tr>
<tr>
<td>Cylinder bore</td>
<td>1500   mm</td>
</tr>
</tbody>
</table>

3.1.2 Capacity, head and power requirements

The total volume of liquid that has be pumped is:

\[ V = n \Delta H \frac{d^2 \pi}{4} = 6 \times 5 \times 1.5^2 \times \frac{3.14}{4} = 53 m^3 \]

where \( n \) is number of cylinders, \( \Delta H \) (m) lifting height and \( d \) (m) cylinder bore. The required total pump capacity is:

\[ Q = \frac{V \Delta H}{\Delta H} = \frac{53 \times 0.01}{5} = 0.11 m^3/s \]

where \( V = 0.6 \) m/min = 0.01 m/s is the lifting rate. The pressure in the system should be:

\[ P = \frac{G}{n \times d^2 \frac{\pi}{4}} = \frac{21000}{6 \times 1.5^2 \times \frac{3.14}{4}} = 1981.6 \approx 2000 kPa \]

where \( G \) (kN) is the total weight to be lifted. Assuming the pump efficiency \( \eta_p = 0.8 \), the required power can be estimated as:

where \( \eta_p \) is the efficiency of electric motor.

Energy consumed for lifting the loaded platform can be simply obtained back in reverse process, i.e. accumulated during platform sinkage (e.g. by means of
counterweight principle - as for elevators). Another possibility is to build two lifting platforms with common hydraulic system. Lowering of one platform (with the ship just being reloaded) should provide the most of energy needed for lifting the second one (with the ship that has to be reloaded).

## 3.2 Flat-deck river barge

Standard E II type barge has been taken as an example for consideration. Her size enables the load of about 40 TEUs in each layer and a total of up to four layers. This limit is defined on account of respecting air draught and sometimes also stability reasons. On the most of European rivers and navigable canals, only two or three layers are allowed due to the bridge clearances. As specifically light cargo, containers need larger hatch volume and deck area respectively, rather than weight capacity. Assuming the average weight of TEU as 125 kN, each layer of 40 TEUs will alter the draught of E II barge for about 0.6 m. As an example we shall consider here the barge with 80 loaded containers (125 kN each) and 40 empty containers (25 kN each) in third (uppermost) layer. The draught of the barge shall be then about 2.0 m. For such case, the rough initial stability checking shows satisfactory results.

The barge should have a flat deck. Referring to Figures 1 and 3, the systems of parallel leading tracks have to be built in deck structure. The combination of transverse and longitudinal tracks is also possible. The advantage could be the applicability in both terminal layouts. Transversal system offers the advantage over the longitudinal one through the higher stowage rate (4 containers abreast vs. 3 only). The mutually independent reloading sequence is possible only with transversal system. Which system (transversal, longitudinal or combined) should be used is subject of further consideration.

Barge with longitudinal track system is on the other side better from strength point of view - lighter and less expensive to build. The further developments in design - installing the elevating platform in hatch of the open top barge could enable the using of double bottoms as cargo deck. Thus, certain air draught and stability problems could be avoided and an introduction of even the fourth layer of containers appears to be possible.
A new Concept for Container Reloading on Inland Waterways Vessels

![Cross-section of the barge built for longitudinal reloading system](image)

3.3 Container palette

Container palette is a rigid flat steel structure that carries a pile of up to 16 loaded TEUs. The total load of $16 \times 125 \text{ kN} = 2000 \text{ kN}$ is assumed as evenly distributed over the palette area. In its elevated position (when in motion), the palette can be considered as a beam freely supported on two points.

![Container palette steel structure](image)

After the strength calculation procedure and selection of appropriate scantlings, the check of palette structure weight (with $\gamma_{\text{mild steel}} = 77 \text{ kN/m}^3$) gives value of about 350 kN and shows that its estimated weight (400 kN) was realistically chosen.

3.4 Undercarriage assembly

The concept for undercarriage assembly is shown in Figure 6. Along the strong steel girder, a proper number of roller sub-assemblies is mounted. The leg of a roller consists of knuckle joint mechanism. All roller legs are mutually linked by means of a system with hydraulic cylinders or with a spindle shaft. This link mechanism enables the synchronous retraction and extraction of rollers respectively.
This extraction provides the lifting height of about 100 mm. The rollers are made of firm solid rubber. The shifting of container palette consists of the following steps:

- Positioning the pair of retracted undercarriage assemblies (that can be moved free through the corresponding recesses) just under the palette;
- Extracting the rollers and thus lifting the palette from ground through the spindle revolving or hydraulic cylinder action;
- Pushing the palette (now on rollers) to the new location;
- Retracting the rollers and thus "landing" the platform on the ground;
- Pulling out the undercarriage assemblies.

The simplified check of power requirements for horizontal shifting and lifting respectively is shown below:

### 3.4.1 Power demand for horizontal shift of loaded palette

The force needed for pushing the loaded palette with constant speed consists of rolling resistance:

\[ F_{\text{roll}} = Q \cdot \frac{f}{r} = 2400 \cdot \frac{0.5}{200} = 6.0kN \]
A new Concept for Container Reloading on Inland Waterways Vessels

and bearing friction:

\[ F_{\text{bearing}} = Q \mu = 2400 \times 0.01 = 24.0 \]

where \( Q = 2400 \text{ kN} \) is the total weight of system, \( f = 0.5 \text{ mm} \) length of touch between roller and ground, \( \mu = 0.01 \) is the bearing friction coefficient, and \( r = 200 \text{ mm} \) roller radius.

The required power assuming the maximal shifting speed \( v = 10 \text{ km/h} \) is then:

\[ N_{\text{roll}} = (F_{\text{roll}} + F_{\text{bearing}}) \times v = (6.0 + 24.0) \times \frac{10 \times 1000}{3600} = 83.33 \text{ kW} \]

3.4.2 Power demand for lifting of loaded palette

The force needed for lifting the loaded palette with constant speed consists of mass lifting resistance:

\[ F_{\text{mass}} = Q = 2400 \text{ kN} \]

and the sum of all resistances in lifting mechanism:

\[ F_{\text{res}} = \sum_{i=1}^{n} R_i = k \times Q \times 0.3 \times 2400 = 720 \text{ kN} \]

where \( k = 0.3 \) is assumed as a correlation factor that takes into account the total inside resistance in mechanism (spindle, knuckle joints, etc.). Required power for achieving the lifting speed of \( v_{\text{lift}} = 0.01 \text{ m/s} \) is then:

\[ N_{\text{lift}} = (F_{\text{lift}} + F_{\text{res}}) \times v_{\text{lift}} = (2400 + 720) \times 0.01 = 31.20 \text{ kW} \]

These rough estimates bring the conclusion that all horizontal and vertical motions in reloading process can be performed using the device with output not exceeding 90 kW.

4 Reloading cycle duration and energy demands - rough estimates

As an example, the longitudinal reloading scenario shown in Figure 8 is selected. The ship has to be elevated to her reloading position. The container packages A1 to A5 have to be removed from the ship to their corresponding locations on the pier C1 to C5. Then the packages B1 to B5 have to be shifted aboard to positions A1 to A5. Upon the reloading is accomplished, the ship has to be lowered to her floating position. In order to simplify the calculation, the following assumptions have been done:

- The average speed of lifting platform is 0.01 m/s (0.6 m/min);
- The lifting/lowering height of platform is 5 metres;
Figure 8: Reloading scenario ("longitudinal system")

- The average speed of undercarriage assembly is 1 m/s (3.6 km/h) regardless the loading condition (full loaded or in void motion);
- The lifting and lowering speed of undercarriage assembly is 0.01 m/s regardless the load;
- The time interval (pause) between any two sequential actions is 5 seconds;
- Time overlapping of two actions is not foreseen;
- During the lifting of a ship the full power of hydraulic pump (300 kW) is involved;
- For any horizontal motion of container palette, the power of 100 kW is involved;
- For any vertical motion of container palette, the power of 30 kW is involved;
- For "void" motions of undercarriage assemblies, the power of 5 kW is involved

4.1 Unloading the ship

All the actions that shall be undertaken for unloading the container package A5 and its removal to pier location C5 are shown in Table I. For each subsequent container package, all the actions (2-13) will be repeated. The values referring sum of $x$, $y$ and $z$ motions are the same as for A5 to C5 transfer.

The above results are summarised (actions 2-13), multiplied by 5 (for five container packages) and assorted in Table II.
A new Concept for Container Reloading on Inland Waterways Vessels

<table>
<thead>
<tr>
<th>Action</th>
<th>Device involved</th>
<th>Power (kW)</th>
<th>Motion in direction</th>
<th>duration (sec)</th>
<th>Energy (kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Lifting the ship</td>
<td>Lifting platform</td>
<td>300</td>
<td>5.0</td>
<td>500</td>
<td>41.67</td>
</tr>
<tr>
<td>2 P1 to A5</td>
<td>UA1</td>
<td>5</td>
<td>28</td>
<td>28</td>
<td>0.04</td>
</tr>
<tr>
<td>3 Lifting A5</td>
<td>UA1 + load</td>
<td>30</td>
<td>0.1</td>
<td>10</td>
<td>0.08</td>
</tr>
<tr>
<td>4 Moving A5 to P1</td>
<td>UA1 + load</td>
<td>90</td>
<td>28</td>
<td>28</td>
<td>0.70</td>
</tr>
<tr>
<td>5 Lowering A5 to P1</td>
<td>UA1 + load</td>
<td>30</td>
<td>0.1</td>
<td>10</td>
<td>0.08</td>
</tr>
<tr>
<td>6 Lifting A5</td>
<td>UA2 + load</td>
<td>30</td>
<td>0.1</td>
<td>10</td>
<td>0.08</td>
</tr>
<tr>
<td>7 Moving A5 to P2</td>
<td>UA2 + load</td>
<td>90</td>
<td>20</td>
<td>20</td>
<td>0.50</td>
</tr>
<tr>
<td>8 Lowering A5 to P2</td>
<td>UA2 + load</td>
<td>30</td>
<td>0.1</td>
<td>10</td>
<td>0.08</td>
</tr>
<tr>
<td>9 Lifting A5</td>
<td>UA3 + load</td>
<td>30</td>
<td>0.1</td>
<td>10</td>
<td>0.08</td>
</tr>
<tr>
<td>10 Moving A5 to C5</td>
<td>UA3 + load</td>
<td>90</td>
<td>66</td>
<td>66</td>
<td>1.65</td>
</tr>
<tr>
<td>11 Lowering A5 to C5</td>
<td>UA3 + load</td>
<td>30</td>
<td>0.1</td>
<td>66</td>
<td>0.08</td>
</tr>
<tr>
<td>12 C1 to P2</td>
<td>UA3</td>
<td>5</td>
<td>66</td>
<td>66</td>
<td>0.09</td>
</tr>
<tr>
<td>13 P2 to P1</td>
<td>UA2</td>
<td>5</td>
<td>20</td>
<td>20</td>
<td>0.03</td>
</tr>
</tbody>
</table>

Table I: Energy requirements for lifting ship and unloading one container package

<table>
<thead>
<tr>
<th>Action</th>
<th>Time elapsed (sec)</th>
<th>Energy consumed (kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizontal motions of palette</td>
<td>114 570</td>
<td>2.85 14.27</td>
</tr>
<tr>
<td>Horizontal motions (void)</td>
<td>114 570</td>
<td>0.16 0.80</td>
</tr>
<tr>
<td>Vertical motions (lifting &amp; lowering)</td>
<td>60 300</td>
<td>0.48 2.40</td>
</tr>
<tr>
<td>Sum of pauses</td>
<td>60 300</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>348 1740</td>
<td>3.49 17.47</td>
</tr>
</tbody>
</table>

Table II: Time and energy required for unloading

4.2 Loading the ship

The actions that shall be undertaken for loading, i.e. removal the container package B1 in position A1 are shown in Table III. For each subsequent container package, all the actions (1-5) will be repeated. The values referring sum of x, y and z motions are the same as for B1 to A1 transfer.

The above results are summarised (actions 1-5), multiplied by 5 (for five container packages) and assorted in Table IV.
Section II - Ships and Terminals

### Table III: Energy requirements for lifting ship and unloading one container package

<table>
<thead>
<tr>
<th>Action</th>
<th>Device involved</th>
<th>Power (kW)</th>
<th>Motion in direction</th>
<th>duration (sec)</th>
<th>Energy (kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 P1 to B1</td>
<td>UA1</td>
<td>5</td>
<td>14 (m)</td>
<td>14</td>
<td>0.02</td>
</tr>
<tr>
<td>2 Lifting B1</td>
<td>UA1 + load</td>
<td>30</td>
<td>0.1 (m)</td>
<td>10</td>
<td>0.08</td>
</tr>
<tr>
<td>3 Moving B1 to A1</td>
<td>UA1 + load</td>
<td>93</td>
<td>93 (m)</td>
<td>93</td>
<td>2.32</td>
</tr>
<tr>
<td>4 Lowering B1 to A1</td>
<td>UA1 + load</td>
<td>30</td>
<td>0.1 (m)</td>
<td>10</td>
<td>0.08</td>
</tr>
<tr>
<td>5 A1 to B1</td>
<td>UA1</td>
<td>5</td>
<td>93 (m)</td>
<td>93</td>
<td>0.13</td>
</tr>
<tr>
<td>6 Lowering the ship</td>
<td>Lifting platform</td>
<td>-</td>
<td>5 (m)</td>
<td>500</td>
<td>-</td>
</tr>
</tbody>
</table>

Table IV: Time and energy required for loading

<table>
<thead>
<tr>
<th>Time elapsed (sec)</th>
<th>Energy consumed (kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>per pallet</td>
<td>per ship</td>
</tr>
<tr>
<td>Horizontal motions of pallette</td>
<td>93</td>
</tr>
<tr>
<td>Horizontal motions (void)</td>
<td>107</td>
</tr>
<tr>
<td>Vertical motions (lifting &amp; lowering)</td>
<td>20</td>
</tr>
<tr>
<td>Sum of pauses</td>
<td>20</td>
</tr>
<tr>
<td>Total</td>
<td>240</td>
</tr>
</tbody>
</table>

5 Rough comparison with conventional container reloading system

The total estimated time needed for lifting the ship, unloading, loading and lowering the reloaded vessel is in given example about one hour and ten minutes. The total energy consumption for these actions is about 72 kWh. Some 42 kWh is required for lifting the ship (lifting height of 5 metres), and the rest of about 30 kWh belongs to the reloading alone. Assuming the ship lifting energy can be accumulated and in great extent utilised for lifting the next ship (Item 3.1.2), the energy demands for reloading process is about 50 kWh. It would be interesting to compare these results with those obtained by using conventional container crane, of course under the same or at least similar prerequisites. In order to perform that realistically, it is necessary to add the required energy for stowing the containers on the platform. To lift 40 TEUs from ground to platform (first layer) and another 40 TEUs from ground to their location in second layer, it is necessary to consume:
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\[ E_{\text{sh}} = 40 \times Q_{\text{TEU}} \times (h_1 + h_2) = 40 \times 125 \times (0.50 + 3.00) = 17,500 \text{ kWs} \approx 5 \text{ kWh} \]

For reloading the container platform (lowering the stowed containers to the ground), it can be assumed the same energy consumption, i.e. once more about 5 kWh. All together that makes about 60 kWh.

In case of conventional vertical reload with modern container bridge, the following assumptions have been done (seems to be ideal, although in reality direct transhipment is not likely):

- The railway wagon or road truck that shall be reloaded come on pier within the reach of crane
- The average lifting height of container (TEU) is 5 metres in both senses (ship-to-pier and pier-to-ship)
- The reload rate is 30 TEUs per hour. In reality, the records are 20-30 containers per hour, regardless the container size (20 or 40 feet), and thus the average of 30 TEUs is selected (e.g. ten 40-feet and ten 20-feet containers)

To unload 80 TEUs of 125 kN each from the ship and to load another 80 (just the vertical motions), the energy demand is:

\[ E_{\text{reload}} = 2 \times 80 \times 125 \times 5 = 100000 \text{ kWs} \approx 27.78 \text{ kWh} \]

The sum of energy required for horizontal motions is at least the same as for new concept, i.e. about 30 kWh. That makes all together about 58 kWh, i.e. energy demand is almost the same as for the new concept. The total reloading time is:

\[ T_{\text{reload}} = 2 \times \frac{80}{18} = 2 \times 4.44 \approx 9 \text{ hours} \]

6 Conclusions

It is obvious that new concept offers a reload of the ship about 5 times faster. The energy consumption is at least of the same order of magnitude as for the conventional vertical reloading system and seems to be not the decisive factor for ad hocc rejecting of the concept. The following facts concerning advantages and disadvantages of new concept in comparison with the conventional one can be summarised:

Advantages:

- The reloading process of ship alone is several times shorter;
- The investment in terminal infrastructure is probably lower (to be checked);
- The required terminal area for the same turnover can be smaller (to be checked);
- The total transport capacity per ship in certain time interval can be sufficiently increased, especially on shorter distances (e.g. less than two days of trip) that are usual on European inland waterways.
Disadvantages:

- Energy demands for reloading process (single lifting platform) are higher;
- The goal is met only when container palette is full-loaded;
- Payload capacity (number of TEUs aboard) is smaller;
- For the same number of containers aboard, the air draught is higher;
- Lower flexibility of transport.

The system can be applied successfully under the following circumstances:

- Time scheduled "point-to-point" transport;
- The ratio between trip duration and reloading time clearly demands the shortening of latter;
- The ship is fast, and its own capital cost requires the fastest possible reloading;
- On the routes where container terminals and waterborne mode of container transport have to be introduced (and so organised) for the first time (the lack of any existing terminal infrastructure);
- On routes where a couple of terminals appear between two end points and where the packages (container palettes) shall be quickly unloaded, and already prepared packages for the following destinations immediately loaded on board. That is valid for side reloading version only.

To evaluate the applicability of the new system, it would be necessary to analyse the whole transport chain in which the inland navigation vessel, harbour terminal and reloading facilities represent just three adjacent links. The conceptual solution presented here brings just one new opportunity in overall container transport scenario.

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INNOVATIVE FAST SHIP DESIGNS FOR AN INTEGRATED SSS SYSTEM - IFSISS

By A. Papanikolaou, D. Vassalos and I. Østvik

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Abstract

The present paper addresses the development of innovative fast ship designs for Short Sea Shipping operations in Europe in the framework of a concerted European research initiative. More specifically, it considers two different designs: a SWATH Multipurpose Container Carrier (SMUCC) and a Fast RoRo Ferry Design (FARO). Both suggested designs are based on the concept of fast sea transportation and efficient cargo transfer from road/rail to ship with a minimum of interruption of the cargo flow through the port. The vessel itself is considered to be a link in the waterborne transportation chain, thus the proposed transportation system is acknowledging the need for efficient interfaces between ship-port and port-road/rail. The SWATH design follows the strategic principle of "function-separation" whereby splitting the functions of the hull enables easy loading/unloading of the cargo. The RoRo design attempts to consider safety-related features and economic aspects in the design procedure more thoroughly by making use of new design techniques. The paper addresses the main aspects of a logistic transportation system, focusing on the vessel designs as well as on the need for an evaluation of the "total economy" in the transportation system.

1 Introduction

In recent years considerable efforts have been expended, world-wide, to develop new types of ships and to increase the share of waterborne transportation. In addition to developments in other countries with highly developed economies (e.g., USA and Japan) similar developments are currently underway in Europe, that might improve the conditions for the necessary cohesion of various national economies within the European Community. It is evident, that in order to maintain or even increase the competitiveness of the European economy as a whole, it is essential to improve the efficiency of the inter-European economy and transportation network as a whole, considering that a significant portion of the final price of many products is paid for transportation (Zachcial, 1994). The competitiveness of any transportation system, including Short Sea Shipping, depends on the price...
and quality of the offered services. The main factor characterising the quality of services is transportation time within a "door to door" delivery concept (Just In Time/JIT products). The inherent advantage of waterborne transportation, namely its low energy consumption per ton-km suggests, that above a certain low limit for the service speed, the value of which is dependent on the transportation scenario, waterborne transportation appears to be a strong competitor to other transportation modes. Considering also the environmental impact of road-bound transport, the huge public funds reserved for this specific transportation mode and the frequent road traffic breakdown, especially during the summer-tourist season, it seems that a further increase of land transport will be in the near future practically impossible. Consequently, a reduction of the road-bound transport and cross-boarder traffic within Europe seems desirable. Thus, alternative transportation modes appear necessary, even at higher cost. The above economical and ecological aspects, encouraging the development of efficient and competitive Short Sea Shipping systems, are also supported by current developments in shipbuilding technology. Considering the time factor as one of the most important elements of any transportation mode, it is evident that developments in Short Sea Shipping are interrelated with developments in Fast Sea Transportation and to technological breakthroughs in unconventional ship designs and in innovative port facilities. It should be clear that an efficient and competitive waterborne transportation concept, that is also inherently fast, must consider technical solutions for both the ship carrier as well as for the ports of call of the vessel for fast loading/unloading. The present study concentrates on two different SSS design concepts:

**SWATH design:** this is an integrated concept, consisting of a SWATH Multipurpose Container Carrier (SMUCC) and an innovative terminal facility, adjusted to the suggested SWATH carrier and securing the least possible turnaround time for the proposed sea transporter. The SMUCC is intended for high-speed transportation of high-value cargo products in standard containers within Europe, aiming to reduce operating costs and make substantial savings in cargo storage and handling expenditures.

**RoRo Ferry Design:** today much of the cargo freighted between European countries is transported by trucks using the ever more congested roads. A reasonably fast RoRo ferry link with efficient port terminals and logistics has undoubtedly the potential to make its way into the aforementioned freight market, provided the vessel has inherently high safety standards. A service between strategic ports throughout Europe linking potential markets will have a significant environmental gain, in addition to being cost-effective and highly competitive in the transportation market.

**The project objective**

The overall aim of the research initiative is to shift the pattern of cargo transportation within the European community from road-based transport systems to waterborne transport systems, based on innovative ship designs. Other on-going research projects, which consider the logistics within waterborne transport, aim to
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improve the port-ship interface, the cargo handling in port, in addition to improving the cargo flow through the port (rail/road-port interface), thus achieving to make use of the port as a catalyst in the transportation link. The present study targets the logistics of waterborne transport by focusing on the vessel design whilst making use of knowledge from on-going research projects, with emphasis on ports and interfaces in the transportation system, as an input in the design process.

2 Concepts of fast short sea shipping

2.1 Qualitative aspects of fast short sea shipping

Initial studies on the competitiveness of Fast Sea Transportation suggest that the employment of high-speed marine vehicles is justified for relatively short routes, assuming the postulated demand for transport of high-value cargo (Akagi, S., 1991). A few general aspects encouraging, and sometimes discouraging, higher speeds for ships are summarised in Table I.

<table>
<thead>
<tr>
<th>Economic Aspects</th>
<th>Technical Aspects</th>
</tr>
</thead>
<tbody>
<tr>
<td>High value of cargoes (JIT - products) High value of time</td>
<td>Improved ship designs by new concepts</td>
</tr>
<tr>
<td>High freight rates</td>
<td>Improved hull form designs through optimisation</td>
</tr>
<tr>
<td>Short turnaround time</td>
<td>Improved propulsive performance</td>
</tr>
<tr>
<td>Cheaper fuel</td>
<td>Improved hull coatings</td>
</tr>
<tr>
<td>Higher interest rates</td>
<td>Improved seakeeping and manoeuvring performance through design</td>
</tr>
<tr>
<td>Relatively high daily operating costs due to increased fuel consumption, but reduced crew costs through automation</td>
<td>Implementation of new construction materials</td>
</tr>
<tr>
<td>Increased trade (although a larger, slower ship would be better)</td>
<td>Reduced volume and mass of machinery plants, lower weight per horsepower</td>
</tr>
<tr>
<td>Competition</td>
<td>Lower specific fuel consumption of engines</td>
</tr>
<tr>
<td>Shortage of building funds or of shipbuilding capacity (greater transport capability per unit investment)</td>
<td>Reduced cost of main machinery from economies of scale in manufacturing, improved materials, improved technology, etc.</td>
</tr>
</tbody>
</table>

Table I: Economic and technical aspects for fast sea transportation
2.2 Logistical Foundation of SSS Designs

The present study focuses on the vessels in the logistical chain from the producer to the customer. The study addresses the need for intermodal transportation systems and the integration of SSS logistics to improve the competitiveness of waterborne transport. The whole transport chain needs to function as one unit, where the links in the chain are interacting with each other. The SSS transport chain from producer to customer comprises three links, namely hinterland, port and ship, in addition to the interfaces between them. Furthermore, the costs of the cargo freight from producer to customer in an intermodal system must be viewed with respect to the "total economy" of the transport.

2.2.1 Interfaces

The interfaces between the various modes of transport are the single most important factor in the transport chain. It is not justified to have excellent transport vehicles and cargo handling equipment, serving a well planned port, if the interfaces between them are inadequate. During transportation the cargo shifts mode of transport up to four times, indicating the importance of the interfaces. The cargo is delivered to port either by rail or road, it is then pre-stacked and properly arranged prior to the ship’s arrival, whereupon it is loaded onto the ship by various means. When the ship reaches her destination, the cargo handling process is reversed and the cargo reaches its customer following a similar procedure. The interfaces road/rail-port and port-ship must be efficient to cope with the demand of modern transport modes. It is very important that the cargo handling process at the interfaces does not demand extensive human resources, ensuring minimisation of handling costs and a reliable service without delays. Furthermore, the port-ship interface is crucial to minimising the turnaround time - this being a fundamental aspect of fast shipping.

2.2.2 Ports & Hinterland

The ports in a transportation chain must function as catalysts bringing the cargo from the hinterland link to the ship link in a safe and time efficient manner. Hence ports should not function - as many do today - as simple storage depots, despite the income created through storage of cargo. The challenge of modern ports is that they must function as efficient and cost effective logistic-hubs where all modes of transport can be effectively interconnected. Handling and control of cargo flow in port should be automated through local computer control systems (LANs). It is important that the distribution in the hinterland mode is in harmony with the cargo handling functions in ports. Hence, cargo should not be delayed in its distribution due to lack of interaction or lack of common standards between various modes in the transportation chain. The port layout in an intermodal transport system should be fitted to the ship and its cargo handling solutions to achieve an efficient cargo flow from port to ship and vice versa. The key point is again to minimise the turnaround time for the ship.
2.2.3 Standard Unitloads

Attempting to establish a network of many small routes, to serve a network of many small ports, a standard unit load based on the conventional ISO container and the stackable swap-body could become the backbone of an improved waterborne transportation system that would replace the long distance road transport in Europe. The decision of standardisation, however, is political and relevant research can only support the decision makers through well-thought arguments. Besides, there are numerous contradicting interests in this area, which makes a further standardisation of containers and swap bodies difficult for the foreseeable future.

2.2.4 EDI Systems

The cargo must be controlled by EDI systems while being transported. EDI is the new technology working in a real time philosophy, which makes it possible to integrate Short Sea Shipping with inland connections as an integral part of the logistic chain from customer to producer. The common objective of EDI is to create a common and effective communication language between computers, running in real time, and simplifying the information created on paper. (Pesquera, M. A. and De La Hoz, L., 1992). EDI will play an increasingly important role in the logistics of future JIT management systems. JIT aims to achieve the goals of maintaining zero stock and achieving no delays in the delivery of goods. EDI plays an important role in JIT transport systems because it offers the vital information bridge between production and demand. EDI will thus be the tool to monitor the cargo flow through the intermodal transport chain. (Pesquera, M. A. and De La Hoz, L., 1992).

2.3 Vessel Loading/Unloading Concepts

Given the availability of a high-speed vessel, of whatever type, there is little benefit for the overall concept of fast sea transportation if time is lost at the port due to slow manoeuvring, mooring and cargo handling. The cargo handling problem is addressed by the industry, demanding a new generation of ship handling technology on one hand, whilst addressing, on the other, the need for standardisation of the cargo carrying units (Sjøbris, A., Wijnolst, N. and Peeters, C., 1994). The selection of the proper port location, so that a high service speed can be maintained for most part of the route, the avoidance of long entrance channels and locks and of shallow water routes, are complementary aspects of a fast marine transportation concept, but they are outside the scope of this paper.
2.3.1 SMUCC Design

The SWATH Multipurpose Container Carrier concept proposal addresses the problem of minimisation of the port time as follows:

1. The proposed SMUCC carrier has excellent manoeuvring capability through twin hull, twin propeller, twin rudders and possibly through twin bow thrusters arrangements. Thus, berthing at the port is greatly simplified.

2. Docking of the suggested SMUCC carrier is taking place at a customised docking facility, fitting beamwise to the dimensions of the proposed ship (about PAN-MAX dimensions). It is assisted by an automatic shore- or vessel-based mooring system. The proposed specialised docking facility is shown in Figure 1.

3. The inherent sensitivity of SWATH ships against weight changes during loading/unloading is alleviated by considering a medium waterplane area hull form design and the provision of an efficient ballasting system, ensuring pre-loading of the vessel to the design draught. Following loading/unloading the vessel can be released to sail out.

4. The terminal facility, serving SMUCC (Figure 1), might be considered as an improved, inter-modal container terminal facility. Cargo units (ISO or EURO containers or similar unitised cargo) are brought to the terminal by rail or road or other conventional ships or even other SMUCC ships. The units can be pre-stacked or directly placed on a remotely controlled, “double lane”, rolling conveyor or rail, container distribution system. The concept considers
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sub-terminals, local control stations and local networks. The control of the movement of the cargo units is achieved through the application of modern data transmission systems (EDI), considering also all the necessary paperwork, so that the cargo unit may be loaded without delays.

5. The container transfer from the rolling conveyor to the ship is enabled by a shore-based gantry crane, overlooking the whole SMUCC docking place and the feeding of the land-based distribution network. The gantry crane could load the suggested SMUCC carrier row-wise, in stacks of up to ten containers per movement. For this, it may be necessary to place the containers on pallets or cassettes, depending on the gantry crane handling design.

6. In case of berthing of the proposed SMUCC carrier at a non-specialised terminal, as described above, the ship may be served as a conventional container ship, loading/unloading deck-containers. Berthing and mooring is simplified, with trimming and draught-keeping provided by the ship's own ballast system.

7. As an extension to the proposed SMUCC concept, considering a vessel of larger size with higher payload capacity, SMUCC could be operated within the so-called Bacat (Barge Aboard CATamaran System of the Danish shipping company of G. Drohse in 1974, shipbuilder Frederikshavn Værft & Tør-dok A/S, Witthoft, 1982).

2.3.2 FARO

The Fast RoRo Design proposal addresses the harbouring problem as follows:

1. On-going research projects (such as the IPSI project managed by Kværner Ships Equipment A/S) aim to improve port-ship interfaces which substantially reduce the turnaround in port. These projects attempt to develop new cargo handling solutions, which reduce the need for the conventional harbour infrastructure as it is understood today. The FARO project group has a close dialogue with these research initiatives and will implement feasible solutions in the RoRo design. Cargo handling solutions which conceptually differ from current practice will influence both the ship design and the harbour infrastructure to a great extent. In addition to reducing the turnaround time, these new solutions must also aim to reduce the time the cargo spends within the harbour infrastructure and thus, distributed more efficiently to the "Hinterland".

2. There is a distinct advantage to be gained from investigations into improved logistics and new operators needs concerning innovative technology within the "total" intermodal transportation system proposed in this project. The complete logistic chain from customer to producer must be considered to achieve the optimum enhancement of the transport system. The investigation must consider all the different transportation legs from producer to
customer, and determine the best solution within each leg and the best interface between each leg. In a harbour there are two interfaces which must readily be dealt with - ship to port and port to "Hinterland" - aspects which underlines the importance of the harbour in the transportation system. Hence, there is a potential for considerable time savings within the harbour, if it is designed according to the philosophy of the present study.

3. The project will develop an efficient harbour infrastructure, which should be functioning as a catalyst in the transportation chain, and not as a storage depot. The harbour design will be closely linked to the function of the cargo handling techniques in the port-ship interface, as well as to the function of the rail/road-port interface. These port functions must be evaluated and constructed with respect to achieving a minimum delay in the interfaces between two different modes of transport. The study will thus develop new port-terminal concepts for highly automated transfer from rail/road to ship or, alternatively, ship to ship.

4. The cargo must be pre-stacked in the harbour prior to the arrival of the RoRo ferry to avoid operational delays in cargo loading. Cargo handling within the port and lashing of cargo onboard the vessel should be done automated. Today, these processes are mostly manual. Thus, there exists a potential for readily reducing the turnaround time in port if the above mentioned tasks were fully automatically and monitored by CCTV and/or harbour staff. There exists a need for more automated ships and by implementing such ships there can only be a gain in the competitiveness for a transport system containing such highly automated ships. There has been some work done in this area concerning the use of cassette concepts to minimise the turnaround time (see e.g., Igielska, J., 1994 and commentary by Fear, K., 1994).

5. The cargo movement in the port is controlled by the local computer network, which is connected to the global EDI network, linking every port within the EDI system. The cargo units in such an EDI system will have sensors attached to them, giving information to shippers, operators, freighters, customer etc. where the cargo unit of interest is in the transportation chain. Thus operators and freighters can monitor the cargo shipment in a easier and more efficient way. Payment of the services provided within the EDI system is readily charged via the same system, which simplifies the paperwork for the workers and reduces the cargo handling time.

6. Manoeuvring and mooring should be simplified by having easily accessible ports and the vessel characteristics optimised thereafter. These are technical aspects which are readily solved by utilising existing technology. The use of bow thrusters is an example which can easily improve docking of the vessel. More advanced tools, such as auto-pilot manoeuvring and mooring based on reference points in the port, are amongst solutions considered by the FARO group. The proposed study considers these tasks important for
the overall efficiency of the transportation system and should be addressed with due priority.

7. A monohull, which is the focus of this particular study, is not sensitive to displacement changes in such manner that interactive ballast systems are necessary.

2.4 Alternative Concepts

Considering common characteristics of catamarans for SSS operations, it can be expected that they will not introduce significant additional problems when harbouring. The concept for loading/unloading of a catamaran is more or less similar to a monohull if the cargo handling solutions are similar. However, alternative loading/unloading solutions for twin hull configurations are feasible, as described in the SMUCC concept. Because of its very high initial stability, the catamaran provides a stable platform when cargo is loaded/unloaded and, in this respect, it may be superior to the monohull. In addition, the catamaran will exhibit improved manoeuvrability in harbours due to the twin hull - twin waterjet/propeller system, possibly enhanced by single or twin bow thrusters.

3 CONCEPTUAL VESSEL DESIGN

3.1 Design Specification

A common ship design procedure considers, in the first step, the specification of the owner’s requirements in terms of the payload capacity and speed for the ship, as well as operational and environmental conditions in the framework of a transportation scenario. The designs considered in this study have a variety of different technical and economic characteristics. The aim is nevertheless the same - to serve in a Short Sea Shipping scenario to the customer’s satisfaction. The proposed designs will be subjected to a comparative study at a later stage where advantages and drawbacks will be highlighted. The common requirements for the SMUCC and FARO concepts are interpreted as follows:

1. The vessel should be unconventional or futuristic, thus it should deviate substantially from existing designs, either in form or in function.

2. The vessel should be suitable for Short Sea Shipping.

3. The design, including the overall transportation concept, should allow fast cargo transfer from road and rail to ship and vice versa. Thus, the incoming cargo must be pre-loaded in standard transportation units, like ISO or EURO containers, allowing for quick transfer within a transportation network, comprising land, sea and even air transport vehicles. The requirement for
quick transfer suggests, in turn, that the transported goods are of high value or that the market potential demands such a transportation system. The cargo must be secured against damage and loss, thus lashing/securing onboard and pre-stacking must be efficient and highly automated.

4. The proposed concept should include proposals of how to minimise the interruption of cargo flow. Thus, it should consider a proper container terminal installation, allowing the pre-stacking of incoming containers by land transport and for quick transfer onboard whilst the sea transporter itself must be operational year-round and near-independent of environmental conditions.

5. The concepts should consider the collection of small lots of cargo with a high frequency of departures and arrivals of the vessel at the ports of call. Thus, in addition to the ease of loading and unloading of specific containers, the ship must be fast both over the sea and during landing in the port (high manoeuvrability and berthing ability).

3.2 The Designs in the SSS Transportation system

There is a general feeling that SSS ships should be fast in order to be able to compete with land transport, and also, for passenger craft to be able to compete with air transport. Since the first fast craft appeared only 50-60 years ago, the speed of such vessels has been determined by the price of oil. Today the oil is cheap and fast craft are more popular than ever before. The trend is so strong that fast craft are becoming attractive in the cargo freight as well as the passenger market. It should be noted, however, if the oil price increases again to levels seen during the oil crises in the seventies, fast cargo freighters could be rendered uneconomic to operate. There are today various fast vessels in operation or being developed within the maritime industry - under the following categories:

- Dynamically supported vessels - Air-cushion vehicles and Hydrofoil craft;
- Multi-hull displacement vessels - Catamaran and SWATH;
- Hybrid vessels - Surface Effects Ships (SES) and Foilcat;
- Displacement vessels - Monohull.

Of the vessel categories mentioned above some are better suited than others to SSS. The competitive factors (see Wijnolst, N., et. al. 1992) which determine the feasibility of a design are:

- Transport time and costs;
- Frequency and flexibility;
- Reliability;
- Environmental Impact;
- Customer Satisfaction;
- Political Acceptability.
The above factors can be systematically evaluated to decide on the suitability of alternative designs for SSS, as shown by J. P. Dobler (see, Proc. Of 2nd European Short Sea Shipping Conference, 1994). Catamarans, wavepiercers, trimarans, etc. are currently being exploited by other research projects, but these projects address mainly passenger/vehicle transportation. Catamarans, such as the STENA HSS super ferry\(^1\), are likely to pour into the market in the near future if the initial attempts are successful. The present study aims to develop complementary alternatives to this one-sided development of catamaran technology. On the other hand, SES and hydrofoil technologies appear not to be ready for implementation to the larger cargo carriers, despite significant developments within the well known TECHNO-Superliner project in Japan (see, Proc. FAST'95 conference). Other innovative vessel designs, such as trimarans, wavepiercers, hydrofoil craft etc. are for the same reasons considered not to be eligible for a deeper evaluation in the study. The project group considers monohull and SWATH to be the most economically feasible vessel configurations for cargo transportation in Short Sea Shipping in the future and this is reflected in the experience and knowledge of the partners comprising the group. The potential advantages of the two proposed concepts are shown in Figure 2.

Figure 2: Potential advantages of the proposed SSS concepts

One part of the present study concentrates on monohulls, which is believed to be the best economic, the most suitable, and most flexible design in a general SSS transportation chain. In addition, a monohull is readily produced and technically a proven design. The other design in this study - namely SMUCC - proves to be suitable for freight of standard containers in a feeder service with high cargo density demanding fast transport and short turnaround time. Safety of the vessels

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\(^1\)STENA's HSS is considered as a "hybrid" SWATH-Catamaran design
and reliability of service will be of major influence in a SSS system when the transportation system is in operation. Safety will ensure the reliability of the vessels, which is a very important factor to the customers. With the increasing focus on safety in the aftermath of the Estonia disaster, monohull safety standards will soon be at the same level as those for high-speed catamarans. The frontier work of the Stability Group at the University of Strathclyde is intended to be implemented in the present study. Regarding the SMUCC concept the strongest argument for its implementation is its reliability in different weather conditions. The monohull has the advantage of loading and unloading simultaneously in the same process using both ends of the vessel. Depending on the design, a RoRo catamaran loading and unloading involve a turning manoeuvre of the cargo inside the vessel, demanding effective cargo handling manuals to achieve a short turnaround time. The SMUCC has developed an innovative turnaround procedure which is promising in keeping the turnaround time at a minimum. A monohull has a clear advantage considering layout and arrangement for the machinery of the vessels. Whilst special considerations must be taken, when designing the propulsion system for a fast catamaran, this is not as much a problem for the monohull.

3.2.1 SMUCC Design

The proposed SMUCC concept is following the strategic principle of "function-separation", introduced by S. Akagi, 1991, for the development of high speed marine vehicles, whereas the hull form of a conventional ship retains a dual function, namely to accommodate the cargo in the holds of the hull and at the same time to support the ship by its buoyancy. In developing container transport vehicles for high-valued cargo, requiring high transportation speed, the resulting hull form for the container ships is consequently slender, with very limited space in the holds. This fact led the designers "naturally" to the introduction of an increased number of "deck" containers, thus splitting the dual function of the vessel hull form and also enabling easy loading and unloading of the deck containers. However, this split of functions was partially paid for by the carriage of "non-paying load" (permanent and/or water ballast), due to the ensuing insufficient stability. The proposed cargo SWATH might be considered as a further development of the above concept towards a complete split of arrangements and functions, with the deck (and the superstructure in general for other ship types) carrying the complete payload, easily accessible from the top or the side and with the lower hull arrangement providing the buoyancy and accommodating the machinery and propulsion units as well as all the outfitting to the maximum extent possible. Despite the increased frictional resistance of the twin-hull configuration, compared to a monohull of equal displacement (due to the increased wetted surface of a twin hull vessel), the hulls of a SWATH ship can be very slender resulting in low wave making and viscous-pressure resistance, in addition to the increased propulsive efficiency due to the slenderness and axi-symmetric form of the lower hulls. Thus, at least some of the above drawbacks of the twin hull vessel concept are alleviated and therefore efficient and competitive SWATH hull forms can be developed for manifold operational profiles. Turning to the safety of the proposed carrier against capsizing, namely the transverse stability problem
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affecting seriously the designs of alternative high-speed monohull vessels, such problem is only of minor importance (e.g., damage stability) due to the large inherent transverse stability of twin-hull configurations. On the other hand, some typical deficiencies of the original SWATH concept, namely the appearance of the vertical plane instabilities due to the action of the so-called MUNK moment, is addressed by the provision of "medium" sized waterplane areas for the struts and the employment of two sets of not necessarily movable or automatically controlled fins (see, Papanikolaou, A., 1990). Through the medium waterplane area of the struts and the placement of the machinery and other outfitting in the lower hulls, the inherent trim, heel and draft sensitivity is counteracted by geometric and design (weight controlled) means to the extent possible. The drawback of having considerable draught of an original SWATH hull form, compared to alternative monohull concepts, that might be of importance for certain Short Sea Shipping routes, can be addressed by increased displacement volume in the waterplane area region or ellipsoidal cross sections, leading to SWATH-CAT hybrids. Furthermore, there are two other important characteristics of the proposed design, namely the construction material used, i.e., steel, except for the aluminium superstructure, and the global structural design of the vessel. Unlike current developments in the construction of large aluminium SWATH like vessels (e.g. the STENA HSS), the present concept considers the use of a conventional shipbuilding material, namely steel, including higher tensile steel, where locally necessary for the load carrying ship structure. The concept relies on the simplicity of a design and the optimisation of the structural design of a vessel to counterbalance the weaknesses of steel against alternative construction materials in terms of the increased structural weight and the reduced payload capacity. Only the superstructure is considered to be built form aluminium alloy, but it is not considered essential for the present design, due to the limited extent of the ship’s superstructure (bridge). The simplicity of the SMUCC design allows the split of the main deck area into two main structural zones, the first supporting the deck superstructure at the forward one third of the ship’s length and the second, the container-load carrying zone, extending backwards over the remaining two thirds of the ship’s length. From the structural design point of view the forward part of the ship is relatively stiff through the closed character of the corresponding frames extending from the circular lower hull cross section to the vertical struts, the wedge type sponsons at the highly loaded haunch area and to the connecting box like main-deck double bottom. For the container carrying deck area the present concept considers an open bedstead configuration, consisting of a properly strengthened mainframe starting at the aft end of the main deck and ending at the aft end of the forward superstructure with several equally spaced box like transverse beams between the sponsons of the relevant frames, giving the open deck-bedstead additional stiffness against transverse bending and torsional loads in a seaway. It should be noted, that due to the proven excellent seakeeping of the suggested SWATH vessel, the wave induced loads, including underdeck pounding, can be expected to be lower than for other comparable designs for the same environmental conditions. Based on the above the present proposal includes the design data of the SMUCC, with the main characteristics given in Table II. The SMUCC has two alternative options for the machinery installation, namely an option for the arrangement of two different machinery configuration. The first
includes two diesel engines giving the vessel a service speed of 26 knots and the second four diesel engines giving the vessel a service speed of 36 knots. The payload capacities vary accordingly between 430 tons for the former and 360 tons for the latter - the range being approximately 400 nautical miles. The deck arrangements of the vessel allow the transport of up to 60 TEU containers in six rows of ten units each beamwise or of other box units of non-standard size.

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Length O.A.</td>
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</tr>
<tr>
<td>Beam O.A.</td>
<td>31.70 m</td>
</tr>
<tr>
<td>Length of Hulls</td>
<td>50.00 m</td>
</tr>
<tr>
<td>Max Beam of Hulls</td>
<td>3.80 m</td>
</tr>
<tr>
<td>Length of Struts</td>
<td>37.60 m</td>
</tr>
<tr>
<td>Max Beam of Struts</td>
<td>2.60 m</td>
</tr>
<tr>
<td>Draft</td>
<td>5.00 m</td>
</tr>
<tr>
<td>Displacement</td>
<td>1060 tons</td>
</tr>
<tr>
<td>Light Ship</td>
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</tr>
<tr>
<td>Deadweight</td>
<td>497 (427) tons</td>
</tr>
<tr>
<td>Payload</td>
<td>430 (360) tons</td>
</tr>
<tr>
<td>Service Speed</td>
<td>26 (36) knots</td>
</tr>
<tr>
<td>Horsepower</td>
<td>14800 (29600) HP</td>
</tr>
</tbody>
</table>

Table 11: SMUCC - Main dimensions and technical characteristics

The SMUCC is technically described in more detail in (Papanikolaou et. al., 1995).

3.2.2 FARO

The design of the fast RoRo vessel will make use of a new design technique - Design Co-ordination - which is developed at the CAD Centre (DMEM) at the University of Strathclyde (see Duffy, A. H. B., 1995 and Duffy, A. H. B., et. al., 1995), and is essentially a generic design methodology, involving multiple sources of expertise operating together but not necessarily in concert to develop a design to satisfy specific requirements - a blackboard is one such "tool" to implement this approach. The traditional "design spiral", which is a naval architecture classic, is enhanced by performing concurrent engineering. Concurrent Engineering in this context means that design tasks which are related, e.g. port-terminal and cargo handling solutions (see Figure 3), are designed concurrently considering the relationship with each other. Other "groups" of relating design tasks are dealt with according to the design development process, co-ordinated by a control centre, thereby performing the tasks in the "design spiral" in a more intelligent and less time consuming way. Figure 3 illustrates the Design Co-ordination method, with the ellipse functioning as the centre of the design process and the various ship design tasks reporting to this co-ordination centre. Regarding the functional requirements, these will be established by an experienced design office, Lund.
Mohr & Giaever-Enger A/S in Bergen, Norway who are one of the industrial partners in this study. The safety-related requirements in the form of a database and knowledge base reflecting all the key factors pertaining to safety enhancing devices, vehicle deck arrangements, hull subdivision, cargo securing arrangements, escape routes, mustering and evacuation procedures as well as risk management and decision support systems will be provided by the Strathclyde University Ship Stability Research Group who are currently at the centre of state-of-the-art developments in the aftermath of the Estonia disaster (see Vassalos, D., et. al., 1996). Furthermore, the technical design of the RoRo ferry will be assisted by the design office mentioned above, a consulting firm of naval architects with considerable design experience. The study aims to develop a design for cargo transportation, which can be easily re-designed to serve the passenger/vehicle transportation market - the classical definition of a RoRo ferry. The RoRo design will comprise innovative features such as efficient and safe hull, modern propulsion systems, and advanced ship controls.

![Design Co-ordination and its Position in the Design Process](image)

Figure 3: Design co-ordination and its position in the design process

A techno-economic study of a fast RoRo ship for the Mediterranean intended for trailer freight (Trincas, G. et. al., 1994) forecasts a market for such a design in competition with road transport. In this respect, a flexible design is the aim for the FARO project group, which can accommodate seasonal demands from future operators/customers, such as bulk loads, unit loads, trailers etc. The present study
evaluates new cargo handling solutions, which can alter the design of the vessel to a great extent. Solutions suggesting a total break-up of the ship by separation of the cargo hold from the rest of the ship during loading and unloading by attaching another pre-stacked cargo hold, are one way to minimise turn-around-time. The vessel will thus deliver the cargo at the port in one single handling operation and reload with the reversed handling operation. More conservative cargo handling solutions may incorporate improved port-ship interfaces, which handle the cargo by utilising new and better procedures in the port, in addition to making the best use of state-of-the-art equipment. The vessel design will thus be greatly influenced by the choice of cargo handling solutions - alternative designs serving different markets and cargoes in a Short Sea Shipping network can prove to be a solution. To achieve a high speed with reasonable power demands a slender hull is a necessity. Model tests conducted for the EuroExpress show that a monohull has lower power demands than catamarans with the same slenderness ratio (Levander, 1992). Alternatively, when a monohull offers the best potential for a short turnaround time, a RoRo design in Short Sea Shipping becomes a justifiable and feasible choice.

The essence of market research, which would pay a key role in the development of FARO, is to determine factors such as seasonal changing demands, varying cargo products, and cargo flows in the future European market. Furthermore, establishing contact with possible future operators and owners of a vessel in Short Sea Shipping has a high priority in the project. This will be used to optimise the design (or various designs) and its productiveness in accordance with demands and requirements. The ship design group will evaluate the feasibility of unit load ships serving a transportation systems in a network of many small ports along a coastline as well as overseas. The ships in such a network could differ in size and speed according to market potential, combined to create a transportation system attractive to the customers. The ports in this system should function as intermodal hubs, serving relevant modes of transport in their region. The trend towards faster cargo ships must be taken into consideration, but should not be considered as a necessity in such a transportation system. An alternative scenario could be considered involving fast SSS vessels in door-to-door transport corridors serving large scale economies. Aspects such as cargo capacity, bunker cost, and speed must be carefully examined to justify the introduction of a fast SSS vessel suitable for such a scheme. Fast in this context means fast enough to attract cargo from land transport. A transportation system could thus just as well be established with, for example, three smaller moderate fast ships, rather than two larger very fast ships, achieving the same cargo carrying capacity at a lower total cost, including operational and initial building costs. Transportation time will of course be longer, but the value of the cargo should be very high, if an increase in time cannot be justified or the customer is willing to pay for very fast transportation. The study of the proposed RoRo design is currently at the conceptual design stage. Thus design data does not exist with aspects such as speed, length and cargo carrying capacity not yet determined. The project group believes that by performing an in-depth study of the demand in the cargo transportation market on feasible routes prior to deciding upon concrete design data will provide the right background for determination of the ship particulars. Speed and size is a question reflecting customer requirements.
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4  Economic aspects of short sea shipping

Fast ships will, in general, have increased operational cost, due to higher initial investment cost and increased fuel cost. Thus, it will require higher freight rates, as compared to a traditional low-speed vessel. However, in evaluating the economy of such vessels the "total economy" of the transportation scenario must be considered. When comparing the costs of shipping based on the leg between two ports, fast ships are losing the competition against slower, hence less operationally-expensive ships. Today, nevertheless, the total cost of shipping also includes cost of handling, storage, turn-around-time, etc. Therefore, by considering the complete logistic transportation chain from market to market there are concepts, such as "value of time"-cargo, JIT-products, etc., which are becoming inherently important for the designer of vessels in Short Sea Shipping (e.g., Levander, K., 1992 and commentary by Wergeland, T., 1992). The present study argues that by having efficient cargo handling solutions and connections to "Hinterland", considerable economic gains can be achieved in a transportation system. Thus, the vessel in a waterborne transportation system is only one of several, equally important, factors in the logistic system. If waterborne transport is to be competitive against land transport, there have to be efficient interfaces between vessel, port and hinterland, which are all interact to bringing the products to the customer without delay, undamaged, and to a competitive price. This study puts emphasis on the vessel design, using the other aspects of the transportation system as an input in the design process. Traditional shipping charges lower rates per ton/mile than fast shipping. However, handling and storage costs adds to the bill, thus rendering it more expensive than it first appears to the customer. Fast shipping concepts reducing or even eliminating the storage and handling time, such as the SMUCC design, offer a "total economy" advantage thus rendering them very competitive, even against traditional slow shipping systems. In a SSS service the transportation must be competitive in terms of economics - this is the most important factor for the cargo owner. He will not be interested in using waterborne transport if better - or cheaper - options exist. To promote SSS as environmental friendly would not attract a single customer unless the transport is also economically attractive. This is ensured by properly designing the intermodal transportation chain and by focusing on attaining a "total economy" advantage for the customer. Thus, SSS would become a door-to-door service which the customer can compare directly with other forms of transport. The concepts addressed in this study aim to win market shares from road transport, especially, and to this end there is a need for speed, cost, efficiency, and reliability. These are the key words for the customer. As the economy in European countries develops there will be a larger demand for these factors. Waterborne transport systems with efficient interfaces is the right solution, economically, to target the increasing transport volume within the EU market. Studies of Short Sea Shipping (e.g., Caspers, F. N. and Ter Brugge, R., 1992) conclude that there is no justification for overlooking Short Sea Shipping as an alternative to intermodal transport. There is also a substantial environmental gain from the fact that waterborne transport releases far less damaging gases and toxic compared to road transport. This aspect has been noticed by policy makers in the EU and research into intermodal transportation systems using waterborne vehicles is strongly encouraged through EU’s 4th
Section II - Ships and Terminals

Framework Programme. Policy recommendations are given to the European Commission in the area of Short Sea Shipping by research work carried out regarding important traffic corridors, which sets the pace for development in this area (Peeters, C., Verbeke, A. and Ceclercq, E., 1994). Furthermore, increasing road traffic can only lead to more congested roads and, hence, delays for the customer. By designing vessels which are operable in changing weather and sea conditions the cargo owner has a reliable transportation source which brings the products to customer according to the JIT philosophy.

Preliminary economic analysis of the smucc design

The following addresses some basic data for the economic evaluation of SMUCC, considering a hypothetical transportation scenario which considers a transportation work of 48 TEU times 132,000 miles/year (6,336,000 TEU miles/year). The latter is estimated on the basis of a moderate travelling distance of 400 miles/day (service speed approximately 28 knots) and operating 330 days/year, and an average of 80% annual capacity utilisation of the 60 TEU capacity. On the basis of the above data the following preliminary economic results have been obtained for SMUCC (see, Table III). These data, even though preliminary, appear to be very competitive against alternative fast cargo ships of comparable size or even traditional ships, when the value of time of the transported cargo or storage and handling costs demand a higher turnaround speed. It should be noted that the results obtained for the RFRs of between 0.125 and 0.200 US $ / ton mile for a speed of 26 to 36 knots compare fairly well and are even lower than the comparable numbers for the much larger EuroExpress design (see Levander, K., 1992). Note that according to K. Levander traditional shipping might charge 0.08 US $ / ton mile for a speed of 17.5 knots, but with additional storage and handling cost of about 40 US $ / ton and at least double the handling and storage time. It should also be noted, that the operation of SMUCC at 17 knots requires only 5500 BHP and the resulting RFR might even be below 0.08 US $ / ton mile.

Finally, the achieved transport speeds of between 50 to 70 km/h seem very competitive in comparison with land transport speeds by road. However, validation of the above data remains to be undertaken within the framework of a more complete and detailed techno-economic analysis.

5 Concluding remarks

Adopting the concept of "total economy" this paper puts forward the argument that fast innovative ship designs could be very competitive against traditional slow shipping within an integrated short sea shipping system. To this end, two alternative designs are put forward, a SWATH and a RoRo, and an outline is provided of the possible features that make these designs attractive in comparison to available alternatives. To develop these concepts further, a consortium has been formed, comprising relevant industry, three universities and two design offices with in-depth knowledge and expertise in conceptual, technical and generic design regarding these two ship types. At present, work is gathering pace in attempting to identify the market, to develop innovative engineering expertise and to define
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<tr>
<th>Displacement</th>
<th>Payload</th>
<th>Deck Length Overall</th>
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<td>1060 tons</td>
<td>430 tons (V2) to 360 tons (V4) or 60 TEU containers</td>
<td>V2 : 2 engines version, 26 knots</td>
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<tr>
<td></td>
<td></td>
<td>V4 : 4 engines version, 36 knots</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7.2 to 6 tons/TEU</td>
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</table>

Table III: Main techno-economic characteristics of high-speed SMUCC

design specifications and constraints enabling innovative ship design to become the focal point in the fast SSS transportation chain.

6 References


Section II - Ships and Terminals


{16} Sjoberis, A., Wijnolst, N. and Peeters, C., 1994, "Fast self-loading and unloading unitload ship systems for coastal and Short Sea Shipping potential
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COASTER EXPRESS: AN OPTION FOR LARGE-SCALE
COASTAL CONTAINER FEEDERING

By J.J.M. Evers and H. Boonstra

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COASTER EXPRESS: AN OPTION FOR LARGE-SCALE COASTAL CONTAINER FEEDERING

Abstract

This paper describes feeder systems for the large future terminal complex on the Maasvlakte. Special attention is given to short sea feeding. The objective is to explore various aspects of the feasibility, taking logistic requirements as boundary conditions. The conclusion is drawn that automated large scale short sea feeding is attractive, especially for the short distances.

1 Survey

This paper aims to present a technologically verified picture of the terminal complex on the Maasvlakte (Rotterdam), together with the feeding processes, as it might appear in the year 2010. Striking aspects are: the increase in scale; the structuring and scaling-up of the feeder connections in the form of intensive shuttle services; Integrated coordination of distributed transport operations (on the basis of the use of telematic techniques), and mathematical control concepts. Special attention is given to short sea feeding.

The feasibility of the project is explored with regard to the equipment, the control technology, coordination with the transport network and spatial aspects. Boundary conditions include the capacity required, the transit speed and also the limitations imposed by the environment. The investigations were based on the actual present situation. This paper is largely based on the results of the R&D programme of the project group INCOMAAS, which works in partnership with ECT (Europe Combined Terminals) and GHR (Port of Rotterdam). The objective of INCOMAAS was to prepare a blueprint for the layout of the Maasvlakte over a time horizon of 15 years. The TRAIL research group was commissioned to provide a number of the studies incorporated in the main research project. The workshops which were organised within the framework of this partnership provided excellent opportunities for the exchange of ideas. Nevertheless, "Coaster Express" presented here, is based on original interpretations and elaborations. The authors take full responsibility for these. Other studies which were also prepared under the auspices of the TRAIL Research School, were used in the preparation of this paper; especially those in the field of large scale inland shipping.

Section 2 starts the exploration with a sketch of the future container-flows and the important technological and logistic developments in this area. In section 3 a presentation is given of the concept Coastal Express. An extensive R&D programme will be needed to optimize several elements as the push-barge coaster,
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the automated combi-crane and the coordination and control systems. However, in our opinion major technical and economic difficulties are not be expected.

2 The context: developments of the Rotterdam container terminals

2.1 The state and the prognoses

Figure 1 gives a sketch of the Maasvlakte which is the most westerly located area of the Rotterdam harbour complex. On this, the so-called ECT-peninsula, two terminals are already operational: the Delta Multi User terminal (DMU) and the Delta Sealand terminal (DSL). The DSL is extensively robotised; The terminal transport is carried out by 50 Automated Guided Vehicles (AGVs) and the stacking is accomplished with the aid of Automatic Stacking Cranes (ASCs).

The extension of the transhipment facilities was anticipated in the layout of the Delta Dedicated East (DDE) and the Delta Dedicated West (DDW) terminals; both of which were laid out according to the DSL. The planned transhipment facilities for road and rail transport will be constructed on the central strip of the ECT-peninsula.

The plans also provide for the construction of a barge service centre in the Hartelhaven and the Distripark, where value adding activities related to the container transport will take place. If necessary, these extensions can be operational in 2005. The ECT-peninsula has an area of 320 ha. The combined capacity of the four terminals is $3 \times 10^6$ container visits per year, taking into account an average stay of 3.5 days for import containers and 2.5 days for export containers. This results in a turnover of 9,375 container visits per hectare per year.

2.2 The prognoses

The layout of the Maasvlakte, including the research into the future layout of the North-West Corner, is being broadly investigated by INCOMAAS, a joint-venture of ECT (Europe Combined Terminals) and GHR (Port of Rotterdam). Projects have been commissioned from various organisations including the TRAIL Research School [4]. The summary report is published in "Masterplan INCOMAAS: final report" [5]. The plans for the layout are based on the following prognoses.

Already the scenario "high" is generally considered to be the most probable. This will mean that the operational capacity limit of the terminals on the ECT-peninsula will have been reached by 2010 and that by then the first terminal facilities on the North-West Corner must be operational.
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<table>
<thead>
<tr>
<th>ECT Peninsula:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>DMU Delta Multi User</td>
<td></td>
</tr>
<tr>
<td>DSL Delta Sea Land</td>
<td></td>
</tr>
<tr>
<td>DDE Delta Dedicated East</td>
<td></td>
</tr>
<tr>
<td>DDW Delta Dedicated West</td>
<td></td>
</tr>
<tr>
<td>--- Railroad</td>
<td></td>
</tr>
</tbody>
</table>

Figure 1: The harbour area of the Maasvlakte

<table>
<thead>
<tr>
<th>Year</th>
<th>1995</th>
<th>2000</th>
<th>20005</th>
<th>2010</th>
<th>2015</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>High scenario</td>
<td>1.5</td>
<td>2.5</td>
<td>3.4</td>
<td>4.1</td>
<td>5.5</td>
<td>7.2</td>
</tr>
<tr>
<td>Low scenario</td>
<td>1.5</td>
<td>1.8</td>
<td>1.9</td>
<td>2.0</td>
<td>2.6</td>
<td>3.2</td>
</tr>
</tbody>
</table>

Table I: Number of moves on the sea-side $\times 10^6$

In addition to a considerable increase in the container flow, a different type of increase in scale is also in progress; namely a considerable increase in the capacity of deep sea carriers. For example the post Panamax ship that recently came into service has a capacity of 6000 TEU, while a ship of 8000 TEU is being designed by the German shipyard Howaldswerke. This vessel, termed a jumbo container vessel, is 335 m. long with a beam of 46 m. and a maximum draught of 14 m. In view of the limitations posed by draught and the engine power required a further increase in scale seems unlikely. It is likely that this ship will be introduced because operational costs per TEU are considerably lower than those of smaller ships.
In conjunction with these changes it is expected that the number of calls will be limited to two or three. Moreover it is expected that on the Maasvlakte 35% to 40% of the containers will be collected together or transported overseas by feeders of small deep-sea ships.

A third phenomenon that is expected involves a considerable decrease in the share of road transport in the transport to the hinterland. An important reason for this is the inadequacy of the road capacity. A further reason for the anticipated relative reduction in road transport is the restrictive policy of the European and Dutch authorities. The share of road transport in the transport to the hinterland is currently 58%, but in the future this will probably decline to 40%. The expected model split on both sea and land sides is given in Figure 2.

![Figure 2: Future modal split on the Maasvlakte](image)

A considerable growth in transport by rail and inland waterways is thus expected. Facilities for the railway, of which the Betuwe line forms a part, will be soon under construction. A dramatic scaling up to the inland shipping facilities will also be necessary. The Barge Express concept makes the construction of outpost terminals in places such as Duisburg, Mainz (or Mannheim) and Antwerp very attractive and these are therefore considered to be part of the 'Terminal Complex of the Future'.

In the project INCOMAAS, limited investigations into a possible construction of a new terminal on the North-West Corner have been carried out in order to accommodate the necessary capacity after 2010. This new terminal must be able to handle approximately the same number of containers as the combined terminals on the ECT-peninsula (DMU, DSL, DDE and DDW). Thus, according to the an-
A critical success factor for the Maasvlakte will be the quality and the efficiency of the inter-terminal transport. Therefore, in partnership with ECT, simulation studies of the anticipated Inter-Terminal Transport (ITT) around the ECT-peninsula have been carried out {5}, {6}. The objective was to obtain a picture of the intensity of the inter-terminal traffic and of the minimum number of terminal vehicles that would be required in 2005 in order to obtain an average service level of 99%. The performance of various types of vehicles were studied: a special inter-terminal AGV (automated guided vehicle) travelling at 5 m./sec. by far shows the best performance. The simulation results suggest that by appropriate logistics, the load rate of these AGVs might be at least 80%. In that case, the inter-terminal transport for the containers flows in 2005 can be done with 75 vehicles.

Figure 3: TEU-flows on the Maasvlakte anno 2010

2.3 Future terminal facilities

The quality of the feeder connections is a critical success factor for the transition of containers on the Maasvlakte. Therefore, one should conceive the 'Maasvlakte Terminal' as a complex consisting of its (future) terminals, the facilities for inter-terminal transport and outpost terminals (or service centers) linked with shuttle trains, barge shuttles, automatic shuttle vehicles or with coaster shuttles. The
Invisible infrastructure in the form of the electronic network and protocols for telematic coordination is essential: the whole should function as an "Intelligent Transport System".

A future terminal, possible situated on the North-West Corner of the Maasvlakte, must be able to accommodate the jumbo container vessels of 8000 TEU. It is expected that every week 10 jumbo vessels (85% loaded) arrive at this North West Terminal and that, on the average, the freight share will be 60%. Restricting the maximum in-port-time to 24 hours, this requires two berths for jumbo vessels each of a capacity of 250 moves per hour. This can be accomplished with the aid of five cranes per berth, each with a capacity of 50 moves per hours.

Facilities for the railway, of which the so-called Betuwe line, will soon be under construction. With this, special opportunities arise for the setup of outpost rail terminals and for a drastic scaling up of the railroad transport.

### 2.4 Delta Transit: distributed truck-semi-trailer service.

Although the share of the road transport will decrease, it is expected that the actual road transport will double within 15 years. For this reason the Maasvlakte-Gorinchem corridor is being studied by the government in the MARICOR project. The advice given includes a proposal to improve the national A15 motorway and to double the number of lanes. But even then, in time, the road capacity will be insufficient. Therefore we have studied the setup of outpost truck service centers, by the expansion of the inter-terminal transport on the Maasvlakte in the entire Maasvlakte-Gorinchem corridor with branches to Delfland and Zevenbergen Hoek (or Moerdijk) {1}, {2}; see Figure 4.

![Figure 4: Delta transit network](image-url)
Coaster Express: An Option for large-scale Coastal Container Feeding

This perspective, for which the name Delta Transit is introduced, embraces an automatic transport system with which the transport of containers between various transhipment stations can be coordinated and carried out in an organisationally neutral manner; Figure 5 shows a possible layout of an outpost transhipment station. Each robot vehicle will be admitted to the Delta Transit link ways, as long as complies with certain standards relating to physical properties, control and safety. Vehicles may be robot truck-semi-trailer combinations (7), tractor-multi-trailer combinations or robot carrier vehicles (2). With the aid of built-in distance sensors the vehicles can maintain the necessary distance apart. The standard speed is 45 km./hr. The system is equipped with a powerful control component, which takes care of the admission of vehicles, traffic control and the logistic coordination. The distributed service of the road traffic has great advantages; these include:

- Large capacity, owing to continuous operation, regularity and density of the traffic flow;
- Reliability, owing to congestion avoiding traffic and access control;
- High productivity of the robot vehicles, owing to the possibility of peak-shaving and of avoiding empty trips;
- Low impact on the natural environment and low energy consumption, owing to the low constant speed;
- High safety, owing to low constant speed and being separated from manned vehicles and private transport.

![Figure 5: An outpost truck service center](image)

Technologically, the Delta Transit concept can be seen as a further development of the present automated terminal transport which is now in operation at the Delta Sealand Terminal. This also fits in with the general trend towards automatic
control of road traffic and the separation of the functions of traffic lanes on motorways.

2.5 Barge Express: large scale inland shipping

The third transport modality for inland feeding is, of course, inland shipping, especially in relation to Antwerp and the Rhine. The new transport market that will rise by the growth of volumes, provide possibilities for specialisation. The concept Barge Express, proposed by the TRAIL Research School, aims to the larger inland waterways shipping market. Offering large scale inexpensive transport of containers, Barge Express also aspires to offer an intermodal alternative to road transport. These objectives lead to the following points of departure:

- Shuttle links to be provided only between the Maasvlakte and the inland ports of Duisburg, Mainz (or Mannheim) and Antwerp;
- Use of the largest possible transport units in the form of push barges and push barge combinations;
- The provision of opportunities for building or modifying facilities to permit automated transhipment in order to permit fully continuous operations with low labour costs;
- Fixed daily schedule, six times a week;
- Offer optimal time windows for external transport, so that are maximum options for combining external trips.

On the Maasvlakte, the Barge Express terminal can make use of the surrounding marine stacks. That means that the Barge Express terminal operator activates the external transport in the form of 'inter-terminal transport'. For that reason we speak of an active terminal. An active terminal is not endowed with stacking facilities. It operates simultaneously on two push barges: one barge for loading and one barge for unloading. Externally arriving containers (via inter-terminal transport) are taken directly on the loading barge, whereas leaving containers (via inter-terminal transport) are taken directly from the unloading barge. In this way the inter-terminal transport can combine delivery and collection of containers in combi-trips.

At the related terminals in Duisburg, Mainz and Antwerp, however, the Barge Express terminal operator probably will not have (substantial) control on the external transport. Indeed, here truck-semi-truck combinations will take care of the external transport and, indeed, the arrivals will be more or less random. In such cases we speak of a passive terminal. For a passive terminal stacking facilities are essential. It should be noted that, because of the intended size of the loads, stacking under the quay cranes is completely inadequate. Therefore, a passive Barge Express terminal must be equipped with its own (automatic) stacking facility and (automated) quay transport. For a passive terminal the following procedure is suitable:

- Complete unloading of a newly arrived push barge at the Barge Express stack;
- Collection of containers from this stack by the external transport;
Coaster Express: An Option for large-scale Coastal Container Feeding

- Delivery of containers by the external transport and direct placing in the push barge;
- Sailing down of the loaded barge and arrival of the new barge.

A truck-semi-trailer combination can thus combine the delivery and collection of containers in combi-trips. With such a setup, the use of push barges is extremely efficient: For the shuttle Maasvlakte-Duisburg, when the barges being exchanged in Duisburg and on the Maasvlakte, only two push boats and four push barges are required for a daily service.

In determining the maximum size of the barge, account is primarily taken of the physical and legal requirements for the Rhine shipping up to Mannheim and shipping to Antwerp. It appears that a beam of 22.80 m. and a length of 72 m. are admissible. The capacity of such a push barge is 280 TEU.

Trips to Duisburg and Antwerp can be made with two barges linked in tandem. Because of its broad beam, this 280-lighter is stable enough for automated transhipment, in both the coupled and separate states. From the viewpoint of safety, the lighters must be equipped with cell guides for the containers.

For automated transhipment the vessel must remain almost still and horizontal; only variations in draught are permissible. This requires: good attachment to the quay, with vertical freedom; berthing at a jetty which diminishes the influence of wind and waves; balanced positioning or removal of the containers. Figure 6 shows a view of a suitable quay crane; the special sheer construction in necessary on the Rhine in order that loads can be fully controlled at times of low water.

![Figure 6: The Barge Express quay crane](image)

By using a jetty it is possible to construct a light rigid crane. The low weight is important because the 'slot selection algorithm' selects places at some distance...
from each other, which will necessitate the movement of the crane. The stiffness is necessary to attain the positioning accuracy that automated transhipment demands. Some stacking is possible under the crane, but only enough for some operational decoupling.

The procedure for automatic transhipment is given in Figure 7. During loading the control computer seeks a place for a random incoming container, such that the trim and list remain within fixed tolerance limits and such that the crane has to travel as little as possible. When unloading, the slot selection algorithm selects a container from the uppermost layer in such a way that the position of the ship remains within the tolerance limits and the crane travels as little as possible. Simulation studies [13] have shown that in this way such accurate balancing can be achieved that automated transhipment is possible. Then, in principle similar techniques can be applied as are operational for automatic stacking. Following on from this, quay transport can also be automated.

![Diagram](https://example.com/diagram.png)

**Figure 7: The 'slot selection algorithm'**

The slot selection algorithm described, accepts any random container during loading, it is not necessary to prepare a loading plan in advance. The flexibility thus attained can also be reached with a semi-automated procedure; The computer indicates the place, after which the crane driver carries out the work. Figure 8 shows a suggestion of the layout of an automated passive Barge Express terminal; the automated area is strictly separated from the manned external area.

From a technological viewpoint, automated transhipment seems entirely possible for large inland waterway vessels. In fact, the control software and some adapta-
Coaster Express: An Option for large-scale Coastal Container Feedering

<table>
<thead>
<tr>
<th>Port</th>
<th>Distance (nm)</th>
<th>Sailing time (hours)</th>
<th>Present freq./week</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hamburg</td>
<td>305</td>
<td>21</td>
<td>3</td>
</tr>
<tr>
<td>Le Havre (+ Dunkirk)</td>
<td>247</td>
<td>18</td>
<td>4</td>
</tr>
<tr>
<td>Bilbao (+ Virgo)</td>
<td>690</td>
<td>49</td>
<td>4</td>
</tr>
<tr>
<td>Lisboa</td>
<td>990</td>
<td>71</td>
<td>3</td>
</tr>
<tr>
<td>Cork</td>
<td>610</td>
<td>44</td>
<td>5</td>
</tr>
<tr>
<td>Dublin</td>
<td>700</td>
<td>50</td>
<td>6</td>
</tr>
<tr>
<td>Belfast (+ Warrenpoint)</td>
<td>780</td>
<td>56</td>
<td>4</td>
</tr>
<tr>
<td>Felistowe</td>
<td>110</td>
<td>8</td>
<td>11</td>
</tr>
<tr>
<td>Edinburgh</td>
<td>380</td>
<td>27</td>
<td>4</td>
</tr>
<tr>
<td>Hull (+ Southshields)</td>
<td>200</td>
<td>14</td>
<td>5</td>
</tr>
<tr>
<td>Riga (+ Tallinn)</td>
<td>880</td>
<td>63</td>
<td>5</td>
</tr>
<tr>
<td>Helsinki</td>
<td>950</td>
<td>68</td>
<td>3</td>
</tr>
</tbody>
</table>

Table II: Current feeder and short sea feeder lines

...tation of known techniques have yet to be developed. In the TRAIL-study on Barge Express [4], estimates are made of the costs per 40ft-container, transported via conventional push-barges versus Barge Express. It turns out that fully automated transition is ± NLG 35,- cheaper per container than manned transition.

Figure 8: A layout of a passive Barge Express terminal
2.6 Coaster Express an obvious perspective for short sea feeder-ing.

As pointed out in par. 2.2, a considerable growth of containerized transport has to be expected; both in volume and in the size of the deep see vessels. The Maasvlakte is an excellent location to accommodate the jumbo container vessel. Essential for a development in this direction is the quality of the short see feeder-ing.

Feeder lines have to be market conform, reliable and competitively priced. A network of such feeder lines also may function in the continental short see container shipping. Indeed, as has been pointed out in the preceding paragraphs, substantial investments are planned to improve the hinterland connection; this all will offer an ideal branching system for the continental container transport.

The transport sector may anticipate on these developments, by bundling of the transport flows, scaling-up the short see facilities, standardization and automatization of the transition processes. Therefore, for the short see feedering a new approach is needed, which is flexible enough to fit in the current practice. This, in some respect, new approach is given the name "Coaster Express". Some obvious candidates for Coaster Express lines are given in Table II; the distances, sailing times at 14 kts and the present weekly frequency are added.

The infrastructure of Coaster Express consists of a number of special automated Coaster Express terminals: one on the Maasvlakte and others (not necessarily automated) on a few important European ports. Between the Maasvlakte and these Coaster Express ports a daily shuttle service is maintained, six times a week. These shuttle lines may operate with special coaster push combinations, consisting of a push boat and a barge with a capacity of about 450 TEU. In this way it is possible to intensivate the exploitation of the expensive push boat, and to use the barge as stacking facility during the loading or unloading process. Apart from this, also conventional coasters with a similar capacity could be taken in consideration. The logistic setup of Coaster Express is such that, for external (road) transport, optimal time-windows are offered with respect to the normal labour times and the possibility to combine the delivery and collection of container in single combi-trips. The innovation of Coaster Express concerns the integration of its constituting elements; the ship, the terminal layout and equipment and the logistics concept.
3 The setup of Coaster Express

3.1 The logistic concept of Coaster Express

Coaster Express - abbreviated CoEx - is intended to accommodate large scale feedering. Apart from this, it may serve continental short sea shipping. This study is restricted to CoEx lines related to the Maasvlakte. Then the starting points of the concept are:

- Shuttle service, point-to-point;
- Fixed daily schedule, six times a week;
- Optimal time-windows for the external transport, offering maximal opportunities for combi-trips;
- Automated transhipment (at least on the Maasvlakte), in order to permit continuous operation at low labour costs;
- The use of standard barges with cell guides.

The first three starting points are purely logistical. Discussing the sailing schemes - cf par. 3.2 - it will be clear that the last two starting points are consequences from the first.

For the coaster barge these starting points are strongly determining. In particular, automated transition requires a minimal width of 18 m., whereas for destinations to Duisburg or Antwerp the maximum width is limited to 22.80 m. Fixing the width on 21 m., it is possible to put seven containers widthwise between cell guides. Automated transition probably will limit the stacking height to six containers. Next, requirements on strength and stiffness limits the length ± 90 m., which allows 12 TEU between cell-guides. Thus, we arrive at a coastal barge with a capacity of about 450 TEU, which is a current size in the practice of short sea container shipping; more details are given in par. 3.3.

In a similar way as proposed in Barge Express, we have two types of CoEx terminals; the active and the passive. An active terminal uses the surrounding (marine) stack, in such a way that the terminal operator activates the external transport in the form of (automated) "inter-terminal transport". It operates simultaneously on two coaster barges: one for loading and one for unloading. Via inter-terminal transport arriving containers, are placed directly on the loading barge, whereas leaving containers are taken from the unloading barge. In this way the inter-terminal transport can operate with combi-trips. In par. 3.4. details are given for a 'combi crane', with a width of ± 48 m., which may operate simultaneously on a loading and an unloading barge. A combined cycle for loading and unloading a container takes 2 minutes. With a loading rate of 80% and a TEU-factor of 1.5 of the barges, two combi-cranes will complete a combined loading-unloading operation in 4 hours. This implies that in a 24-hours cycle, 5 destinations can be
served. Clearly, the automated active CoEx terminal is an excellent option for the Maasvlakte.

Starting point for a passive CoEx terminal is that the terminal operator has no control on the external transport and that, therefore, the terminal has to be equipped with its own (automatic) stacking facility. The setup may be the same as being pictured for Barge Express; c.f. figure 6 and figure 8. The protocol is the same as the protocol for the passive Barge Express terminal. This implies that, for the external transport, there are optimal opportunities for a width time-window and for combi-trip operations. A passive terminal is an option for a site with a low degree of coordination.

3.2 Examples of fixed sailing schedules

In this section it is assumed that the CoEx terminal on the Maasvlakte is active whereas the CoEx terminals on the related ports are passive. In section 3.1. we observed that an active terminal with two combi-crane operating is able to handle five destinations within 24 hours of continuous operation. More precisely, the combined loading and unloading operation of two parallel 450 TEU barges with 80% loading rate and a TEU-factor 1.5, takes 4 hours; for the calculation of the sailing schedules 5 hours are taken.

The combined loading-unloading may operate on two barges for the same CoEx-line. Accounting 2 hours for docking and undocking on each terminal and assuming a sailing speed of 14 kts, this leads to Table III concerning the ranges corresponding to the cycle time of a push boat. In addition, the number of barges and the number of push boats are given, being required for a daily service.

<table>
<thead>
<tr>
<th>Cycle time (days)</th>
<th>Range (nm)</th>
<th>Number of barges</th>
<th>Number of pushers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>105</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>273</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>441</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>609</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>777</td>
<td>6</td>
<td>5</td>
</tr>
</tbody>
</table>

Table III: Range and numbers of barges and push boats, symmetric operation

It should be noted that one additional barge is required for the terminal on the Maasvlakte, which supports in continuous operations five destinations. When these services are maintained with conventional coasters, their number is equal to the number of barges being required.
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It is possible to interweave the operation for different destinations. For example: consider two destinations A and B where, on the Maasvlakte, the following unloading-loading scheme is followed:

- Loading destination A and unloading arrival from B;
- Arrival of A and departure of A;
- Loading destination B and unloading arrival from A;
- Arrival of C and departure of B.

In this schedule, the transition time of 5 hours is removed from the cycle of A, but appears two times in the schedule of B. To sketch the consequences, suppose that both schedules are based upon a cycle time of 2 days. Then for A and B we have effective sailing times of $48-2 \times 2 = 44$ hours and $48-2 \times 4.8-2 \times 2 = 34.4$ hours, respectively, corresponding to ranges of 308 NM and 241 NM.

Using these principles, we consider an example of five short sea destinations presented in Table IV: Hamburg, Le Havre, Edinburgh, Felixtowe and Hull. The left hand side of the table specifies the schedules; the right hand side presents the consequences in the form of margins, the number of barges and the number of push boats.

<table>
<thead>
<tr>
<th>Arrival</th>
<th>Unload</th>
<th>Load</th>
<th>Depart</th>
<th>Line</th>
<th>Margin</th>
<th>No. of barges</th>
<th>No. push</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hull</td>
<td>Hull</td>
<td>Hamb.</td>
<td>Edin</td>
<td>Edin.</td>
<td>4</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Le H.</td>
<td>Le H.</td>
<td>Le H.</td>
<td>Hull</td>
<td>Hull.</td>
<td>6</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Edin.</td>
<td>Edin.</td>
<td>Feli.</td>
<td>Le H.</td>
<td>Le H.</td>
<td>3</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Feli.</td>
<td>Feli.</td>
<td>Edin.</td>
<td>Edin.</td>
<td>Edin.</td>
<td>4</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

Table IV: Example of five lines, served by one service center on the Maasvlakte

Consequently, this CoEx service on these five lines requires $15 + 1 = 16$ barges and $10 - 1 = 9$ pushers. In case this service is maintained with conventional coasters, 16 of them are required.

In par. 3.3. it is shown that the investment costs of a barge and a pusher can be estimated on 64% and 57%, respectively with respect to a conventional coaster of this size. Then, applying this figures to the example of table 4, the rates of the investment costs of push-barges versus conventional shipping is 15.4 versus 16. for the push-barge concept; one needs crew for 9 ships, whereas for the conven-
tional coastal shipping crew for 16 ships are required. On the other hand this push-barge service probably will consume 12.5% more fuel.

The calculation suggest that for long distances, conventional coastal shipping might be preferred over push-barge shipping. For instance, service on Bilbao, Lisboa, Dublin, Belfast and Helsinki requires 32 barges and 25 pushers. However, when the time-windows for the external service on these locations can be restricted to 7 hours (which limits the import time to 13 hours) the service can be maintained by 28 conventional coasters. Then the corresponding rate of investments cost is: 35.7 versus 28.

3.3 The push-barge coaster

It appears to be very beneficial to operate full continuously with the CoEx terminal on the Maasvlakte. Therefore automatic transition is economically attractive. These leads to the following starting points for both a conventional and a push-barge coaster:

- Width 18 m. to 20.80 m., corresponding to 6 and 8 TEU widthside;
- Maximal height 6 TEU;
- Length 12 to 16 TEU;
- Cell guides;
- No hatch covers, which requires high free boards;
- Standard sized containers, no specials.

The latter is compatible with the intention that CoEx concerns large quantities. The maximum size coaster will be about 720 TEU and the minimum about 400 TEU. Figure 9 shows a push-barge combination with a capacity of 450 TEU, operating at a speed of 14 kts.

For an inland push-barge combination a soft/wire connection suffices. However, for short see purposes a rigid connection is necessary. A rigid connection forces the barge and pusher to behave in seaway as one rigid body. The propulsion efficiency is 10 to 15% lower than in case of a ship of similar dimensions. Rigid connection allows a permanent fixed connection of electrical cabling between the pusher and the barge. Personnel can safely move to and from barge, also when at sea.

Practical observations, mostly publications in 'Hansa', show that the investment costs of a conventional container feeder with the indicated characteristics can be estimated on NLG. 37.5*10^6. Her daily energy consumption will be 17.5 ton. It is noted that these costs are based on the number of TEU slots, including empty containers in the upper positions. The "effective" number of loaded containers (average 14 tons) is approximately 60 or 70% of the number of slots. The data from 'Hansa' are presented in Figure 10.
Coaster Express: An Option for large-scale Coastal Container Feeding

Figure 9: Sketch of a 450 TEU push-barge combination

Figure 10: Prices of container ships

The investment costs of the pusher (4000 kW) and the barge will be approximately NLG. $21.5 \times 10^6$ and NLG. $24 \times 10^6$, respectively which is 55% and 67%
Section II - Ships and Terminals

with respect to the conventional ship. The daily energy consumption of the push­
barge combination will be 20 ton.

3.4 Coaster Express terminals

Figure 6 shows a quay crane for Barge Express. A similar design might be used for
an (automated) passive CoEx terminal. In the case of CoEx, the operational stack­
ing facility under the quay cane is important. Indeed, externally arriving empty (or
light loaded) containers should be put on this stack, to be placed on the upper
layer of the ship at the end of the loading process. In this way a stable ship load­
ing can be obtained. An example of a layout of an (automated) passive terminal is
given in Figure 8; a similar setup applies to CoEx. Apart from such automation­
oriented design, passive CoEx terminals also can be equipped with conventional
manned controlled facilities.

A setup for an (automated) combi-crane to be used at an active CoEx terminal (i.e.
the Maasvlakte) is presented in Figure 11. The combi-crane is able to operate
simultaneously on two ships with a maximum width of 22.80 m. An important
R&D point should be an optimized design.

Figure 11: A quay crane for combined loading and unloading

Crucial is the integrated control of two combi-cranes operating on one berth. An
accurate balancing can be achieved using the setup being depicted in Figure 7:
"the slot selection algorithm". A layout of two berths for combi-operations is
given in Figure 12.

In this setup the docking is rather simple. In addition, the quay transport can take
place without reversing the direction. Essential is the "invisible terminal" in the
form of facilities for telematic communication and control.
Coaster Express: An Option for large-scale Coastal Container Feeder

Figure 12: Berths for combi-operations

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FAST FERRIES IN THE EUROPEAN SHORTSEA NETWORK - THE POTENTIAL AND THE IMPLICATIONS

By T. Wergeland and A. Osmundsvaag

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Definition of the market

It is somewhat problematic to clearly define the market for fast ferries. In the following we shall mainly concentrate on the larger ferries with car, and in some cases, trailer and bus capacity with or without passengers. This eliminates all the fast going pure passenger ferries, of which there are more than 1200 in operation. We have developed a database of 946 ferries that we call conventional ferries (i.e. all the ferries with some car carrying capacity that do not move fast). We have defined "fast" to mean ferries with a service speed above 25 knots. The main source of our database is the data provided by Plus 2 Ferryconsultations and is from 1994.

The ferries are distributed according to size as given in Figure 1.

Figure 1: Size distribution of the 946 conventional ferries studied

The distribution of the ferries according to flag, which corresponds closely to the country of operation, is illustrated in Figure 2. Clearly Europe is the main market with almost 52% of all ferries. Together with Far East Asia, the two markets operate 80% of all conventional ferries.
Fast Ferries in the European Shortsea Network - The Potential and the Implications

<table>
<thead>
<tr>
<th>Region</th>
<th>No of vessels</th>
<th>Per cent</th>
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<tbody>
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<td>488</td>
<td>51.6%</td>
</tr>
<tr>
<td>Far East</td>
<td>267</td>
<td>28.2%</td>
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<tr>
<td>North America</td>
<td>94</td>
<td>9.9%</td>
</tr>
<tr>
<td>South America</td>
<td>53</td>
<td>5.6%</td>
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<tr>
<td>Africa</td>
<td>20</td>
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<td>Austral Asia</td>
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<tr>
<td>n.a.</td>
<td>5</td>
<td>0.5%</td>
</tr>
</tbody>
</table>

Figure 2: Flag distribution of the 946 conventional ferries studied

The life of a conventional ferry is changing

The Baltic Sea market has been the most technologically advanced market over the last 20 years and the Finnish yards have been technology leaders in developing the large ferries. The typical pattern of a conventional Baltic Sea ferry can be illustrated as in Figure 3.

After having been replaced by new technology in the Baltic Sea, a typical ferry was sold to an operator either in Skagerrak or in the English Channel. From there the ferry was later sold to be operated in the Mediterranean. At an old age the ferry was further sold to either Africa or Asia from where it finally was scrapped at a very high age.

In later years this pattern has started to change, and will change further fairly dramatically with the introduction of the larger fast ferries. In 1994 we saw newbuildings directly to markets both in the Mediterranean and in Asia. Furthermore, a Baltic Sea ferry was sold directly to the Far East, without going through the traditional stages of ageing. Some of this was due to very special ships that should be used for gambling onboard, but the development reflects more fundamental issues like increased incomes due to high economic growth in some Asian regions, and the lower cost level introduced by the fast ferry technology. In 1995 and so far in 1996 a number of new fast ferries have come into operation and new contracts have been signed for fast ferries to operate in all the main European markets. This has already had an impact on the second-hand
markets for ferries and will no doubt lead to a complete change of the competitive structure of the European ferry market in the years to come.

The new technology - the fast ferries

There is hardly any other newbuilding market for ships growing faster than the fast ferry market at the moment. It is, however, rather difficult to offer a precise definition of the fast ferry segment, as the ships vary a lot as regard size, car capacity, seakeeping capabilities and basic design. We find it useful to distinguish among three main types of fast ferries, as indicated in Table I, but there are no clear criteria for defining the border cases.

<table>
<thead>
<tr>
<th>Type</th>
<th>Length</th>
<th>Passenger capacity</th>
<th>Car capacity</th>
<th>Max. waves (m)</th>
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<tr>
<td>Medium large fast ferries</td>
<td>75-105</td>
<td>500-900</td>
<td>140-210</td>
<td>3</td>
</tr>
<tr>
<td>Large fast ferries</td>
<td>120-130</td>
<td>900-1500</td>
<td>240-375</td>
<td>4-5</td>
</tr>
</tbody>
</table>

Table I: Main types of fast ferries

The small fast ferries are typically enlarged fast boats with some car carrying capacity for pure transportation routes only. They can be built in yards with
experience from building smaller fast vessels. The current designs include enlarged catamarans, wavepiercing catamarans and monohulls of various designs.

The medium large fast ferries are equipped with onboard space for various activities and the designs are again a mix of monohulls and enlarged catamarans.

The large fast ferries are equipped with space for onboard activities similar to what you find in conventional ferries. So far this category is dominated by catamaran designs, but several yards offer monohulls also in this category.

The larger the ferries become, the more the building process will resemble that of traditional shipbuilding and require larger yards. After the first large wavepiercers were introduced in the early 90s, the development has been very fast. Stena is, however, the only company that completely has controlled the entire development of their HSS design.

The main objections against fast ferries have up to now been that they are noisy, give uncomfortable rides in high waves and offer passengers limited or no space for other activities than just sitting in a chair and being transported. This has quite clearly changed with the largest fast ferries that can show seakeeping capabilities on par with, or even surpassing, conventional alternatives, the noise problem is solved and the onboard activities are just as good as for conventional alternatives.

Fast ferry shipbuilders

The fast ferries have developed naturally out of the fast passenger vessel segment. In the 1950s the Italian yard Rodriguez dominated with their hydrofoil design. Then Norwegian builders introduced catamarans that completely dominated the market in the late 1970s and 80s. By almost pure accident, as a dry bulk carrier collided with the bridge that divides Hobart in Tasmania in two parts, an Australian fisherman, Robert Clifford, saw an opportunity in passenger transport. After having built a steel catamaran for his own operation with success, he formed INCAT Australia Pty. Ltd. and became shipbuilder of cheap and fast aluminium catamarans that became great commercial successes in Australia. Without any shipbuilding tradition as we know it from Europe, Australia in a few years became the leading producers of fast passenger vessels. They built upon a yacht tradition, excellent hull designers and a lot of experience in building fast aluminium fishing boats. Even before the local market became saturated, the Australians started exporting, mostly to the fast growing Asian market and is currently market leaders in fast passenger vessels. In the early 90s Robert Clifford again pioneered the business by going up in scale with his own design, the wavepiercing catamaran. At the time he did this, Det Norske Veritas defined a fast passenger vessel as a boat under 50m. As INCAT increased the size of the wavepiercer to 74 meter, Veritas had to revise the rules. Currently INCAT offers an 86 meter (800 passengers and 200 cars). A number of other Australian yards have followed this development, most notably Austal Shipbuilding in Fremantle.
After INCAT's success with the large wavepiercer, a number of European yards have offered fast ferry designs, but most of these designs have been monohull. This is mainly because yards like Bazan, Leroux & Lotz and Fincantieri all have a background as producers of naval vessels, so their designs are inspired by frigate designs and building experiences.

Alternative designs are the large catamarans. The larger they become, the more complicated is the building process and the more it resembles highly specialised traditional shipbuilding. Here most builders completely lack experience, and it is the dominating operator, Stena, that have developed the entire technology around the HHS and brought it to yards like Finnyard and Westamarin. Both are yards with experience either from fast ships or cruise and conventional ferries.

With the important exception of Stenas HSS design, most designs are offered on the basis of previous experience and not so much on what the market requires. One is, therefore, bound to see a number of different designs being offered, dependent on the background of the yard. The trend will be towards tailor-made designs based on operators' specifications, and this implies that more traditional shipyards will gradually try to develop this as a highly specialised product. Here, European shipbuilders should be able to lead on in the competition. Europe has a very strong and complete ferry cluster with both operational expertise, shipbuilding competence and strong ship equipment producers.

**Fast ferry demand: Operational criteria**

A ferry route is a complex business because there are many parameters that determine the economics of a ferry route viewed from the demand side:

- Volume of traffic;
- Composition of traffic, passenger needs and their purchasing power;
- Length of route;
- Weather and sea conditions;
- Port and terminal infrastructure;
- Hinterland transportation connections;
- Customer's willingness to pay for speed and their total utility in travelling.

**Volume of traffic**

Besides sufficient volume, the profile of the flow of traffic is also important. As fast ferries normally will have less capacity than conventional alternatives, a given volume must be served by a higher frequency. To have an even flow of passengers during the day is the ideal situation. If there are traffic peaks, this may create problems. This is illustrated in Figure 4. In this example the peak around 7 o'clock fills up the fast ferry and some of the passengers will have to wait for the next fast ferry. This situation does not occur for the larger conventional alternative. From the point of view of the passenger it is normally much worse to be left behind, having to wait for the next ferry one hour later than to wait the same
amount of time for a scheduled departure. Some of this drawback for fast ferries can be reduced through an efficient booking system. The fast ferry successfully employed on the route to Sardinia is, as an example, practically fully booked a year in advance.

Figure 4: Passenger flow and waiting profiles

So far the fast ferries have mostly been employed on already well developed routes where the traffic flow information is good and volume is sufficient.

Composition of traffic and passenger needs

The first generation fast ferries was designed for transportation purposes only, so the higher the percentage of travellers with a real transport need (commuters, business travellers, etc.), the more suitable is a fast ferry. The largest fast ferry currently operating (Stena Line’s ferry in the Irish Sea) is, however, designed to have many onboard facilities for amusement and shopping, so the clear distinction between transport needs and other aspects of travelling is no longer as important. There are, however, big differences among the various routes regarding how much the passengers spend on board and how much they pay for the ticket. This makes almost every route unique with respect to the concept one must offer. In Figures 5 and 6 the experience of Stena and Color Line is indicated for selected routes.

As indicated in Figure 5, onboard sales account for only 29% on Stena’s route in the Irish Sea, while Color Line (Figure 6) has 72% of the revenue on the Oslo-Hirtshals route as onboard sales.
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Figure 5: The Stena line sales experience 1994

Figure 6: The Color line sales experience

The unweighted average for the routes given in Figure 7 indicates that 54% of all gross revenue is from onboard sales. These figures clearly indicate that the various routes require different concepts. The high onboard sales volumes can to a large extent be explained by the sales of tax free goods. Tax-free sales are,
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however, fairly independent of the length of the journey, which is positive for the fast ferry operator.

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**Figure 7: Distribution of gross revenue on various routes**

Some years ago, the majority of onboard sales revenue was related to tax free goods only. This has changed over the last years and the distribution of revenue in Color Line’s shops, as given in Figure 8, indicates that other types of shopping currently are almost equally important as the traditional tax free goods. This is partly because the new ships offer more shopping possibilities, but also due to the fact that the concepts for shopping are generally changing and will have ship design implications.

**Length of route**

There is no simple answer to the question of what is an optimal length of route for a fast ferry. On the one hand the distance must not be too short, as the ratio of time spent in ports vs. time saved at sea becomes too high and there may be too little time to do any shopping onboard. On the other hand the route must not be too long, as fast ferries (at least the smaller type) generally are less comfortable than the conventional alternatives and have limited space onboard for movement and entertainment. An interval between 35 and 120 nautical miles seems to be natural intervals for fast ferries. An interesting time interval is 45 minutes. On the route Rødby-Puttgarden over the Fehmarn Belt between Denmark and Germany, the current conventional ferries use 75-90 minutes to cross. These ferries are planned to be replaced by faster ferries, some of which would have been able to cross in 35-40 minutes. This is not a feasible policy, however, as the
Figure 8: Distribution of onboard sales revenues - Color line shops 1994

regulations for truck drivers specify a minimum of 45 minutes as a "rest hour". This example shows how many parameters that need to be taken into consideration.

Weather and sea conditions

A fast ferry has advantageous conditions in calm waters and most small to medium large fast ferries are not comfortable in high waves. This has been one of the biggest limitations to the introduction of fast ferries, but is currently no longer a main obstacle. The Stena HSS ferry in the Irish Sea is reported to have superior seakeeping capabilities and new designs of big fast ferries, like the 120 m SPS Ferry (Lewthwaite, 1996) that is designed to carry 1220 passengers and 400 cars in 40 knots up to Sea State 6 (equivalent to full gale) in UK waters.

However, the fast ferries will be limited by ice in winter. This has been the case on several routes in Danish waters in the exceptionally cold winter of 1995/96, causing many cancellations and long delays, both for fast and conventional ferries.

Port and terminal infrastructure

The small- to medium-sized fast ferries have limited needs in terms of shore infrastructure. Gangways for cars and passengers can be improvised (Jepperson, 1996) by using an old barge, cutting it in two and fitting it with a deck and two flexible arms to allow it to follow the tide, but larger ferries need to invest in port facilities equal to larger conventional ferries. In some places berth rights are subject to governmental approval, and this can limit competition from fast ferries.
Hinterland transportation connections

Just as for any other shipping route, the connection from sea to land is important. If a fast ferry route ends farther away from main traffic routes than conventional ones, this will obviously limit the attractiveness of the route. At the same time, higher speed and smaller vessel size may allow the operator to go to ports closer to main connections, so this element can go either way. Since a fast ferry saves time on the sea leg of the journey, this may be combined with onshore cultural or amusement activities to create the most marketable product.

Customers' willingness to pay for speed and their total utility in travelling

By the end of the day this will be a determining factor for the demand for fast ferry routes. Fast ferries will have a relative advantage the higher the income level in the area of the route, the higher the willingness to pay for speed, and the higher the price level for conventional alternatives.

It is in this case important to remember that it is not only what happens when onboard a ferry that will determine passenger behaviour. The utility for a passenger is determined by a sequence of activities, both before the trip, under the trip and after the trip and it is a total evaluation of all activities together that determine what a passenger will choose to do. A Mediterranean operator said in an interview with us that the essence of the ferry business is to get the departure time and arrival time right. Many of the conventional ferries depart late afternoon or early evening because they have cabins and the onboard activities are typically evening activities. This is not necessarily what passengers want. If a passenger is mainly looking for entertainment, then the onboard activities may be important, but it could also be that a quicker sea journey combined with some onshore activities is an attractive alternative. An example of the former is the Stockholm - Åbo route, where the party on board is the essential matter. An example of the latter is the route from Hong Kong to Macao, where the casinos are the main attraction.

The conventional ferries try to attract business from trucks, cruise passengers and transport passengers. To do so large ferries with high lane meter capacity, large number of cabins and a high level of onboard services have been constructed. As it is a fact that passenger demand can fluctuate over the day, the week, the seasons and the year, the big ferries obviously have lost a lot of flexibility to obtain economies of scale. The fast ferries offer a lot more flexibility at low cost, so a better understanding of passenger preferences is crucial to the fast ferry business.

The utility of passengers is state dependent and thus vary a lot over time and with changing circumstances. Studies of time preferences from other modes of transport cannot immediately be transferred to the fast ferry business. Travelling is a sequence of events, and it is not the length of the journey that determines the willingness to pay, but an evaluation of the entire sequence of events and activities (time saved, departure times, arrival times, onboard activities, onshore
activities, comfort, alternative activities made possible by the times saved, etc., etc.), valued against the best alternative.

A fundamental understanding of what elements form the total utility of the passenger is very important and is also where most operators are lacking insight. It is, however, not only a question of identifying passenger needs, but also to form the supply so that passenger needs are "created". This is clearly what Stena is attempting by equipping the HSS with a lot of onboard activities on what is one of the most transport intensive routes in all of Europe.

Demand side conclusion: Unique routes require unique ferries

By combining speed, frequency, total capacity and the mix of transport, shopping and entertainment in the concept, a fast ferry operator can tailor-make a ferry to a particular route. The various routes are so different in structure that each route requires a particular solution. The trend is clear: From the first, almost standardised, large wavepiercing catamarans, where the design was influenced by the shipyard, the operators will in the future not only co-operate with the shipyard to get the correct concept built, but may take complete control of the specifications. So far only Stena has been in this situation.

Fast ferry supply: Technology and costs

The track record of the fast ferries currently in operation has so far been that a majority have had some technical problems, ranging from inability to obtain planned service speed, cracks in hull due to either inadequate welding, engine failure, higher vibration than expected, or a combination. This will most likely continue as we are still talking about fairly new and untested technology.

With the introduction of the largest fast ferries, two of the most serious technological gaps relative to conventional alternatives have been bridged. The larger fast ferries have now good seakeeping capabilities and they have space onboard for shopping and amusement almost as good as the conventional ferries. Still the fast ferries will have limited dwt capacity and under the current IMO rules are not allowed to be equipped with cabins, so in some cases fast ferries will not be able to fully replace conventional alternatives, but on a number of routes the fast ferries have come to stay. It may also be just a question of time before the IMO will have to change their rules as the technology matures and more knowledge about the seakeeping capabilities of the large fast ships accumulates.

The costs of fast ferries

The main advantage of a fast ferry alternative is that the capital cost of the vessel is much lower than for conventional alternatives. Generally one can say that a typical fast ferry has:

- Higher costs per passenger seat/car space than a conventional day ferry;
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- Somewhat higher costs per passenger seat/car space than an overnight ferry;
- Much lower costs per passenger trip than a day ferry (assuming high utilisation rate);
- Up to 50% lower costs per passenger trip than an overnight ferry.

A cost comparison has been made in Figure 9, where two fast alternatives are compared to two conventional alternatives.

The first comparison is between two new 78m wavepiercers, operating all year round on a 100 nautical miles route. These ferries have a capacity of about 600 passengers and 160 cars, so two of them should be able to compete with a 2400 passenger newbuilding. These two alternatives are compared to the Color Line average as this can be calculated from public records.

The second alternative is a comparison of a slightly smaller wavepiercer designed for operation on a 40 miles route in the Greek islands. This is again compared to cost calculations made available through interviews with Greek operators.

![Figure 9: Cost comparisons - fast vs. conventional ferries (mln US$ per year)](image)

As indicated in Figure 9, the cost structure is very different. Fast ferries have:

- Much lower crew costs;
- Much higher bunker costs;
- Lower maintenance costs;
- Lower capital costs.
Technological substitution possibilities

The cost structure of the fast ferries indicates that they are formidable competitors to conventional alternatives if the ferries can match demand requirements. From our database of 356 European ferry routes, we selected 241 routes for detailed analysis as to the technical potential for fast ferry substitution. For each route we calculated how new fast ferries of fixed size (600 passengers and 160 cars) could replace the conventional ferries already in operation.

![Figure 10: Route length, speed and number of trips per day](image)

We looked first at the distances involved and how many routes that could be covered by a fast alternative without making the sea journey too long. This is shown in Figure 10, where the lines indicate the number of trips per day for either 24 hours' service (overnight ferries) or 18 hours' service (day ferries) as a function of speed.

The small dots in Figure 10 indicate the 241 existing routes studied (one dot can be more than one route). At 40 knots and a maximum sea journey of 3 hours, the fast ferries could in principle replace all conventional ferries on routes shorter than 110 nautical miles. This includes all current day services. If one allows a 4 hours' sea journey, all routes under 150 nautical miles could be substituted and a further increase to a 5 hours' sea journey would allow substitution up to 190 miles. It is apparent from this that if a 5 hours' sea journey at 40 knots is an acceptable experience, then virtually all the ferry routes studied could in principle be replaced by a fast alternative.
Fast Ferries in the European Shortsea Network - The Potential and the Implications

This will not happen, however, due to the many conditions that must be met on the demand side as discussed above, but the potential is clearly vast from a purely technological perspective. It is also interesting to note that the fast ferries currently in operation on Corsica and Sardinia have been replacing some of the most sophisticated, cruise-like ferries. This is mainly because southern European passengers do not particularly like overnight sea trips, but prefer a quick ride allowing more time on shore. The fast ferries will, therefore, most likely be found in almost all types of routes in the future.

Current slack on routes

By studying the current frequency on existing routes and comparing this to the theoretical maximum per day if traffic allowed this, one can get a picture of the current slack on existing routes. This is indicated in Figure 11.

As can be seen from this graph, several routes show substantial slack regarding the number of departures per day. This indicates that the traffic volumes on many routes are quite thin, or very concentrated on short time intervals, and both situations are disadvantageous for fast ferries, so there are many cases where fast alternatives do not suit the route.

Substitution of technical capacity

For 191 of the selected 241 routes for which we have complete operational data, we also did the experiment of calculating how many fast ferries of size 600 passengers at a speed of 40 knots one would need to technically replace existing
capacity, measured over the day. This exercise disregards the passenger volumes
as there are so much slack on several routes. The exercise is summarised in figure
12 and shows that in total one would need 241 fast ferries to replace the existing
191. In practise this will not happen, of course, but on many routes the fast
ferries will no doubt change the character of the routes fundamentally.

Typically one would get higher frequency, but if passengers are to pay more for
speed, they will be very intolerant against waiting. Even on very short routes with
high frequency, waiting will be almost intolerable. The ferry operators need,
therefore, to make detailed traffic studies to get the right combination of total
capacity and speed. Also one will see fast ferries being operated in parallel with
conventional tonnage on already established routes, creating a much more
diversified ferry supply.

![Figure 12: Technical substitution of current capacity with fast ferries](image)

**Market structure: an oligopolistic market facing dramatic changes**

If we look at some of the main ferry routes in Europe and the companies operating
these routes, we get a picture as given in **Figure 13**

The figure indicates that most routes are dominated by one or two large operators
and that a number of smaller, local operators exist, but they have moderate
market shares. It is reasonable to assume that the market structure can be
characterised by differentiated oligopoly.
Fast Ferries in the European Shortsea Network - The Potential and the Implications

Under differentiated oligopoly, one can expect the main players to secure their positions and attempt curbing competition by trying to build barriers to entry to their particular market segment. Barriers to entry in the ferry market have so far been substantial. Sometimes the barriers are politically determined, e.g. ferry terminal monopolies. Important barriers to entry exist, however, both because each ferry is very expensive to build and because the various companies through active marketing have created a product that is costly to copy. Some of the almost pure amusement routes, like Stockholm-Åbo, Oslo-Copenhagen and Oslo-Kiel have been built up through marketing where the aim has been to:

- Differentiate the product as much as possible;
- Create a brand name and thus create switching costs for customers;
- Try to build up customer loyalty.

Implications of the cost structure of fast ferries

With the cost structure of the fast ferries as discussed above, a completely new situation has emerged. The barriers to entry have come down so substantially that even non-experienced operators now consider opening a fast ferry route. As the fast ferry product by itself is a novelty, the first to move will get almost free marketing services just by the media coverage of the new fast ships. Since the fast ferries represent a new product, newcomers achieve product differentiation simply by investing in the new ship and need only limited marketing to become established. For the established owners, the investment in fast ferries is quite marginal compared to a newbuilding project of the conventional type.
A second, very important implication of the new technology is that the second-hand values of both existing ferries as well as "yesterday's" fast vessel technology will be reduced, in some cases substantially. This is already a fact. Some second-hand prices have dropped by 15-30% according to brokers in the market, and some expect them to be further reduced. There is, therefore, currently great uncertainty attached to the value of conventional tonnage.

This is of course very serious for the established operators as a major part of their equity is tied to the value of the vessels and the goodwill accumulated over the years through heavy marketing. For some of the operators currently competing with both conventional and fast ferries in the Skagerrak market, some key figures are given in Table II.

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<th>Goodwill</th>
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<td>3.54</td>
<td>38.4</td>
<td>0.83</td>
<td>9.0</td>
</tr>
<tr>
<td>Color Line</td>
<td>3.45</td>
<td>2.71</td>
<td>78.5</td>
<td>0.17</td>
<td>4.8</td>
</tr>
<tr>
<td>Larvik Line</td>
<td>1.20</td>
<td>0.61</td>
<td>50.8</td>
<td>0.36</td>
<td>29.8</td>
</tr>
</tbody>
</table>

*Figures are from 1994 and the numbers are in SEK

Table II: The balance sheet of main ferry operators, billion NOK and %

Stena has a policy of chartering a high proportion of the controlled tonnage. For the two other companies, more than 80% of the book value of the company is related to ships owned and goodwill accumulated. This will clearly be a major problem for these companies if second-hand values come down substantially. The very high goodwill of Larvik Line must be worrying, indeed.

Fast ferry pioneers

Four companies could be said to be the pioneers of fast ferry business - Buquebus, SeaContainers, Holyman and Stena.

Buquebus operates a most profitable route on the Rio del la Plata between Uruguay and Argentine, probably one of the best fast ferry routes in the world. By cutting travel time between Buenos Aires and Montevideo from 9-12 hours with conventional tonnage down to 2-3 hours with fast ferries, they suddenly could offer a good alternative to airline services. The number of passengers per year went up from 400,000 in 1990 to 1.4 million in 1993. The profit earned on this route has been used by Buquebus to build more fast ferries, some of which are chartered to Stena, some are operated in co-operation with Trasmediterranea. Buquebus has demonstrated that fast ferry business can be a global business.

Stena is the world's largest ferry operator with 30 ferries, of which at least 8 (including those on order) are fast ferries. Stena has been early in placing orders for fast ferries and has been pioneers in building larger ferries that have brought
this technology a giant step forward. Stena has developed the concepts themselves and has thus complete control of the technology. After some years with unsatisfactory financial results, the company is today a solid company with resources enough to invest large amounts of money per year to stay ahead in the competition.

SeaContainers pioneered the market by investing in 5 wavepiercers after selling most of their conventional fleet to Stena. Afterwards they have taken up competition with Stena on several routes, and the price competition on the Gothenburg-Fredrikshavn route has been fierce. In the early stages of expansion, SeaContainers demanded an exclusive deal with InCat, but today a number of yards can provide the market with medium large fast ferries. SeaContainers recently sold out Withlink with 3 routes and 7 conventional ferries to further concentrate on the fast ferry segment.

Holyman is an Australian operator (previously TNT Business Development Division) without their own routes and thus a strategy of co-operating with partners. They operate all their fast vessels in a pool to rationalise on operation and maintenance. They have been successful in the selection of routes and partners and are constantly looking for new partners. Currently they plan a new fast ferry route between Malmö and Copenhagen.

National policies influencing the level of competition

Many ferry routes are dominated by national carriers, some of which are almost monopolies in the market, or they receive large subsidies from national governments. This is the case with e.g. DSB Ferries in Denmark, that over the next 3-4 years will receive almost DKR 500 mill. in subsidies according to plan. Their ScandiLine ferry company has had monopoly on the use of the ferry terminal in Helsingør, but this monopoly has recently been broken by granting the company Mercandia access to the very attractive 12-13 million passengers per year ferry route. This development is in line with EU’s competition legislation and will be keenly supervised by the appropriate EU bodies and limit the possibilities of national authorities to prevent competition in the ferry market. This development, in combination with a reduction in the cost barrier to entries in the ferry markets caused by the fast ferries, will no doubt influence the number of new operators that will try to profit on the growing ferry market.

On the other side of the coin, proposals have been voiced in favour of taxing the use of fast ferries, mostly from an energy saving and environmental perspective. This could be potentially very harmful to the fast ferry business.

Strategies in the survival game

Facing the potential threat of this new technology, a number of actions might be considered by established players to secure their position:
Section II - Ships and Terminals

- Move first into fast ferries and reap the benefits of first mover advantages;
- Block potential "holes" in the market by investing in the entire range of transportation alternatives;
- Block competitors by filling up the best yards with orders for a fairly long period of time;
- Invest to show strong commitment;
- Lower prices on established routes to create an artificially low price level where the new fast ferries hardly get a contribution to fixed costs;
- Start up fast ferry services on routes where competitors are already established to take the lion's share of peak markets, thus destroying the cash flow of competitors;

We have witnessed and are currently witnessing all of these strategies being played out in the market.

First mover advantages

All the four pioneers mentioned above moved early to gain experience with the new technology. They are all professional operators and probably did expect to face technical problems. The advantages of being early have, however, most probably more than outweighed the costs of failing technology. They have all gained technical experience, learned how to improve on future designs and have gained operational experience with fast alternatives in the market place.

Blocking "holes" in the service range

Stena was among the first of the big operators that went for larger fast ferries and the solutions they have chosen for their Irish Sea routes indicate that they are trying to block the market by providing the entire range of services. The company made the car deck high enough to accommodate trucks and has also invested in a separate RoRo vessel for this route, obviously to keep competitors away. Although this is one of the routes in Europe with the highest transportation contents, Stena has built a fast ferry with a lot of onboard activities although the trip has come down from 3.5-4 hours to 99 minutes. Stena has obviously not planned for passengers just to sit waiting, but to indulge in both shopping and other activities during the short journey.

Another very important aspect of filling the entire range, is the possibility to differentiate prices across the service range. This can be very profitable, but requires that one can control all the prices. If one competitor is controlling one part of the service, he can also destroy an optimal price differentiation strategy, which can be very costly.

Blocking yard facilities

The smaller fast ferries are enlarged fast boats that can be built by a number of yards around the world. The larger ferries represent technologically new challenges for yards and there are so far only a few yards that can build these
Fast Ferries in the European Shortsea Network - The Potential and the Implications

satisfactorily. Stena has virtually blocked a lot of this capacity with their orders to Finnyard and Westamarin, and SeaContainers has placed an order for 6 large monohulls at Fincantieri that will have some of the same effect - keeping competitors out of the market for a while. It will, however, only be a matter of time before other yards start offering large ferry concepts.

**Investments as signals of commitment**

By investing in a series of newbuildings, an operator signals very clearly that it is committed to its services. This is a most efficient credible threat to anyone contemplating starting up competitive routes. SeaContainers’ orders by Fincantieri could be such a signal, more than an attempt of blocking newbuilding capacity.

**Price competition**

This has most clearly been witnessed on the Gothenburg-Fredrikshavn route, where Stena has reduced their income by as much as 200-300 million SEK to keep SeaContainers from getting a too high market share, but still SeaCat managed in 1995 to get 14% of this 3.2 million passenger per year market. On other short routes, like Malmö-Copenhagen, competition has driven the prices down to levels 50-60% lower than a few years ago in real terms. Mercandia has also indicated that they will cut ticket prices by as much as 30% when entering the Helsingør-Helsingborg route.

The low cost level of the fast ferries makes a price war strategy from established operators an unattractive alternative. In some cases one might see that operators will lower prices to "scare off" potential competitors, but this is a very costly alternative.

**Taking lion’s shares of competitors markets**

This is a very recent development that can have dramatic consequences for the market. When second-hand values fall and the accumulated goodwill is eroded by new products and new operators, some of the established operators will have financial problems in terms of reduced possibilities to follow up with new investments to keep up their market shares. Sales of old ferries will be limited, because no-one is interested in actually showing the drop in ship values. To further decrease the manoeuvring possibilities of competitors an effective strategy could therefore be to hit the competitor where it hurts the most - to attack the cash flow of the competitor. A fast ferry is the ideal instrument with which to achieve this.

Stena plans to start up a summer route from Kristiansand to Hirtshals in direct competition with the sole operator on this 1 mill. passengers per year route - Color Line. This will no doubt reduce Color Line’s revenues substantially as this is a very profitable summer route with 3-4 departures per day. It remains to be seen if this materialises.

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Larvik Line has recently started up a fast ferry line from Larvik to Skagen that is an attractive region with many onshore activities. Color Line has also started a fast ferry route from Langesund to Fredrikshavn, that is a direct competitor to Larvik Line, although they probably aim more for those travellers wishing to go by car south through Denmark. They have already started a fierce price competition, but both operators have had a lot of technical problems, as expected. This increased competition and the cutting in on competitors' markets may have structural implications for the ferry market. In the short- to medium term one would probably see some newcomers alongside with the main current operators, then in the longer run there will be a consolidation period where the larger and more successful companies will buy up competitors. Those companies owning a lot of conventional tonnage will be at a disadvantage in this situation. It is difficult to see any strategic moves they could do to get out of this situation, unless they have financially very strong owners. The fact that the new technology has reduced the barriers to entry to the market will, therefore, secure a very dynamic ferry market in the years to come.

Near future perspectives

The current order book for fast ferries as per March 1996 is indicated in Table III. The figures show that it is the largest type of medium large ferries that are most popular.

<table>
<thead>
<tr>
<th>Type</th>
<th>Number</th>
<th>Passenger capacity</th>
<th>Car capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small fast ferries</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- existing</td>
<td>9</td>
<td>3112</td>
<td>318</td>
</tr>
<tr>
<td>- new orders</td>
<td>4</td>
<td>1495</td>
<td>100</td>
</tr>
<tr>
<td>Medium large fast ferries</td>
<td>18</td>
<td>10792</td>
<td>2316</td>
</tr>
<tr>
<td>- new orders</td>
<td>33</td>
<td>17896</td>
<td>4523</td>
</tr>
<tr>
<td>Large fast ferries</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- existing</td>
<td>2</td>
<td>6050</td>
<td>469</td>
</tr>
<tr>
<td>- new orders</td>
<td>5</td>
<td>8010</td>
<td>1420</td>
</tr>
<tr>
<td>Total</td>
<td>29</td>
<td>15664</td>
<td>3103</td>
</tr>
<tr>
<td>- new orders</td>
<td>42</td>
<td>25441</td>
<td>6043</td>
</tr>
</tbody>
</table>

Table III: Existing fast ferry fleet and orderbook as per March 1996

If this is converted into the equivalent of 1500 passenger conventional tonnage, the fast fleet corresponds to 21 conventional ferries and the order book to 34 ferries. By the summer 1998 fast ferries will constitute more than 10% of the total ferry capacity in Europe, and will represent a most dynamic element in the ferry market.
Fast Ferries in the European Shortsea Network - The Potential and the Implications

To what extent the fast ferries will be a commercial success will depend on four major factors and their mutual interplay:

- Customers preferences and willingness to pay;
- The cost advantages relative to conventional tonnage and the possibilities of adjusting both prices and costs;
- Technological development with respect to both costs and substitution possibilities;
- The competitive climate in the various ferry segments;

We believe that many ferry operators are underestimating the importance of the fast ferry technology. Some of these companies will not survive in the market.

Implications of the fast ferry development

We will assert that the introduction of large fast ferries is perhaps the greatest technological change in shipping since the introduction of the VLCCs and the container vessels in the late 60s. Even if this technology is in its infancy and the introduction of it often has been problematic with much technical trouble, this technology has come to stay. It will have a number of effects not only on the traditional ferry market, but will also affect the transport sector more generally and will no doubt increase the importance of short sea shipping in European transport.

Implications for the ferry market

This has been discussed at length above, but a summary would be that, due to reduced costs and high performance, the fast ferries will:

- Increase the degree of differentiation in the ferry market;
- Increase competition both from established operators, but also newcomers;
- Lead to dramatic reductions in second hand values of existing tonnage;
- Lead to generally lower transportation costs due to overcapacity, high level of competition and a lower cost of the new technology;
- Create completely new routes;
- Cause a fundamental restructuring of the ferry market with regard to competition.

Implications for the transport sector

One of the implications of this new technology is that it may affect the profitability of transport infrastructure investments. Furthermore, the fact that the fast ferries can go really fast, now also in fairly rough waters, opens up for completely new routes and traffic patterns.

The fast ferries represent a substitute to bridges and tunnels that may affect such transport projects negatively. Two good examples are the Eurotunnel and the
bridge over Øresund currently under construction. Fast ferries represent an alternative on both these routes and this will affect the prices that in the future can be charged for passing the tunnel and the bridge. Both projects will have to lower their prices to meet this competition. It will be particularly interesting to follow the co-operation of Stena and P&O on their joint fast ferry cross Channel route. This may not necessarily reduce the profitability of the projects as the price elasticity may be high enough to compensate for lower unit prices, but it will at least lower transportation costs.

When the Swedish and Danish governments agreed on the Øresund connection, the longer term plan was that another bridge should be constructed across the Fehmarn Belt (Rødby-Puttgarden), connecting Denmark with Germany thus creating a transport route from Scandinavia to the Continent without any ferries. This project is now highly uncertain, partly because this implies increased traffic to the already congested area around Hamburg. New fast RoRo connections from either Gedser or Trelleborg to Warnemünde and traffic connections south towards Berlin are only a couple of many examples of alternatives that may be in operation long before such a bridge could be constructed, and that could completely alter the economics of such a giant project.

Implications for policy makers

The nature of the fast ferry technology represents an almost revolutionary element in short sea shipping. So far, not enough resources have been allocated to study the market implications and the longer term consequences for other transport modes. This may lead to misallocation of transport infrastructure investment projects, some of which are gigantic in size. Knowing what we know about this technology today might have changed the way one would have looked at the multi-billion investment in the Eurotunnel or the Øresund-connection.

The European ferry cluster is very strong and complete. From an EU perspective all kinds of support to assist the fast ferry industry might have very positive effects. European shipbuilders, ship equipment producers and ferry operators have all the competence needed to be leaders in this technologically advanced business. Rather than thinking in terms of taxing the use of fast ferries, research support should be given to the development of the next generations of fast ships. This support must not, however, only go to the technical institutions and the yards. More than for any other shipping market are commercial understanding and market knowledge a prerequisite for success.

Fast ferries have come to stay and the sooner this is understood and incorporated in transportation policies, the better are the chances of avoiding spending scarce resources on the wrong transport infrastructure projects in the future.
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POTENTIAL FOR NETWORK DEVELOPMENT IN SHORTSEA SHIPPING

By M. Garratt

Paper will be added later
THE ROLE OF GREEK SHIPPING AND PORTS IN THE GREEK-ITALIAN SHORTSEA NETWORK

By A.M. Goulielmos

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THE ROLE OF GREEK SHIPPING AND PORTS IN THE GREEK-ITALIAN SHORTSEA NETWORK

1 Introduction

One of the objectives of the European Union is to create and develop Trans-european Transport Networks (TTN). These TTN are one step further than the Common Transport Policy (CTP), which has been developed initially since 1985, but especially since 1992. One must note that the formulation of a Common Transport Policy in the E.U. has delayed, without persuasive explanation, for many decades. At the end of 1992 E.U. realised the importance of CTP and the implications that it may have on E.U. economy.

Economists, however, long ago have argued that for Competition to be effective free movement of all factors of production should be established. And this free movement of factors of production ensures the least cost combination in the production process (which at the same time is a profit maximisation combination given the prices of factors of production as well as other elements). Apart from the criterion of competition, which in my view is the only correct one, there is also the concept of free trade. Free trade is considered by Economists as a perfect substitute for factor mobility. Free trade will have the effect of equalising the rate of payment to any factor of production in all E.U. countries. Free movement of goods as well, in addition to that of factors of production, means also that prices

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2 In 1985 the European Court decided that all land transportation of goods and passengers is free for all companies (no matter their nationality or location). This was a Court decision that established "legal" competition, in our view.

3 Year 1992 is considered as a crucial land mark in the development of CTP, as it has been moved towards a more integrated policy. Also obtained a critical attitude towards Community’s transport systems with a view to correct their mal-function. The objective here is to abolish any remaining restrictions or distortions in transport and to increase respect to the environment.

4 See CEC op. cit.

5 This is the well celebrated theory of factor-price equalisation i.e. a proposition from the Heckscher-Ohlin approach to International Trade, which argues-given certain assumptions which are considered restrictive-free trade is a perfect substitute for factor mobility. See J. Vanek, (1962), "International Trade: Theory and Economic Policy"
of goods will be, too, equal in E.U. Moreover, the relative scarcity of some factors of production in different countries of E.U. will be alleviated through free trade. Competition in general is one of the objectives of the EU, but competition must work in Labour Markets as well. Competition in labour markets means free mobility. It is obvious from the analysis so far that a single market in order to be successful, it should be competitive and in order to be competitive, it should ensure free mobility of factors of production including labour plus other factors that can be secured by free trade. Transportation is indeed one of the basic means by which mobility is practically achieved. Other prerequisites (for labour e.g. free information as proposed by EURES) are, too, needed. Transportation is also the mean to create a market together with Communication. This idea is based on the market definition which is a place where demand and supply "meet". More scientifically a market is the area within which the price of a commodity tends to uniformity, taking into account costs of transportation. This means that this form must be taken also by the so called single market. Efficient and competitive transportation thus complements a market or rather creates it, taking into account costs of transportation. The lower the costs of transportation, the greater the number of goods or services entering the market, given elasticity of demand.

Commission of E.C. successfully issued White Book for the purposes of integrating the Internal Market and more importantly considered Transportation to come under the actions that should receive priority. C.E.C. recognised that abolishing the restrictions that exist in the provision of services in the transport sector, that will be of a decisive importance for the full abolition of other restrictions to trade like administrative, technical, fiscal, and those related to customs.

2 Transeuropean Transport Networks (TTN)

It is well recognised that up to 1992, transport networks were designed to a great degree with national needs in mind. There was, obviously, a lack of coordination not only at European level but, in my view, also at National level with

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1 To be in conformity with theory we must pay attention to the three assumptions that are made: (a) closeness in factor endowments in EU countries, (b) absence of factor reversals, and (c) absence of transport costs.

2 A principle based on the theory of the equalisation of Net advantages formulated by A. Smith (Book 1, ch. X, 1776). Competition in Labour markets ensures that the whole of the advantages and disadvantages of different jobs will be either perfectly equal or continually tending to equality. This theory is also called the fundamental-long run-equilibrium construction in Labour Economics. See R. F. Elliott, (1991), "Labour Economics", A comparative text.


4 Single Act indeed speeded up the decision-making process in EU by introducing the majority voting in such matters like Sea and Air Transport.

5 C.E.C., Com. (92) 494 final (in Greek).
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reference to various means of transportation. Moreover, a greater emphasis were given on the development of single transport networks of one type, than on the relationships between them or their place within one greater integrated set. The problems that have been so far created: (1) frequent absence of suitable connections of national networks, (2) existence of congestion, (3) absence of services, (4) lack of co-ordination and inoperability. In the above picture, where inadequacies of TTN are indicated, one must add the different geographical and economic history of Member Countries, which may be responsible for different levels of quality and development of transport infrastructure. Also, there are additional problems at the periphery of EU and at its South Regions. TTN maximise the role of transportation and indeed Commission not only considers them basic for the free movement of goods, services and people, but also for economic development and growth of Member Countries, for social and economic cohesion of EU and for the supply of better quality services to transportation users.

In effect EU has to implement title XI of the EU Convention for the creation of TTN and for this purpose Commission issued on 7/4/94 a proposal which has been connected with the directions of EU in the development of TTN [Com(94) 105 as amended by Com.(95) 48 22/2/95]. The European Parliament endorsed the opinion that in the design and development of TTN, Member Countries should take into account the required protection of the environment. Indeed, accordingly with article 130 II of the Convention, European Parliament proposed the use of the lesser environment damaging means of transport based on national geographical situations.

It is now clear that CTP is there to help in creating a new and freer market, without obstacles and quantitative restrictions, which at the same time would provide guarantees to all equal terms of competition. Some progress has already been made towards improving competition, economic efficiency, effectiveness and quality of transport companies, but still a lot remains to be done. Measures are planned to be introduced for: (1) the protection of the environment, (2) transport research and development, (3) improvement in a selective way of transport infrastructure, (4) relationships with third Countries, (5) improvement of safety in Transport.

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1See A. Italianer, (1989), "Economic Implications of the Completion of the EU Internal Market", p. 25,37-38. All transport means (Inland, Maritime, Air, Auxiliary) assumed to add to welfare about 12%, or 2.51% share in final EU product other estimations determine this up to 6% of GDP.


4Indeed the new Maastricht treaty will ratify and at the same time will give a new move forward of CTP.

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3 TTN and Greece

TTN have as an objective to offer a uniform transport system which will cover the following networks: (1) roads, (2) railways, (3) rivers, (4) airports, (5) ports, (6) management of the transport means (telematics in transport) and why not (7) short sea routes. European Union indeed has today proceeded fast to the adoption of a uniform European Transport Policy with a view of modernising, developing and encouraging the competitiveness of European Transportation.

TTN in particular should be so designed as to achieve:

1. The long term sustained movement of persons and goods in a borderless area within the best possible social and safety conditions, taking into account Community’s targets, especially those with respect to the environment;
2. The improvement of the economic and social cohesion of the community;
3. The provision to users of a quality transport infrastructure under best possible economic terms;
4. The coverage of the totality of means of transport, each of course with its comparative advantage;
5. The best use of the existing transport infrastructure, in a complementary, non antagonistic, approach;
6. The interoperability and their economic viability where possible;
7. The coverage of the total area of the Community, with special emphasis on the accessibility in general and especially between islands, between peripheries and central areas, between large civil zones and unpopulated areas, and all the above without phenomena of congestion;
8. The possibility of a future connection of EU transport networks with the EFTA area, the Central and East Europe and the Mediterranean. This last target works towards the idea of the so called Pan European Transport Networks
9. The further development of a Combined European Transportation.

The above list is a very impressive mentioning of the targets of the TTN policy by European Union, where moreover transportation is a mean of economic justice between Member Countries. All Member Countries should have free and equal participation in the Single European Market, from any point, and this cannot be done unless transportation meets the above requirements.

Creacee recognised the critical importance of TTN and PTN for its further development and cohesion with EU and East Europe and tried to contribute in determining

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1As mentioned above 1992 can be considered as a landmark when White Book of Transportation approved in Dec. 1992. The White Book of Transport determined the main directions of how to adopt a strategy to implement the Common European Policy in the Transport Sector.

2See documentation of the 2nd Pan-European Transport Conference, 14, 15, 16 March 1994, Crete, European Conference of Ministries of Transport, Submission by ECMT.
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The priority of TTN works that should be carried out. The fourteen works have received their priority in TTN and have been confirmed by the European Council in December 1994 at Essen. Each of the above works according to a degree of priority will start between 1995 and 1996. Further twenty one and additional five works were planned to complement those original fourteen for a structural development of the TTN (starting from 1997 up to year 2000). In the first bundle of works, Greece has two important ones: one is the high speed motorway (closed) between Patras and Salonica. Both cities at the beginning and at the end in this motorway are also important ports. Patras is also an international short sea port connecting Greece with Italy and with the TTN starting from Italy. The second is the Egnatia Road. This last road is considered very important for the north Greece horizontal connection of the two coasts of Greece. This connection due to geological obstacles was not ever possible. This road includes three short sea ports Igoumenitsa-Salonica-Alexandroupolis. Igoumenitsa will become very important international short sea port in the west coast of Greece. Being also at the upper end of Greece is best located for Greece-Italy connection as it makes sea distances shorter (for Italy and Europe). But Egnatia road is something more important as it may connect all Countries that have borders with Greece with Igoumenitsa port and thus with Europe and vice versa. All ports of Italy that are today used by Greek Ferries i.e. Ancona, Bari, Brindisi, Venezia, it is planned to have: (a) high speed Railway lines by 2010 (see map 1), (b) new road routes planned as that between Brindisi and Bari (2010 horizon) and between Roma and Venezia (see map 2). The other ports have existing road connections. As far as Greece is concerned high speed railway lines are planned (2010), between Patras-Korinthos-Athens-Salonica-Idomeni borders (see map 3). Unfortunately railway lines planned to Igoumenitsa port will be conventional. This puts this port in disadvantage comparatively with Patras Port. As far as roads are concerned both Igoumenitsa and Patras ports are served (see map 4). The possible disadvantages of the above set up is that both Ports of Patras and Igoumenitsa are constrained for expansion by the city. One possible existing port that can be used is that at Astakos (map 5) provided road, railway and air connections are developed. Astakos port can be used as a "relief" port for both Patras and Igoumenitsa. In case that these three ports become congested, Action (see map 5) port may be expanded, especially after the Rio-Antirio bridge construction.

1This has been done during the European Meeting of the Prime Ministers of Member Countries at Corfu in 1994.
3Igoumenitsa-Salonica-Alexandroupolis-Ormenio (Greece/Bulgaria borders)-Kipi (Greece/Turkey borders).
4See modified proposal of a decision of European Parliament and Council op. cit., p.44,58.
5Ibid p. 40, 54.
In the second bundle of works the new Athens (Spata) airport is included (1999-2010). We turn now to the Short Sea Network (SSN).

4 Greece-Italy Short Sea Shipping Network

4.1 Introduction

Between Greece and Italy takes place an important short sea network connecting Greece and East Mediterranean with Italy and Europe. This article will examine the RoRo short sea traffic that is provided in this service (passengers, wheeled traffic). We will analyse the pattern of supply and demand, the way freight rates are made, the way competition is formed; especially the competition that has appeared lately by three new units, the so-called fast ferries providing 20-25 knots per hour, will be examined. This short sea network should be examined, however, whether is compatible with the policy of European Union vis-à-vis TTN and PTN, and how this fits into the Road, Air, Railway and River Networks that are planned to be developed in Greece and in Italy.

Short sea shipping has long been recognised as possessing beneficial features like being friendly to the Environment and able to relief roads from congested and polluting traffic. The Shipping Companies that serve Greece and Italy and the ships they own are shown below in Table I.

As far as the pollution of the air environment is concerned indeed, with the RoRo system, private cars and lorries are kept out of operation in ship’s garages and away from congested roads. Especially, in the Greece-Italy network North Italian ports like Venice (954 kil. from Brindisi) and Trieste, especially from port of Igumenitsa, provide an opportunity for cars and lorries to avoid covering a considerable road distance given that their origin and destination fit with these ports.

1 See “Transeuropean Transport Networks and Greece”, article by Greek ex Minister of Transport and Telecommunications, Mr Th. Tsouras, in the “Constructor of Houses and Technical works”, May-June 1995 (in Greek). Also see E. Vasilakos, ibid, “Transeuropean Networks-latest developments”, p. 240-247 (in Greek).

2 In accordance with data from Port of Patras, vessels Superfast I started in April, Superfast II started in June and Aretousa started in July, 1995.

3 Pan European Transport Network.

4 Between 1973 and 1993 the emission of carbon dioxide by freight and passenger motor vehicles increased by almost 50% (community adopted the target of stabilising CO2 emissions by 2000 at 1990 levels). Concern is also shown about increased Nitrogen oxide emissions that create the “green house effect”. Transport is also accused for water, soil pollution, noise, and vibration. See European Commission, Task Force, Transport Intermodality. A calculation carried out by Julia Englezou at our Dept. of Maritime Studies, at high season, a selected vessel emits out 4032 kgs of CO, while wheeled traffic could emit 16325.1 kgs of CO when on road. For NOx vessel is worse to wheeled means in a proportion of 7 to 4.
The Role of Greek Shipping and Ports in the Greek-Italian Shortsea Network

<table>
<thead>
<tr>
<th>No.</th>
<th>Company</th>
<th>Number of ships</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1990</td>
</tr>
<tr>
<td>1</td>
<td>Med. Link</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>Adriatica</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>Greek Med. Lines</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>Ventouris Ferries</td>
<td>5</td>
</tr>
<tr>
<td>5</td>
<td>Marlines</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>A.K. Ventouris</td>
<td>-</td>
</tr>
<tr>
<td>7</td>
<td>Ikaria Sh.A.S.</td>
<td>-</td>
</tr>
<tr>
<td>8</td>
<td>Fragline</td>
<td>2</td>
</tr>
<tr>
<td>9</td>
<td>Richmond Shipping Ltd</td>
<td>-</td>
</tr>
<tr>
<td>10</td>
<td>European Seaways</td>
<td>2</td>
</tr>
<tr>
<td>11</td>
<td>IS Lines Maritime SA</td>
<td>-</td>
</tr>
<tr>
<td>12</td>
<td>New Olympic Ferries</td>
<td>1</td>
</tr>
<tr>
<td>13</td>
<td>Poseidon Lines</td>
<td>-</td>
</tr>
<tr>
<td>14</td>
<td>ANEK</td>
<td>2</td>
</tr>
<tr>
<td>15</td>
<td>Minoan Lines</td>
<td>3</td>
</tr>
<tr>
<td>16</td>
<td>Strinzis Lines</td>
<td>5</td>
</tr>
<tr>
<td>17</td>
<td>Oriental Marine Srl</td>
<td>-</td>
</tr>
<tr>
<td>18</td>
<td>Saint Efthimios Nav.</td>
<td>-</td>
</tr>
<tr>
<td>19</td>
<td>Various companies</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>41</td>
</tr>
</tbody>
</table>

Source: Compiled from data provided by Port of Patras Authority

Table I: Ownership pattern of the shortsea shipping on the Patras-Italy route

From interviews made, one can broadly derive that people going to Brindisi and Bari have for destination South Italy, those going to Venice have Austria and Germany and those going to Ancona intend to go to North Italy and France. While those going to Trieste have destination Switzerland, Austria and Croatia. So, Bari and Brindisi are competitive ports as well Venice and Trieste.

Between port of Patras and Italy moved in 1995 216,244 lorries and 166,018 private cars. The existing pattern, as will be argued, should change as south Italian ports like Ancona, Brindisi and Bari covered in 1995 86% of passenger traffic, while Trieste and Venice only 14%. In wheeled traffic Venice and Trieste covered also in 1995 only 9% (34,240 units including private cars, lorries and buses). Ports will be analysed in a separate section.

4.2 Pattern of Supply of ships between Greece and Italy

Looking at the supply data for 1990, 1993, 1995 we can see from Table I, that the companies involved in the Patras-Italy short sea network are less than twenty owning about 50 ships. The interesting pattern is the strong seasonality and
cream skimming\(^1\) pattern that has been found in both supply and demand, as shown in Figure 1.

![Diagram 1: Seasonality pattern of traffic between Greece and Italy 1995](image)

**Figure 1: Seasonality pattern of traffic between Greece and Italy 1995**

As it is shown by the above table only 18 companies served the routes using 52 vessels in 1993 with three ships on average. This size of three ships seems to be the right one to serve these particular routes given that five companies maintained this size. Five large companies maintain fleets of four and up to seven ships each. As a conclusion we may say that in this itinerary the majority of the companies are small (13 companies have three or fewer ships). This pattern i.e. of small ownership base is also found in licensed Greek Coastal Passenger Shipping\(^2\). Though is not required by law, 11 ships in 1994 had licenses, belonging to ANEK, Minoan and Strintzis Lines. These companies serve also other Greek ports where a license is required.

As for the flag pattern of the above ships, in 1993, 20 ships (38%) had Greek flag, 19 ships had Cypriot flag, 8 ships had Maltese, 3 Italian, 1 Croatian and 1 that of the Netherlands. In 1990, 18 ships (44%) had Greek flag, 10 Cypriot, 7 Maltese, 5 Italian and 1 Yugoslavian. One may notice that between 1990 and


\(^2\)According to Greek Law all domestic coastal lines have to obtain a license from Greek Ministry of Shipping. International routes like that of Greece-Italy does not require the possession of a license. This means that free entry and exit is possible and needs no Governmental permission. See B. P. Pashigian, (1995), "The price theory and its applications", p. 236-240, McGraw-Hill, Inc.
The Role of Greek Shipping and Ports in the Greek-Italian Shortsea Network

1993 a limited (6%) flagging out from Greek flag has taken place following the general pattern in shipping since 1983. An important pattern in the route, is the volatility of both Companies and Ships that come into the route and get out, either over the years or over the months of the same year. We turn now to the itinerary pattern of the route.

It is our objective to find out whether competition can been developed between these 18 companies one criterion is the route served. The routes served in 1990 and 1993 are shown in Table II.

<table>
<thead>
<tr>
<th>No.</th>
<th>Route</th>
<th>No. of vessels</th>
<th>No. of companies</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1990</td>
<td>1993</td>
</tr>
<tr>
<td>1</td>
<td>Patras-Brindisi</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>Patras-Igoumenitsa-Corfo-Brindisi</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>3</td>
<td>Patras-Sami-Brindisi</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>Patras-Igoumenitsa-Bari</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td>Tsesme-Patras-Ancona</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>6</td>
<td>Patras-Igoumenitsa-Brindisi</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>7</td>
<td>Tsesme-Iraklion-Patras-Ancona</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>Patras-Igoumenitsa-Ancona (or Trieste)</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>9</td>
<td>Patras-Ancona</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>10</td>
<td>Patras-Bari</td>
<td>-</td>
<td>5</td>
</tr>
<tr>
<td>11</td>
<td>Patras-Igoumenitsa-Corfu-Ancona</td>
<td>11</td>
<td>10</td>
</tr>
<tr>
<td>12</td>
<td>Constantza-Ikalion</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>13</td>
<td>Patras-Venizia</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>14</td>
<td>Patras-Cefa.-Paxi-Ig.-Corfu-Brindisi</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>41</td>
<td>52</td>
</tr>
</tbody>
</table>

Source: Compiled from data provided by the Port of Patras Authority

Table II: Greece-Italy itinararies 1990, 1993

As can be concluded from the above analysis apart from Greece, also, Turkey, Rumania and Italy are served by Greek Ferries. At the end of these routes is of course the European Transport Network of Italy. The mostly served ports of Italy are first Ancona with 21 ships, Brindisi with 19 ships and Bari with 11 ships. Certain routes are monopoly routes as in these one company appears only (three routes, No 3, 7, 12, table 2). In all the remaining nine routes, companies competing are two or more and the number of ships comes up to ten in one route. Competition must also increase due to the fact that many companies go finally to the same destination either directly or indirectly serving mostly the same ports as well as the same country.

1In 1995 the flag pattern was Greek 41%, Cypriot 39%, Maltese 11% and Italian 9%.

2See below for the pattern of calls between ports and ships.
Section III - Shortsea Shipping and ports

One must repeat here that these Italy-Greece routes show a strong seasonal pattern. So, from the 52 ships found in 1993 to serve the routes, 24 ships served the routes for three months or less, i.e. the summer months. In 1990, 41 ships worked 221 months and 11 days, while in 1993 52 ships worked 281 months. Interesting enough is the fact that on average in both years the duration per ship is the same and equal to 5.4 months. This means that more traffic means more ships not more trips.

This last point means further that economics of scale have not been as yet fully exploited. In 1995, we must note that the pattern of service has developed as shown in Table III.

<table>
<thead>
<tr>
<th>No.</th>
<th>Port of destination</th>
<th>No of passengers</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Brindisi</td>
<td>343,751</td>
<td>35</td>
</tr>
<tr>
<td>2</td>
<td>Tsesme (Turkey)</td>
<td>55</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>Baris</td>
<td>98,478</td>
<td>10</td>
</tr>
<tr>
<td>4</td>
<td>Venice</td>
<td>103,440</td>
<td>11</td>
</tr>
<tr>
<td>5</td>
<td>Ancona</td>
<td>388,203</td>
<td>40</td>
</tr>
<tr>
<td>6</td>
<td>Kusantasi (Turkey)</td>
<td>5</td>
<td>-</td>
</tr>
<tr>
<td>7</td>
<td>Trieste</td>
<td>36,881</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>970,813</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: Compiled from data from Port Patras Authority

Table III: Ports of Italy served (%) by ro-ro shortsea shipping 1995 from Patras

As shown in the above table Ancona (is quite north in Italy, see map 1) keeps the majority of traffic followed closely by Brindisi (which is at the other end in South Italy). Trieste and Venice as mentioned had only a 15% share.

The seasonality pattern is very strong among passengers and as well as in private cars. The seasonality, however, does not appear in the traffic of goods by lorries as shown in Table IV and Figure 1.

As shown in Figure 1, strong seasonality pattern is shown as mentioned only between passengers and private cars in all routes between Greece and Italy especially months of July, August and September. Traffic of lorries is evenly distributed over the year.

One can notice in these routes the cream skimming situation as ships appear only during summer months as shown in Table V.

Port of Trieste is entirely in the hands of Cretan Company ANEK, as three of its ships serve the route: Lato, Criti (which has now been sold) and El. Venizeilos (which covers 75% of year calls). Venice is entirely in the hands of co-operating companies of Minoan and Strintzis. The number of calls are almost evenly distributed between the five vessels out of six, as follows:
Table IV: Traffic’s seasonal pattern, 1995

<table>
<thead>
<tr>
<th>Vessels</th>
<th>% of calls</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Ionian Galaxy</td>
<td>0.46</td>
</tr>
<tr>
<td>2. Dehalus</td>
<td>22.37</td>
</tr>
<tr>
<td>3. Ionian Island</td>
<td>25.80</td>
</tr>
<tr>
<td>4. Fedra</td>
<td>25.34</td>
</tr>
<tr>
<td>5. El Greco</td>
<td>26.03</td>
</tr>
<tr>
<td>Total</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Ports of Tsesme, but also Kusantasi (July-August), are served only during summer months:

<table>
<thead>
<tr>
<th>Vessels</th>
<th>Port</th>
<th>% of calls</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Poseldon</td>
<td>Tsesme</td>
<td>44.3 June-August</td>
</tr>
<tr>
<td>2. Ag. Andreas</td>
<td>&quot;</td>
<td>8.2 June-July</td>
</tr>
<tr>
<td>3. Charm M.</td>
<td>&quot;</td>
<td>47.5 July-Sept.</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>100.00</td>
</tr>
</tbody>
</table>

The Tsesme route in 1995 was in the hands of Marlines S.A. and P. Shipping Ltd (Malta) (92%). The Kusantasi route is 100% in the hands of Marlines S.A.

<table>
<thead>
<tr>
<th>Vessels</th>
<th>Port</th>
<th>% of calls</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Countess M</td>
<td>Kusantasi</td>
<td>100.00 August-Sept.</td>
</tr>
</tbody>
</table>
Table A: Port of Brindisi

<table>
<thead>
<tr>
<th>No.</th>
<th>Vessel</th>
<th>Port</th>
<th>% of year calls</th>
<th>Months</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Media II</td>
<td>Brindisi</td>
<td>6.49</td>
<td>March-Oct.</td>
</tr>
<tr>
<td>2</td>
<td>Egitto Express</td>
<td>&quot;</td>
<td>2.91</td>
<td>June-Sept.</td>
</tr>
<tr>
<td>4</td>
<td>Poseidonia</td>
<td>&quot;</td>
<td>2.47</td>
<td>June-Sept.</td>
</tr>
<tr>
<td>5</td>
<td>Sansovino</td>
<td>&quot;</td>
<td>0.51</td>
<td>Sept.</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td>16.59</td>
<td></td>
</tr>
</tbody>
</table>

Table B: Port of Bari

<table>
<thead>
<tr>
<th>No.</th>
<th>Vessel</th>
<th>Port</th>
<th>% of year calls</th>
<th>Months</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Criti</td>
<td>Bari</td>
<td>10.32</td>
<td>Apr-Sept.</td>
</tr>
<tr>
<td>2</td>
<td>Baroness M.</td>
<td>&quot;</td>
<td>0.74</td>
<td>June</td>
</tr>
<tr>
<td>3</td>
<td>Charm M.</td>
<td>&quot;</td>
<td>2.58</td>
<td>July-Sept.</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td>13.64</td>
<td></td>
</tr>
</tbody>
</table>

Table C: Port of Ancona

<table>
<thead>
<tr>
<th>No.</th>
<th>Vessel</th>
<th>Port</th>
<th>% of year calls</th>
<th>Months</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Contess M.</td>
<td>Ancona</td>
<td>1.05</td>
<td>March, July, Sept</td>
</tr>
<tr>
<td>2</td>
<td>Duchess M.</td>
<td>&quot;</td>
<td>0.60</td>
<td>June, July</td>
</tr>
<tr>
<td>3</td>
<td>Crown M.</td>
<td>&quot;</td>
<td>1.74</td>
<td>July-Sept.</td>
</tr>
<tr>
<td>4</td>
<td>Fillipos</td>
<td>&quot;</td>
<td>0.92</td>
<td>June-July</td>
</tr>
<tr>
<td>5</td>
<td>Marietta</td>
<td>&quot;</td>
<td>0.88</td>
<td>June-July</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td>5.18</td>
<td></td>
</tr>
</tbody>
</table>

Source: Compiled from data from Port of Patras Authority

Table V: Vessels that have skimmed the cream in 1995 in Greece-Italy shortsea

Source: Compiled from data from Port of Patras Authority

1.4.3. Fleet’s age and size profiles

As it is shown in Figure 2, the age profile of Greece-Italy 1995 fleet as determined by the mode, is 25 years. This is indeed a high typical age. As shown in Figure 2, the majority (77%) of old tonnage is between 21 and 30 years. Careful observation however of the 0-5 box of age with a 11.4% shows a sign that with the second vessel of Minoan (perhaps called Aretousa II), age profile will improve and this may prove that free competition brings in also latest technology.

In Greek licensed coastal shipping, in 1990 though, we had average (not typical) age 21 years. This means that free exit and entry did not help to improve age despite what could assume theory. Do we expect after above finding that waiving cabotage we will have newer ships after 2004?
The Role of Greek Shipping and Ports in the Greek-Italian Shortsea Network

Figure 2: Age profile of Greece-Italy 1995 fleet

As for size, Figure 3, shows the typical (mode) size of the Greece-Italy 1995 fleet as equal to 6000 GRT. This is again a small size but greater than the average (not typical though) size in Greek licensed coastal shipping which in 1990 was only 4068 GRT. Size depends heavily on distance, but also on age due to economies of scale, port dues, other costs depending on size, and demand, to mention the main components.

It is worth noting that the three Italian ships of Adriatica Co have rather small sizes between 8400-9000 GRT, whether new or old and whether going to Venice, Bari or Brindisi, (speeds between 17-19 knots). The "new" Greek ships, however, combine big size, high speed and low age as follows:

1. Aretousa 31000 GRT 20 knots 1 year
2. El. Venizelos 38261 " 21 " 8 "
3. Superfast I 23663 25 " 1 "
4. Superfast II 23663 25 " 1 "
5. Ionian Star 19400 18 " 5 "

4.3 Shares in the Market

Table VI shows the shares in calls that each ship had in 1995. As we may conclude from above analysis rather few (up to six) companies and few (up to nine) vessels dominate in each route. For Ancona, the new ships Superfast I and II covered in 1995 (though started April and June 1995) 17.93% of total calls and this is expected to increase for full year operations in 1996. Superfast Ferries I and II belong to one and the same company. The share of Superfast Ferries I, II, in
the traffic is greater than the share in the calls indicates. Indeed, the share in the calls does not represent exactly the share in the traffic. In passengers, shares improved gradually and stabilised to about 20-25% of total as follows:

From Table VII we may conclude that Superfasts I and II soon gained more than half (51%) of the passenger traffic with typical shares as shown in Figure 4a/b and Aretousa with clearly less typical share (15%) is shown in part c of Figure 4.

It is easy to derive from the above analysis that both Superfast II and Aretousa obtained traffic from Superfast I comparing period April to June with the rest of the year. As it is shown, three new and fast ferries “on appearance” secured 66% of traffic of the route and this was gained away from old ferries. This is a sign of high competition that most probably will continue. We consider Greece-Italy service also as the door to licensed Greek Coastal Shipping after 2004. Companies trained there will be at best fit to survive in deregulated Greek Coastal Shipping when time comes.

The characteristics of Competition are of course there: ships come in and go, companies come in and go, services become unstable, competition becomes strong. Few fast ferries will bring in more of this type. Companies, however, based on monopoly routes (like Strintzis, ANEK, Minoan) in the rest of Greece, and as long as this geographical monopoly holds, will resist to competition. The advantages of the new ferries, which some of them are close to cruising ships levels, transform trip time to a rather city entertainment time. So, it is our prediction that (after 2004) these Greece-Italy new ships will integrate also Aegean Islands with Europe (Rhodes, Paros, Santorini, Kos, Mykonos and others). This last prediction will fit well with the situation where former Yugoslavia becomes again
### A. Port of destination: Brindisi

<table>
<thead>
<tr>
<th>No.</th>
<th>Vessels</th>
<th>%</th>
<th>Company</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Valentino</td>
<td>10.32</td>
<td>Jannina Nav.</td>
</tr>
<tr>
<td>2</td>
<td>Laurana</td>
<td>10.20</td>
<td>Adriatica</td>
</tr>
<tr>
<td>3</td>
<td>Arion</td>
<td>10.23</td>
<td>Ventouris K.A.</td>
</tr>
<tr>
<td>4</td>
<td>Brindisi</td>
<td>10.80</td>
<td>Laird Mar.</td>
</tr>
<tr>
<td>5</td>
<td>Aphrodite II</td>
<td>10.26</td>
<td>Namora Shipping</td>
</tr>
<tr>
<td>6</td>
<td>Poseidon</td>
<td>9.09</td>
<td>P. Shipping</td>
</tr>
<tr>
<td>7</td>
<td>Anna V</td>
<td>9.75</td>
<td>Ventouris K.A.</td>
</tr>
</tbody>
</table>

Total vessels on the route: 18 70.65%

### B. Port of destination: Bari

<table>
<thead>
<tr>
<th>No.</th>
<th>Vessels</th>
<th>%</th>
<th>Company</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Venus</td>
<td>20.87</td>
<td>Ventouris</td>
</tr>
<tr>
<td>2</td>
<td>Saturnus</td>
<td>19.91</td>
<td>Ventouris</td>
</tr>
<tr>
<td>3</td>
<td>Polaris</td>
<td>19.76</td>
<td>Ventouris</td>
</tr>
<tr>
<td>4</td>
<td>Sea Serenade</td>
<td>15.63</td>
<td>Poseidon</td>
</tr>
<tr>
<td>5</td>
<td>Criti</td>
<td>10.32</td>
<td>ANEK</td>
</tr>
</tbody>
</table>

Total vessels on the route: 10 86.49%

This route is in the hands (60.54%) of Ventouris Group Enterprises S.A.

### C. Port of destination: Ancona

<table>
<thead>
<tr>
<th>No.</th>
<th>Vessels</th>
<th>%</th>
<th>Company</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Superfast I</td>
<td>10.18</td>
<td>Superfast Ferries</td>
</tr>
<tr>
<td>2</td>
<td>Erotokritos</td>
<td>10.18</td>
<td>2 Minoan</td>
</tr>
<tr>
<td>3</td>
<td>Superfast II</td>
<td>7.75</td>
<td>1 Superfast Ferries</td>
</tr>
<tr>
<td>4</td>
<td>Dame M</td>
<td>8.76</td>
<td>3 Marlines</td>
</tr>
<tr>
<td>5</td>
<td>Ionian Star</td>
<td>8.30</td>
<td>4 Strintzis</td>
</tr>
<tr>
<td>6</td>
<td>Lato</td>
<td>7.80</td>
<td>5 ANEK</td>
</tr>
<tr>
<td>7</td>
<td>Ariadne</td>
<td>6.19</td>
<td>2 Minoan</td>
</tr>
<tr>
<td>8</td>
<td>Festos</td>
<td>6.15</td>
<td>2 Minoan</td>
</tr>
<tr>
<td>9</td>
<td>Aretouse</td>
<td>6.10</td>
<td>2 Minoan</td>
</tr>
</tbody>
</table>

Total vessels on the route: 23 71.41%

Source: Compiled from data from Port of Patras Authority, Greek Shipping Directory 1994, Patras Port Police

Table VI

"Navigable". Certain companies (Erotokritos, Superfists I, II) provide in their vessels camping opportunities during sea journey in attractive rates.
Section III - Shortsea Shipping and ports

<table>
<thead>
<tr>
<th></th>
<th>% April 1995</th>
<th>% May 1995</th>
<th>% June 1995</th>
<th>% July 1995</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Superfast I</td>
<td>P.</td>
<td>A.</td>
<td>P.</td>
<td>A.</td>
</tr>
<tr>
<td>-Passengers</td>
<td>12</td>
<td>18</td>
<td>32</td>
<td>34</td>
</tr>
<tr>
<td>-Private car</td>
<td>7</td>
<td>13</td>
<td>34</td>
<td>35</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Superfast II</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>-Passengers</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>-Private car</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aretousa</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>-Passengers</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>-Private car</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

*P = Patras, A = Ancona

Source: Compiled from data from Patras Port Authority

Table VII: Shares in traffic Patras-Ancona of new Fast Ferries 1995

4.4 Fare competition in Greece-Italy route

Competition on passenger fares in 1996 among the new fast vessels in the Greece-Italy route does not seem to be apparent. Competition is rather based on quality of service including speed and port area advantages. Service discrimination is of course attempted through advertising. Fares charged are not substantially apart. From cases analysed, Superfast ferries change in all cabins less, from 1% to 26%, except certain cabins where fares are higher from 1% to 18%. Large percentage differences occur in the lux cabins (called A2), where Superfast ferries charge from 5%-26% less than their antagonists. Marked difference has been noticed only in Deck passenger fare return low season, to the extent of 30% in comparison with antagonists. In all other aircraft type seats and deck seats for

1Cabins A3 low season and high season return are charged more, from 2% to 10%. AB3 similarly from 4% to 18% and AB4 from 1% to 12%.
passengers Superfast ferries charge more from 4% to 36%. The above fares seem to have been slightly adjusted from the experience gained from the service provided during part of 1995 as few fares remained as were and some increased by a few thousand drachmas.

Despite of what happens in passenger fares, in private car freights, the new Superfast Ferries charge more than antagonists in all, but few cases, by a percentage from 0 to 71 (Motorcycles high season return). So, competition between the two companies is complex. Cheaper cabins are combined with more expensive car freights. At the end Superfast Ferries become more slightly expensive by (e.g. cabin AB4 high season return with car) 7.5%. Moreover, it is worth noting that the cost of the car to the total passenger fare is a small percentage (15%-22%). So, it is more wise to charge less for the cabins and more for the accompanied cars. In addition more passengers mean more spending in other revenue centres in the vessel. The above rule works better as the number of persons per private car rises.

As far as the lorries are concerned freight rates differ for Aretousa whether one goes to Italy or returns from Italy and between low and high season. Superfast Ferries have a uniform price list at the moment for 1996. Aretousa charges more for low season and from Ancona to Greece and less for low season and from Patras to Ancona. High season rates are not yet published. This differentiation is rather successful because lorries returning to Greece cannot stay in Italy and will

\[^1\] Campers-Trailers-Wheeled Houses over 7 m. high season return 2.5% less and Buses high season return 11% less.
choose the available ferry boat, which may be one of the Minoan/Strintzis Lines, even at 9% more than antagonists.

5 Greek Ports in the Short Sea Shipping Network

5.1 Introduction

Both Greeks and Italians, since the date of the De Piccoli report₁, speak about the "Adriatica-Ionian Sea Corridor". Moreover, the main Greek idea is based on connecting East Coast of Greece with West Coast of Greece, at various geographical levels of the country. Due to intervening mountains, this was and still is, an important task that has to be made with the help of European Union on the basis of the principle of subsidiarity. Such efforts are the connections through Egnatia Road, the Athens-Patras railway connection, and other horizontal East-West connections, as mentioned above. These horizontal connections will at the same time add value on the vertical connections that have or will be developed between the two axis, vertical and horizontal. This depends on the developments that will take place. One development is the situation in the former Yugoslavia. One second development is the degree of expansion of the PTN². A third is the accession of Cyprus into the European Union and a fourth is the intermodal trade relationships of E.U. with countries East and South of Greece.

An important port in the above context is Volos, which is planned to be connected with Port of Igumenitsa (by road and railway). This port is planned to be connected also with Syria by a ferry boat route, as used to be in the past (1977-1985)³. South Italians speak also about the axis of the so-called five Bs i.e. an axis that will connect Bari, Bar (Montenero), Belgrade, Bucharest, Budapest. European Parliament has approved (Oct. 1995) an amount of 1 million ECU for the first 1996 studies for the De Piccoli proposal. In this axis Igumenitsa-Volos connection and railway connection between Igumenitsa and Kalampaka are included (see maps 3/4).

---

₁ During 27th and 28th October 1995, an International Conference took place at port of Ancona, Italy, with main theme the "Adriatica-Ionian Sea Corridor", based on the proposal submitted by Italian MP De Piccoli to European Parliament. Countries that have shown active interest were, apart from Greece and Italy, Albania, Bulgaria and Ukraine.

² Greek Ports of Thessaloniki (or Salonica) and Alexandroupolis are included in the Pan-European Transport Corridors, one of which connects Thessaloniki with Skopje, Beograd, Budapest, Wien, Praha etc and with Sofia, Bucarest, Moscow. Alexandroupolis is moreover connected with Istanbul, Ankara, Iskenderum and Izmir as well as Bucarest, Constantza etc. See ECMT, Submission to the 2nd Pan-European Transport Conference, Map of Multimodal priority corridors in a Pan-European context, Crete, 1994.

³ De Piccoli talks about the Munich-Patras corridor, and a suitable infrastructure at ports of Patras, Igumenitsa, Volos, road axis of Egnatia and the Volos-Igumenitsa connection.
5.2 Planned investments in Greek Ports

As far as the Greek ports are concerned, the planned investments of Greek ports, considered Short Sea Ports and terminals, for either the TTN and/or PTN, were as in Table VIII.

<table>
<thead>
<tr>
<th>Selected ports</th>
<th>Amount (b. drachm)</th>
<th>%</th>
<th>Cohesion funds</th>
<th>Delors (centres)</th>
<th>Interreg</th>
<th>Delors (regional)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Alexandroupolis</td>
<td>11.5</td>
<td>8.4</td>
<td>6.0</td>
<td>3.5</td>
<td>2.0</td>
<td>-</td>
</tr>
<tr>
<td>2 Igumenitsa</td>
<td>9.0</td>
<td>6.6</td>
<td>50</td>
<td>1.0</td>
<td>3.0</td>
<td>-</td>
</tr>
<tr>
<td>3 Volos</td>
<td>15.6</td>
<td>11.4</td>
<td>2.2</td>
<td>3.0</td>
<td>-</td>
<td>10.4</td>
</tr>
<tr>
<td>4 Corfu</td>
<td>1.0</td>
<td>0.7</td>
<td>-</td>
<td>1.0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>5 Patras</td>
<td>23.0</td>
<td>16.8</td>
<td>-</td>
<td>13.0</td>
<td>-</td>
<td>10.0</td>
</tr>
<tr>
<td>6 Other ports</td>
<td>77.0</td>
<td>56.1</td>
<td>7.0</td>
<td>16.0</td>
<td>5.0</td>
<td>54.0</td>
</tr>
<tr>
<td></td>
<td>137.1</td>
<td>100</td>
<td>20.2</td>
<td>37.5</td>
<td>5.0</td>
<td>74.4</td>
</tr>
</tbody>
</table>

* Note: 240 drachmas = 1 US$

Source: Greek Ministry of Public Works, Environment and Town Planning, 1994

Table VIII: Funds planned for selected Greek shortsea port works 1994

As shown in Table VIII, the five selected Short Sea Ports (Thessaloniki is excluded strangely from any E.U. program), is planned to receive only 27.10% of all funds devoted to the development of all Greek ports. We should not overlook that 39.4% of total covers ports on regional criteria. My opinion is that tasks that need above average funds, show special difficulties, and make a break through, should receive funds by priority and as much as required. From the above ports Patras rightly receives 17% (23 b. drachmas or 96 m. US$), but for Igumenitsa, this is rather a low amount. Volos has its own merits, but Alexandroupolis receives a rather respectful amount due to its future role with PTN’s. Especially for Igumenitsa, the total amount required for the full development of the port and its connection with Egnatia Road is 25-30 billion drachmas. So, the amounts devoted by Cohesion Fund, Intereg and Delors amounts almost to 1/3 of what is required for port of Igumenitsa.

As for the Passenger traffic in the above Short Sea Ports this has been developed as show in Table IX.

---

1 Such task is Egnatia Road.

2 See special edition of Port of Igumenitsa Authority titled: "Thesprotia: The gate of Europe". One of the problems of Igumenitsa is dredging of the channel due to river Kalamas accumulations.
Section III - Shortsea Shipping and ports

Table IX: Passenger (foreign-domestic) traffic in selected Greek shortsea ports

Notes:
Igoumenitsa and Patras belong to the West Axis of North South and are the West Gate Ports. Now can belong also to the West Axis of the West-East. Thessaloniki and Volos belong to East Axis of North South and together with Alexandroupolis are the North Gate Ports. Now can serve West-East connections, too.
Aastakos port at Platygiali is considered private port (belongs to a Public Greek Bank/ETVA) and thus is not mentioned in official Greek port statistics. This despite the fact that E.U.'s and Greek Public Funds have been spent for this port. Astakos at Platygiali is a MIDA, not only a port. This port could develop to a distribution centre (Free Industrial Zone exists), if a multimodal network is developed.

As shown in Table IX, Patras Port is by far the most important international passenger and RoRo port of Greece. Patras port is considered, as mentioned above, as the main West Gate to Greece of both passenger and goods traffic.

1 See Doxiades Study, (1985), "Plan of Greek Ports".
2 For Alexandroupolis we have talked before
3 Maritime Industrial Development Area.
5 According to Port of Patras Authority, Port of Patras increased passenger traffic from 888,685 (1991) to 923,972 (1994) i.e. by 4%, Lorries from 79,139 (1991) to 193,212 (1994) i.e. by 144% and private cars from 145,840 (1991) to 152,373 (1994) i.e. by 5%. So, the important change is that due to Lorry traffic, which has been created due to Yugoslavian civil war. Port offers a 3000m. quay at depths 8.5 to 10.5 m. Large passenger ships cannot fully be served as there is a limit for sizes above 16,000 GRT and 220 m. long.

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Patras Port possesses an extensive hinterland, and is a RoRo port of a special seasonal and tourist interest. The basic problem of this port, as mentioned, is that port expansion is restricted by the City of Patras, as shown in Figure 5.

Moreover, the accessibility of the railway and road network becomes difficult as one have to cross out the congested roads of the city before succeeds to reach networks. In addition, Port of Patras receives also a low mark in the land traffic organisation. Port of Patras plans to build a new port one kilometre south of the existing one (at Dymaion Coast), which consists of 500m of quay at depth 11m and 900 m of breakwater. Here is planned to receive seven RoRo ships. This will cost 13 b. dr. and it will be ready by 1999 at best (from Delors and National Funds).

The problem of Port of Patras is also encountered in the port of Ancona as shown in Figure 6, i.e. the city restricts expansion of the port.

Figures 7 and 8 show the share of each of the Italian ports and Turkey ones in the traffic on the one hand and in number of ship calls on the other hand. Comparison between the two diagrams gives the productivity (demand) of the ships in the
Figure 7: Ports of Italy served (%) by shortsea shipping 1995

Figure 8: Port share in ship calls, 1995

Various routes. In Brindisi port for example, one needs 43.5% of the calls to secure 35% of traffic. In Ancona, 30% of call “produce” 40% of traffic. Bari needs 19% of calls to give only 10% of traffic. Venice needs only 6% of calls to give 11% of traffic and Trieste needs 2% of calls to produce 4% of traffic. Mor-
The Role of Greek Shipping and Ports in the Greek-Italian Shortsea Network

ever, port dues rise with number of calls (calls cannot be numerous, if distance becomes long).

Policy Recommendations and Conclusions

As can be concluded from the above, Greece should create, the soonest possible, North-South Motorway Roads and High Speed Railway connections. Also, and more important, by priority, are the East-West Road and Railway high speed connections at three at least levels: one at North Greece with Egnatia Road, one at Volos level ending at Action or Astakos (Platygiali) and one at Athens ending at Patras Port. All road and railway connections should include ports of Alexandroupolis, Thessaloniki, Igumenitsa, Volos, Patras, Action and/or Astakos (Platygiali). Road and railway connections from North to South are correctly indicated in maps 3 and 4 in the two or three corridors. Our proposals are based first on the principle of accessibility, as they improve existing connections (if available) in time and perhaps in cost and accessibility, between places\(^1\). These proposals achieve interoperability as they cover road, railway, port, vessel and air means of transport. Shortsea shipping, moreover, succeeds in achieving the principle of interconnectivity as it connects Greek TN with TTN (Italy). Above proposals achieve also accessibility with PTN.

As far as the short sea shipping is concerned it can be again recognised that it can play the role of relieving congested roads (see Commission’s report at the end of 1995 for Short Sea Shipping\(^2\)) given the extensive coastline of Europe, but also SSS capacity to be more friendly to the environment than road transport. One obstacle to the principle of interconnectivity, however, which should be removed, is the situation (either natural, obstructed by cities or technical, obstructed by mentality) in Greek Short Sea Ports. Greek Short Sea Ports should be developed by devoting adequate funds, and should be modernised, in such a way as to minimise exit and entry time to the port and the adjacent city. Certain Greek ports should be developed as distribution centres and/or as feeder ports by increasing their interport co-operation and specialisation, marketing, and obtaining a new management style etc.

Competition so far did not help much to modernise short sea RoRo fleet between Greece and Italy, and both Europe and Greece as well Italy are lucky for certain private initiatives which brought, in 1995, three new units in the Patras-Ancona route. This should be only the starting point as more units are expected to come. These units were built in Europe and financed by European Banks.

In case that short sea shipping did not exist, then Greece and their East and South neighbours could not pass over to Europe, either their passengers or their goods.

In the route Patras-Ancona, competition brought in bigger and faster ships. So, ports should encourage this development by modifying their price policy.

\(^1\) See TRCM/II/010/re 1/95 p.3

\(^2\) See Journal of Hellenic Chamber of Shipping, 3rd quarter, 1995, p.82.
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age. As history has proved, ships will take the lead in the technology of ships, whereas ports will adapt in a very slow pace. Here a substantial sock on Greek ports is needed to keep in pace with the developments in their customers.

References

(3) C.E.C, doc. TRC/VII/ 013. rel./95 Dec. 95, TRC/VII/ 010 rel.95, TRC/VII 008, re 1/95.
(4) C.E.C, (1992), "The future development of the Common Transport Policy" (in Greek), Com(92) 494 final, Brussels.
(5) Doxiades, (1985), Study, "Plan of Greek Ports"
(9) Hellenic Chamber of Shipping, Various publications (in Greek).
(11) Interviews with Shipowners, Agents, Union of Greek Coastal Shipowners.
(12) Italiane A., (1989), "Economic Implications of the Completion of the EU Internal Market".
(15) Price Lists of relevant ferry boats companies Greece-Italy.
(16) Relevant port books (Igumenitsa, Volos, Alexandroupolis, Patras).
(18) Smith A. (1776), "Wealth of Nations", Book 1, ch. X.
The Role of Greek Shipping and Ports in the Greek-Italian Shortsea Network

Map 1
Section III - Shortsea Shipping and ports

Map 2

European Shortsea Shipping
The Role of Greek Shipping and Ports in the Greek-Italian Shortsea Network

Map 3
The Role of Greek Shipping and Ports in the Greek-Italian Shortsea Network

Map 5
IMPROVING SHORTSEA BULK OPERATIONS

By K. Fagerholt and S.I. Heimdal

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4 Finding potentials for improvement ............................ 270
5 Deciding the capacity of a system fleet ....................... 272
6 Conclusions .................................................... 275
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1 Introduction

The significance of short sea shipping

Norwegian industry as the industry sectors in most peripheral regions totally depend on the services of the European short sea fleet. National trade statistics show that 80-85% of all foreign trade is lifted by seagoing ships. With the European Union as the most important trading partner, the significance of a cost-efficient and logistical high quality short sea sector is self evident.

Table I lists 12 countries or regions in Europe where sea transportation represents high percentages of intra European freight. For several or most countries in Table I the high percentages are dominated by bulk or break bulk cargo. The table is based on ECMT-data from 1990. Though the political changes since the data were collected are dramatic and there are much to say about the accuracy of international transport statistics, the logistical structures and the market shares for short sea shipping are comparable.

<table>
<thead>
<tr>
<th>Country</th>
<th>Market Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ireland and UK</td>
<td>89.31 %</td>
</tr>
<tr>
<td>Finland</td>
<td>87.33 %</td>
</tr>
<tr>
<td>Norway</td>
<td>81.06 %</td>
</tr>
<tr>
<td>Greece</td>
<td>75.32 %</td>
</tr>
<tr>
<td>Denmark</td>
<td>65.58 %</td>
</tr>
<tr>
<td>Sweden</td>
<td>60.01 %</td>
</tr>
<tr>
<td>Portugal and Spain</td>
<td>55.42 %</td>
</tr>
<tr>
<td>Poland</td>
<td>52.63 %</td>
</tr>
<tr>
<td>Italy</td>
<td>33.38 %</td>
</tr>
<tr>
<td>France</td>
<td>29.65 %</td>
</tr>
<tr>
<td>The Netherlands</td>
<td>29.40 %</td>
</tr>
</tbody>
</table>

Table I: Seaborne foreign trade market shares (Metric Tonnes 1990)

A Norwegian short sea research programme

As an initiative to maintain and improve the competitive position of short sea shipping the Norwegian Shipowners Association and it’s members, industry companies and the Norwegian Research Council have launched a joint short sea

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1ECMT - European Conference of Ministers of Transport (Hei 94)
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research programme. The basic idea is to define projects including both ship owners and cargo owners. First phase of this programme has been several case studies covering current freight operations for important Norwegian export articles. The products analyzed have been:

- Paper reels;
- Fresh fish;
- Frozen fish;
- Fertilizer;
- General cargo from rural areas.

These products represent cargo groups with different logistical requirements and substantial variations in the opportunity to balance cargo flows. Together they give a good picture of the competitive challenges in a demanding freight market.

Details about the paper

This paper will describe the outcome of one of the case studies demonstrating the inter-relationship between the potential for improving short sea efficiency and how changes depend on corresponding adjustments ashore. The chosen case study is intra European shipments of fertilizer with special emphasis on co-ordinating shipments to two neighbouring market areas.

The next section presents a short description of a fertilizer operation with a single company perspective. The following section will discuss challenges and strategic implications following changes to the existing operation. The main findings and conclusions from the case study covering a limited geographical area will then be presented. These first sections will cover most elements in the logistic chain directly related to seagoing shipments and short sea shipping opportunities in the light of customer demand to logistic systems.

Results from calculations showing the capacity of alternative combinations of ships operating in a dedicated freight system will be presented next. The calculations are based on a of industry shipping concept where transportation systems are tailor made into high performance logistic systems and often in joint ventures between shipping companies and cargo owners.

The concluding paragraphs discuss implications for short sea shipping based on this specific case study and general findings from the other case studies. Emphasis will be put on challenges and pitfalls in projects involving cargo owners, shipowners and researchers or consultants.
2 The fertilizer case

About fertilizer

Fertilizer is a dry bulk product. Production is usually order based and scale of economy gives strong incentives to operate the plants at maximum capacity. Compared to other dry bulk products fertilizer is a high value cargo. It is sensitive to water and can not be loaded or unloaded in rain without special equipment. Impurities or remnants in holds from previous cargo are not accepted. There are plant ports which have refused to accept more than 40% of all ships on an annual basis after first notice of arrival. Among the dominant causes is insufficient cleaning of holds.

The European fertilizer shipments

The case study on fertilizer was performed in co-operation between a producer of fertilizer with production facilities in several European countries, two shipping companies and a logistic research unit. The project goals were to describe the important logistic elements for fertilizer shipments within Europe and evaluate the potential for more efficient shipping concepts.

The first step was to collect information about the volumes shipped by seagoing ships and to identify the port to port structure. Total worldwide production capacity of the producer is approximately 10 mill. metric tonnes (MT). Data describing the shipments in 1994 showed that approximately 3 MT were shipped between European ports. The corresponding number of shipments was almost 2,400:

- 1,800 with products;
- 600 with raw materials.

Ports and market structures

Figure 1 shows the ports used for discharging products. Totally there were calls at approximately 200 different ports. The map showing European port calls shows a significant variation in port density. The port structure in each country is to a large extent a result of traditions, the commercial terms and customer structure in each country. A process of gradually focusing on a limited number of ports has been accepted in some markets and has also been combined with packaging and retail distribution.

The European market structure is mapped in the company market organization. The general rule is that each country is defined as a separate market. Customer demand has top priority and customer preferences have often explicit references to transportation. A consequence has been that distribution systems are optimized...
for each market and there have been few incentives to build distribution systems that co-ordinate shipments to several markets at sales order level.

Figure 1: Ports for unloading fertilizer

Ships and chartering

Looking into the details about each shipment reveal that most shipments are with quantities up to 2,000 MT. Figure 2 shows a frequency diagram for the European shipments. Most bulk ships operating in the Baltic or North Sea trade with cargo capacity in the smallest end of the HANDYMIN segment are very old. Available ships with capacity up to 1,000 MT have an average age of 30-40 years.

The structure of chartering units responsible for organizing shipments from the production plants is also important. Markets based on sourcing from several plants may have their shipments organized by several chartering units. The contractual coverage for shipments into each market historically show significant variations. For many markets spot shipments are dominating.
3 Challenges - strategic implications

Age of ships

The most important threat to the existing system of shipments is probably the age of the ships available for the small volume trade. Very old ships combined with an increasing set of requirements related to safety and technical condition may reduce the number of available ships. On the other side, the existing freight rates is not sufficient for building new ships. The number of new ships with capacities less than 2,000 MT are very few. The supply side for ships with capacities above 2,000 MT are more comfortable. Details about the ship age structure in the Baltic and the North Sea can be found in {LOj 94}.

Ports

Small ports in several countries have work hour agreements limiting discharge operations to 1 shift or 8 hours pr. day. Concentrating on few ports would increase the volume through each port and give increased strength in negotiations on service levels, terminal fees and port dues. An additional benefit could be improved positions for optimizing cargo handling and minimize total time in ports. This would increase the annual production of ships and reduce the costs of transportation to the benefit of all parties. A concentrated port structure combined with inventories could further increase volumes in each shipment.

Logistics

An important characteristic of the industrial development in the last decade is the increased focus on logistics. Concepts as value chains and logistic chains have underlined the necessity of having an overall view on all elements of transportation, inventories, equipment and information flows making a logistical system.

Among ship owners and not least among the consumers of shipping services the process has resulted in a growing awareness that the narrow port-to-port perspective is not sufficient to meet or foresee potential changes to existing logistic systems. Competing land modes and the full consequences of new combined transport systems will influence on markets and the competitive position of short sea shipping as well as other transport sectors.
Alternative generic strategies for improving competitive positions of transport companies are discussed in {AAW 94}. This paper describes the five step TOVER method:

1. Definition of the relevant market;
2. Analysis of current position;
3. Analysis of external conditions;
4. Strategic options for improving current position;
5. Strategic options for changing current position.

The strategic options for improving current position are value adding, specialisation or changing the price/service ratio. These may be regarded as short term strategies. Changing current position requires an increased time horizon and the corresponding strategic options are to change the geographical perspective, modify the transport network or change the level of logistic activities.

For companies with continuous production and large volumes long term partnerships aiming at developing logistic systems are of special interest. Increased emphasis on customer preferences has introduced an awareness of the competitive advantage of "leading edge logistics". New distribution systems with potentials for improving logistic performance is often a key element in business reorganization activities. Key elements in such processes are {MCh 93}:

- Focusing on inter-disciplinary skills and looking for trade-off opportunities between functional areas;
- Attract attention from products (cargo) to customers (consumers);
- Building long term partnerships with suppliers and customers;
- Reducing the need for inventory by introducing information systems which reduce uncertainty and make the logistic pipeline more transparent.

Alternatives for the fertilizer operation

A concentration of ports and combination of shipments to larger volumes are from a shipping perspective usually attractive. Scale of economy implies that the shipping companies in the long run will be able to offer reduced freight rates. Larger ships, however, may exclude some of the discharge ports. Customers receiving their cargo in port and not further out in the distribution chain usually select ports close to final consumption. Many customers prefer the flexibility of many small shipments compared to few large shipments. A shift towards larger volumes for each shipment and a port structure increasing the distances fertilizer are transported by road or rail from ports may be regarded as unacceptable by important customers.

For the producers of fertilizer a strategic move could be to build warehouses and integrate into retail distribution. The costs of warehousing and retail distribution are not negligible. Besides, changes can not be introduced without co-operation and corresponding changes in customer operations.
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Incentives for ship owners

For shipping companies increased interests for logistics represents opportunities. Long term partnerships is the basis for industry shipping or long term contracts between producers and shipowners. In a market with potential high uncertainty and surplus capacity this is probably the best basis for financing new ships at acceptable terms. Shipowners will miss the potential high profits in peak periods, but a industry contract with a horizon of 5-10 years could be an attractive opportunity for holding an almost new ship when the contract expires if other incentives for renewing the existing fleet is not expected.

Incentives for cargo owners

For the producers or cargo owners industry shipping could also be attractive if freight rates or the availability of acceptable ships are regarded as uncertain. The most significant advantage could however be to have full control of the distribution chain as close up to the consumer as possible. Control more easily gives the opportunity of continuously improvement. In short sea trades where ships have a relative high number of port calls, a concentration on ports with high discharge capacity and few restrictions on service hours should have high priority.

The relevance for short sea networks

The paradigm of short sea networks is probably not so relevant for bulk cargo as for general cargo and standardized cargo units. The idea of industrial shipping, however, is relevant for large companies with high volumes and logistic requirements not met by existing short sea services. A development towards industry shipping will in its full consequence dry up significant parts of the spot market with the following changes for chartering and freight brokerage activities. For the actors involved this strategy could be regarded as "building a short sea network" on their own.

4 Finding potentials for improvement

Limiting the geographical perspective
Attempts to introduce distribution systems or new shipping concepts must be balanced with requirements and the degrees of freedom found within the sourcing production units and in each market. Different market structures make it difficult to apply carbon copies of the same concept in each market.

This chapter will discuss the potential for a dedicated shipment system to the Danish and German market. With reference to the TOVER method this would imply changes to current position. The motivation for concentrating on these markets can be found in Figure 1 which shows that both countries have a very dense port structure. The road systems are very good which indicate a flexibility
concerning entry points. More than other markets they have maintained a ship­ment structure with many ports and very small ships.

Seasonal volumes

Figure 3 shows the detailed port structure for the Danish and German market. Summing all volume data showed that the total annual volume to these markets by seagoing ships reached a total of 700,000 MT. The average volume for shipments into both markets were less than 1,000 MT. The number of shipments to these markets actually represented more than 40 % of all shipments with products within Europe. Denmark and Germany thus represent a significant part of the workload for the chartering units and the other administrative units involved.

An important observation was that both markets almost exclusively are sup­ported by a Norwegian and a German plant. Their products are not equal and are used for different periods of the fertilizer season. The two plants belong to different profit centres and use different chartering units. Figure 4 and 5 show the seasonal profiles of shipments into both markets. Each profile separately shows great variations from month to month. It would be difficult to introduce a shipping system from each plant into these neighbouring markets when volumes in 5 out of 12 months are on a low level.

A closer look at the profiles show that they are counter phased. Adding the shipments to the Danish and German markets give a more stable picture with the minimum volume in one month approximately 40,000 MT. The distances from any port in this combined market to the ports for loading fertilizer are within the distance of normal ballast voyages. Proper routing and scheduling will have a potential for reducing ballast voyages to a minimum.

Conclusions and consequences

The conclusion from this preliminary study was that ships going back and forth in a dedicated system have the necessary cargo basis and may represent an alternative to the existing spot shipments. Besides the strategic implications and the analysis of costs compared to risk and logistical benefits a new system requires co-ordination at a higher level. Other challenges are customer preferences for
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ports and the opportunities for co-shipments if several customers ask for deliveries within almost equal time windows.

The potential benefits from a concentrated port structure must be offset against the consequences of changing distribution systems ashore. A reduction of the number of ports will increase the costs and transport work by road or rail. A preliminary calculation from a county in Denmark showed that a reduction from three to two ports increased the transport work with 5% while a reduction from three to one port gave a corresponding increase of 56%.

In the county used as an example fertilizer have to be transported by road. Besides the economic and logistical challenges increased demand for road transportation has environmental consequences. There is a general opinion that dry bulk trucking should be converted to waterbased transportation if possible (JLP 94). A concentration on few ports will represent the opposite development.

5 Deciding the capacity of a system fleet

System scenarios

One of the most important elements when developing a system fleet is to decide total capacity defined by the number of ships and the capacity of each ship. There exist probably no off the shelf methodology for deciding this capacity. Every decision method from experience and rules of thumb to advanced analytical methods could be applied.

This chapter will present results from calculations based on an optimization method called integer programming. First the Danish and German markets were divided into 4 regions:

- Germany east;
Then the monthly volumes from both plants were calculated for each market. Most ports had at an initial stage of the process been classified with discharge capacities and the number of service hours per day. Representative port service and capacity values and average distances from the two sourcing plants to each market region were established. These data are all necessary to calculate round trip times as a function of vessel speed and cargo capacity.

The next step was to define a set of system scenarios. Each scenario was defined by:

- The type of ships (conventional bulk or self discharger);
- The number of ships;
- Speed for each ship;
- Cargo capacity;
- Load and unload capacities.

**Model structure**

The following step was to calculate total system capacity for each system with a model maximizing annual transport work within the constraints of each system. For each scenario the calculations produced the number of shipments and the volumes shipped between each pair of ports in every month.

Some details about the model should be mentioned. The basic idea has been to build a model which maximize shipments within a month and develop mechanisms which handles the continuous shifts between months. Insufficient capacity is assumed to be shipped spot. Some flexibility is built into the model allowing fertilizer to be shipped the month before delivery. For practical purposes this mechanism only suspend the artificial limits between months since the system will be a continuous operation and the flexibility allows cargo scheduled for delivery the first week of a month to be shipped the last week in the previous month.

The model allows sailings through the Kiefer canal if optimal. The model does not allow co-shipments to several ports within a single round trip. This constraint combined with the structure of monthly volumes classifies the model as not order based. However, the level of detail is regarded as sufficient to define system capacity. Co-shipments will only increase the flexibility of the system and thus increase system capacity. The only limitation which will represent a serious obstacle is if volumes for each shipment deviate substantially from ship capacity.

A mathematical description of the model is not within the scope of this paper. The model is based on an extension of the Travelling Salesman Problem and is imple-
Figure 6: System capacity

mentioned in a model language called GAMS\(^1\). The model is as all other mixed integer programming models based on a set of equations with continuous and integer variables. The following list describes the set of equations without mathematical notation:

- The goal function calculates the amount of cargo lifted by the ships included in the system;
- Two sets of equations calculates the volumes shipped between each pair of load and unload ports by the system and the volumes which have to be shipped spot or by other systems;
- The capacity of each ship in each month is limited by the number of trips with cargo multiplied by the capacity of the ship;
- Total operating time within a month for each ship is calculated as necessary sailing time at service speed plus the time for loading and unloading cargo. Capacity figures for cargo handling have been estimated for all load ports and regions with unload ports;
- A set of equations define the opportunity for soft shifts between months. If the operating time in a month deviates from the available time in a calendar month the month in model terms is prolonged or reduced. The time available for the following month is then reduced or prolonged depending on the correction in the previous month. The maximum limits for soft corrections are defined by two parameters which have been set to 2 days for the calculations in this study;

\(^1\)GAMS - General Algebraic Modelling System
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- Two sets of equations require that the number of shipments into each port equals the number of shipments out from the port. Some corrections are done for load ports since a ship serving several load ports within a month may have a number of entries to a port which is equal or \( \pm 1 \) the number of exits. This correction follows the monthly model structure and the model assumption that a round trip starts with loading and exit from a load port and ends by an entry to the same or another load port;

- Sub-tours which are combinations of port entries without the necessary connections are eliminated by corrections to the set of equations balancing the number of entries and exits from load ports or additional equations fixing some connections. Necessary corrections are identified by preprocessing of freight demand and inspection of results;

- A set of equations calculate the production by the system:
  - The annual number of shipments made by each ship;
  - The annual volume of fertilizer lifted by each ship;
  - The volume of fertilizer shipped in each month;
  - The total volume of fertilizer shipped in its month of demand and the amount shipped the month in advance;
  - Total volume of fertilizer shipped between each pair of load and unload ports;
  - The annual amount at sea for each ship;
  - The number of passages through the Kieler canal.

Model results

Figure 6 shows the results from 13 scenarios or systems tested with the model. For each set of calculations the results are plotted in a XY-diagram showing system occupancy rate and contractual coverage for all volumes shipped into both markets. The calculations show that most systems have a high capacity utilization or occupancy rate up to 70% contractual coverage. Smaller ships tend to be more preferable than larger ships at the same level of contractual coverage.

The most important factor influencing on the results is the monthly volume profile. Figure 7 shows how the monthly demand and the calculated volume of system shipments fluctuate from month to month for one of the scenarios. The darkest part of the bars indicate shipments the month in advance. Similar calculations show that these volumes only represent a small part of annual volume.

The difference between monthly demand and monthly capacity define the demand for spot shipments. Besides the value of defining system capacity the residual volumes identify the monthly demand for spot shipments or shipments which could be handled by excess capacity in other systems.
6 Conclusions

The fertilizer case study as several other case studies have shown that potentials for changing existing or making new logistic chains usually are restricted by conditions in the "dry" parts of the chains. Constraints may be customer preferences, seasonal variations in markets, the geographical distribution of "sinks and sources", efficiency and service levels in ports and the environmental challenges confronting especially road transportation. The sea legs in the chains are usually not regarded among the most important challenges. Cargo owners obviously appreciate the flexibility of waterborne transport and the comparably low freight rates following a market with excess supply and very competitive actors.

Few Norwegian shipowners have explored the opportunity of integrating into total chain management. Focusing on core business seems to be dominant. The long term consequences of concentrating only on a limited part of logistical chains could be financial depletion and minor development in skills and knowledge since challenges, opportunities and most value added is expected to be found within chain elements ashore.

The case study on fertilizer has produced results which indicate a potential for an industry system. The obstacles and most requirements to be met refer to constraints in the "dry" parts of the transport chains. The final system, if different from the existing, will probably be sub-optimal from a shipping perspective. As long as short sea shipments represent low cost parts of the chains, requirements from other parts of the chains are expected to dominate. This is not an argument for not looking for improvements. Savings on the port-to-port legs following new
technology or new organization can compensate cost increases in other parts and even give a reduction for the chain in total.

The findings in the fertilizer case study were completely dependent on access to reliable data. In contrast to many similar studies the data became available within reasonable consumption of time and resources. The most significant contribution from the research team was to put together data from several sources. This is often a process of trial and error. The intuition which direct the attention towards potential improvements is very difficult to describe or systemize. A general conclusion from similar studies is that most companies have not explored the opportunities hidden in their own databases. This applies to almost all types of companies.

Some remarks should be made about research projects involving cargo owners and ship owners. The cultural differences are significant. The domains of experience and methodology defining the basis for dealing with problems are only partly overlapping. Communication is one of the main challenges.

A strategy of developing logistic systems based on long term co-operation between cargo owners and ship owners could include research. Ambitions of continuous improvement supports this view. The role of the researcher, however, require acceptance and well defined limits since the other parties at some points will play a zero sum game through contract negotiations. Maintaining impartiality during such periods will be vital for future involvement and it is required that everyone understand the roles of all parties involved.

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Improving Shortsea Bulk Operations


INVESTMENT POLICIES IN PORTS' INFRASTRUCTURE IN THE PERSPECTIVE OF THE EUROPEAN SHORTSEA SHIPPING NETWORKS: THE CASE OF GREECE

By C.I. Chlomoudis and A.A. Pallis

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1 Introduction

The transport sector is an inseparable part of the Single European Market which has been established since January 1993. The challenge posed for the integration of the European transport markets is interrelated with the modernisation of the transport modes, the techniques, and the equipment, as well as with the construction, operation, and maintenance of the adequate infrastructure. The perspective of a pan-European transportation system that will satisfy the demands of the next century requires sagacious planning. Such planning should take into account the capacities and the problems inherent to each transport mode, as well as the potential of their combined use in a multimodal prospective.

Short-sea shipping is a transport mode with significant growth opportunities and the potential of progressively turning out to a critical part of the European Union's economic life. The development of the European short-sea shipping networks facilitates the increasing movements of freights and people, while it decreases significantly the private, the social, and the environmental costs of transport. Whenever a sea leg is part of the transportation process, ports are the connection points between the short-sea shipping and the other modes of transport. Therefore, the ports are crucial nodes of the transport chain. Directing significant levels of investments to the modernisation of the ports is among the measures that improve the competitive position of short-sea shipping, advance the sectors' expansion, and facilitate its integration to the trans-European transport networks. On the other hand, insufficient, or irrational development of their infrastructure can interfere with and make inefficient any other measures to modernise the transportation process.

Within this context this paper aims to provide a better understanding of the policies in ports' developments. More specifically it generates knowledge of the exercised investment policies in ports' infrastructure. The case of Greece, a peripheral Member State of the European Union (EU) with significant coastline, numerous islands, and multiple short-sea shipping links, is studied. We examine the investment activities in ports' infrastructure which are applied by the national authorities as well as the financial intervention of the supranational EU institutions. Then, the volume of these investments is compared with the total of the investments in transport infrastructure. Focal points of the analysis are the evaluation of the capital mobilisation that the supranational financial contribution generates and the volume of the national funds that have been devoted to the development of the ports' infrastructure. The investment policies that have been employed during the period from 1980 to 1994 are examined. The decision is dictated by the fact that the accession of Greece to the EU took place in 1981.
Since then the country has been incorporated within the EU, at least regarding the policies of the transport sector. The quantitative data which are exploited are the data of the Public Investment Programme. The chief national institution for the development of the infrastructure in Greece - the Ministry of Environment, Fiscal Planning, and Public Works (M.E.FP.PW) - primary records in three digital classifications all the payments in investment related to the transport sector. These data have been collected and processed. Here, the results of the compilation are presented. The presented data include solely the payments in infrastructure investments. Funds that have been provided for studies of the transport sector (i.e. feasibility studies) are excluded. However, the inclusion of the available but incomplete data regarding these payments would not have changed the trends of the indicators under examination.

National policies in ports’ infrastructure are applicable to all the ports of the country, whether those ports have national, local, or a Community level interest. Based on this, we compare the findings of the national level analysis with the relevant data of the Port of Thessaloniki, a commercial port of Community interest. It is a valuable test on whether a similar pattern of policies is followed by one of the two Greek Port Authorities or not.

2 Short-sea shipping and ports

Short-sea shipping is a genuine economic sector which has an important role on the transportation of goods between the EU Member States as well as within the EU Member States. The Eurostat data, the most valid short-sea shipping statistics currently available,\(^1\) clearly intimate the significance of the short-sea shipping. In 1992, the volume of the seaborne trade between the Member States, was 203.7 million tonnes, or 29.7% of the total intra-EU trade. The national coastwise traffic in EU countries total upwards of 260-270 million tonnes, being a significant part of the internal trade.\(^2\)

Short-sea shipping is a transport mode having the following characteristics:

- In comparison to other modes, it is an environmental friendly transport mode;
- It is a relatively energy efficient economic sector;
- There is a spare capacity available and, generally speaking there is a significant growth potential to accommodate the shift of the traffic from the congested haulage transportation;


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- In most cases, new ports infrastructure does not require substantial investment in order to accommodate increased demand and, moreover, its construction means relatively low environmental costs.

In regard of the ports, the sector has the potential to offer:

- Access to the European Union, including the connection of the Trans-European transport network with the non-EU and many non-European countries;
- Connection services between different parts of the transport network, including those which are the most environmental friendly; and
- A significant contribution to the concept of the sustainable mobility, especially in the cases that the sea leg of the transportation process is the main part of the journey.

Thus, it would have been entirely justifiable if shippers had embraced lengthier sea journeys, instead of using the traditional intermodal combination of sea-rail or sea-land modes with the sea leg being a minor part of the transportation process. This would limit the already congested inland traffic and remove bottlenecks. Yet, this shift has not been attained. The use of short-sea shipping is in generally limited, with the exception of the cases that geographical factors - like the sea passes whereas the land transportation is impossible - make it an irreplaceable transport mode. The potential of the further development of the short-sea shipping at the expense of the land-based modes has to be exploited, especially now that the progressive liberalisation of cabotage is expected to redefine the structure of the short-sea shipping services in the Southern peripheral EU coastal areas and islands.

2.1 The importance of the investments in ports' infrastructure for the development of short-sea shipping

A factor which impedes or furthers the realisation of the aforementioned shift is the state of the infrastructure of the European ports. Today, the general perception is that short-sea shipping is slow, not competitive in terms of price mode, which involves double handling, and risks delays and disruption.¹ The cost of the transportation, the delays within the ports for reasons related to their modernisation - i.e. the delays during the loading, or re-loading the goods from one mode to another - the complicated document proceedings, and the negative image that accompanies the traditional services of the sea transportation of small and medium climax, are the parameters that restrict its satisfactorily development.

Devoting a significant level of investment in ports’ infrastructure can reduce drastically many of these inefficiencies and reverse this perception.\(^1\)

Short-sea shipping is a transportation process which lacks speed when compared to its competitors on European trade corridors. This is exacerbated by port related deficiencies, as short-sea vessels spend more than 40% of their total time in ports.\(^2\) Investing in ports’ infrastructure is a means to increase the speed of the mode’s services. Employment of the state of the art technology minimises the turn round time improving dramatically the speed of the transportation. Cargo gains can be expected as the limitation of the time spent in ports makes short-sea shipping more attractive for fast cargoes and expands the range of the potential freights. Nowadays, in the more competitive ports of North Europe there is the potential of unloading 30 containers per hour largely because developments in their infrastructure have contributed to meeting the innovations in transhipment methods. On the other hand, in some ports in South Europe the productivity is up to 50% lower than in North Europe, a considerable constraint for the expansion of short-sea shipping.

The replacement of the traditional methods of handling goods in ports would influence substantially the variation of the cost of short-sea shipping. Since the mid-80s’ road transport’s real rates have declined. Shipping costs have also declined but port costs have remained high. Costs related to the port interface - the stevedoring cost, harbour and conservancy dues, pilotage as well as the cost of ship time in port - are on average above the 50% of the total costs of sea transport. A reduction of these costs could be achieved through the development of the ports’ infrastructure. This is of great significance since the transportation cost of a product varies from 7% to 35% of its final price, especially as the shorter the distance the higher is the port cost as a proportion.\(^3\)

In addition, modernising the ports’ infrastructure offers apparent advantages in terms of reliability. The growing demands for an unbroken chain of door-to-door services, and transport and for just-in-time delivery, have meant that the factor of reliable delivery time is increasing, and the role played by ports services and equipment to transfer goods smoothly between transport modes is becoming an increasingly significant factor in price, quality, and speed of transport services. Infrastructure developments create the conditions under which the use of different transportation modes is simplified. When ports’ infrastructure lags behind there are difficulties in providing facilities to meet the increasing demand for commodities to be delivered quickly and predictable. On the contrary, with the use of

\(^1\)This concept has been highlighted since the early stages of the debate on the promotion of short-sea shipping in Europe (See: European Conference of Ministers of Transport (1982), “Short-Sea Shipping in the economy of inland Transport in Europe”, Report of the 60th Round Table on Transport Economics, Paris: OECD).

\(^2\)European Commission’s publications increase that percentage to 60%. However, the industry believes that this is an overestimation (See: Paliis, A.A. (1996), “EU-proposals to improve port infrastructure and efficiency and the industry’s perceptions: The cases of British and Greek ports”, a paper to be presented at the 24th Transport Forum, London, UK).

modern infrastructure the reliability of the delivery times increases, and the short-sea shipping user is encouraged not to consider the change of the mode as a disadvantage of the production function. Likewise, a fast network operation reduces the transit times, which tend to be longer than those of other modes. This creates the potential of many short-sea stops without problems. All these promote the compatibility of short-sea shipping with the inland legs of the transportation, and lead to the adjustment of the mode to the demands of the users. Notably, the importance of the level of investments in ports increases as a great transformation is underway. The traditional conception of the port as a gate which facilitates modal inter-changes and the realisation of the continuous flow is gradually replaced by ports which increasingly work as a logistic centre that provides complementary operations of the transport, logistic services, and integrates traffic. Together with the conventional services the provision of modern logistics and distribution services has become an essential condition for rapid and efficient cargo flows. Thus, ports should provide demand oriented infrastructure which adequately links the different transport modes. Infrastructure developments including integrated management systems and EDI linking port authorities, shippers, stevedores, shipowners can stimulus short-sea shipping, and assist its compilation with the just-in-time requirements. Whether a port will manage to introduce and improve these communication systems or not is largely dependent on the available funds for investment.

Besides, the short-sea shipping sector can expect further qualitative benefits by the modernisation of inland infrastructure within the ports' area as well as by the developments of peripheral functions of the transportation process, like ticketing facilities. They may not be related directly to short-sea shipping but they are important for the improvement of the image of the seagoing trade. It is frequently argued that the competitive disadvantage of the short-sea shipping is mainly a consequence of the fact that the road transportation sector does not fully pay the social and environmental costs it generates. Undoubtedly, the internalisation of these external costs - which in many OECD countries are estimated up to 5% of the GDP - is necessary, not least for social reasons. However, the effects of measures aimed at this internalisation on the development of short-sea shipping should not be overestimated, but emphasis should be put on measures to improve the competitive position of the mode. It is the modernisation of the system itself that facilitates the regularity and the reliability of the shipping services at a reasonable cost which provides the main competition to alternative modes. The shift towards the short-sea shipping will be realised only in the case of the improvements of the operation and its integration into multimodal transport chains.

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2.2 Financial contributions to the modernisation of ports’ infrastructure

Most of the European ports have a need for infrastructure developments. The relatively large ports aim at the integration into the logistical systems which characterise modern short-sea traffic flows while small and medium ports try to overcome their less efficient and less specialised facilities and offset their weaknesses regarding economies of scale. One positive feature of the port sector is that comparatively small infrastructure projects which have the potential to be realised in any small commercial port of the European Union can have a significant important effect on the development of the transportation. Always, the criteria for these investments are the advance of the ports’ capacity and productiveness. This enhances the substantial increase of the competitiveness of short sea shipping services.

Consequently, giving priority on the development of the ports that provide short-sea shipping links is a critical policy initiative that furthers the Common Transport Policy, and the concept of the trans-European networks. One of the Common Transport Policy pillars concentrates on the improvement of the transport infrastructure. In like manner, in the case of short-sea shipping the central point is the development of the ports’ infrastructure, either in terms of facilities or in terms of services, because ports provide the interoperability and create new meeting points with the other modes. The major part of the realised, or planned, investments in ports and port-related infrastructures enhance their efficiency and facilitates the integration of short-sea shipping with the trans-European multimodal transport network of the future.

Nevertheless, for reasons mainly attributed to the nature and the importance of the competition within the port sector EU does not provide a defined plan of a strategic or priority port network. Neither does it confine itself in a policy of rigid lines of ports’ infrastructure which should be constructed in a certain time.

Elements of the case-study may suggest that this policy approach contradicts the necessities of short-sea shipping. However, the widespread view is that the EU policy strategy could not be different since the principal choice is to avoid the adoption of initiatives which could harm the competition of the sector. The feasibility of the definition of a list of Community interest ports is rather unrealistic, at least in the near future.

Within this milieu the EU supports projects which are financed by the Member States by providing funds under the trans-European network budget line. Whenever port projects conform the EU guidelines appropriate to transport infrastructure, EU funds are available for investment and they are expected to induce significant mobilisation of other capital resources. In conclusion, the questions to be answered in regard of ports’ infrastructure are:

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2 Commission of the EU (1995), op. cit.
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(i) Whether the national level investment policies have exploited fully the financial intervention opportunities provided, by the EU; and

(ii) Whether national level initiatives have maximised the efficiency of the EU incentives through a rational combination of the available financial resources.

The following sections attempt to answer these questions in the case of the Greek investment policies in ports’ infrastructure.

3 Trans-European Transport Networks and the Investments in their Infrastructure

The 1994 EU guidelines for the development of the trans-European transport networks constitute a first attempt to include the planning of all the transport modes in a unified and integrated European multimodal approach. This scheme reflects the choices of the EU in regard of the structure that these networks should have in the future: they must become gradually integrated in operational terms in a wider context, i.e. the Community, and beyond that, the continent of Europe.

The conclusions of the two 1994 European Councils, held in Corfu and Essen respectively, re-emphasised the importance of the trans-European transport networks in the functioning of the internal market, and highlighted the need for action, according to the Articles 129c and 129b of the Treaty on European Union (Maastricht Treaty). To fulfil this objective, a list of the priority projects was endorsed (Christophersen Group), performing as a guideline for the investments in transport infrastructure. Among these priority projects are the development of the multimodal transport infrastructure (i.e. re-loading equipment, traffic and navigation infrastructure, etc.) to ensure the efficiency of the intermodal links, including development of ports’ infrastructure as it can contribute to the development of cabotage and short maritime links, thus, promote the use of the environmental friendly short-sea shipping.

In this context, the terminal points of the transportation process, or the intermediate points, which facilitate the shift between the different modes, are recognised as key characteristics of the multimodal transport network. In the cases of sea-land, sea-sea (feeder), or sea-inland waterways transportation the critical nodes of the chain are the ports. Nevertheless, while a growth of the demand for port services has been notified, the level of the investments in ports’ infrastruc-

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2 A characteristic of a growing economy is that the demand for transport grows at an even faster rate. In the period 1985-89 freight transport in the community grew at an average of 4.8% whilst economic growth averaged 3.1%. Although forecasts for transport are difficult, the growth of freight transport in the 1990s is expected to range between 30% and 40% (Commission of the EU (1992a), "Communication and legislative proposals concerning the creation of a European combined transport network", Com(92) 230
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ture (comprising new construction, expansion, re-construction, and renewal) in Europe is following a negative trend, whether it is expressed as a share of the total of the investments in transport infrastructure, or as a percentage of the Gross Domestic Product (GDP).

The aggregate European investments in transport infrastructure declined from 1.5% of GDP in 1975 to 0.9% in 1980. This decline was halted in the beginning of the 1980s when investments were brought to a standstill at the relatively low 1% of the GDP. Although there are fluctuations on a year to year basis, the relative size of the investment in all the transport modes but the pipelines in the years 1980 and 1989 indicates that:

- The share from both ports and inland waterways have decreased from 5% to 3.5% and from 2% to 1.5% of the total investment respectively;
- Road accounted for just over 66% of all investments with a small downwards trend;
- The share of investments in railroad has slightly increased to about 33%;
- Airports have benefited from the redistribution of the investments, their share increased significantly from 2.9% to 5.6%.

The allocation of these investments is not irrespective from (and for) the alteration in the distribution of the freight traffic volume to the various modes within the period 1975-1988. Considering that the level of goods transport in the EU was increased from 630 million tonne-kilometres to 1026 million tonne-kilometres, indicators suggest that the growth was not evenly shared:

- Transport by road has increased from the 58% of the total volume to 74%;
- Transport by rail has increased from 12% to 10%; and
- The share of the waterways decreased from 27% to 16%.

These data suggest that almost the total of the substantial traffic volume increase which has taken place has been absorbed by road transport. Unambiguously, among the factors that advanced this *spontaneous* and distorted development is the distribution of the investment among the different modes.

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Several EU initiatives attempt to overcome the geographical disadvantages of the less favoured Member States. Since the creation of the then E.E.C., the European Investment Bank (EIB) operates as an autonomous non-profit EU institution which finances infrastructure projects of common interest and projects targeting the balanced regional development. By supplementing equity capital or loans, EIB finances transport infrastructure projects. Therefore, it supports investments in ports' infrastructure, with EIB contribution being about a third of the total cost of a project (the ceiling is normally 50%). The period 1987-1991 it allocated ECU 7 million in the transport sector, 22% of the ECU 31.8 million EIB budget. A special EIB operation is in process for the implementation of the financial instruments listed in the Maastricht Treaty. Under the so-called Edinburgh Facility the EIB is committed to give the total of ECU 6.7 billion in loans conducing major transport and energy infrastructure projects of strategic interest for the period 1994-1999.¹ Moreover, the European Investment Fund came formally into existence in June 1994 playing a role of growing importance providing guarantees for major transport infrastructure projects.

Another major financial contributor is the European Regional and Development Fund (ERDF) which was established in 1975. The period 1975-1988, it granted ECU 8.786.6 million - 36% of its total budget - to improve transport infrastructure in lagging regions. In 1982 the Council adopted the Commission’s proposal for a Regulation on the financing of infrastructure projects. The target was to use the EU contribution as means to encourage national investments in transport infrastructure. Therefore, an allocation of the EU budget was devoted to investments in transport infrastructure. This annual Regulation was renewed year-by-year until 1990 when the three-annual Regulation 3359/90 was adopted enabling financial constraints to be counterbalanced by a longer term commitment. On the other hand, the successive enlargements in the 1980s - the accession of Greece in 1981 and the accession of Spain and Portugal in 1986 - increased the inefficiencies of the EU transport infrastructure.

The answer of the EU was the amendment of the Regional Funds in 1988. This resulted in the contribution of the amount of the ECU 5583.9 million the period 1989-1993 for the funding of transport infrastructure projects in the more peripheral regions mainly through the Community Support Framework. Nowadays, complementary projects are financed in the context of other programmes, like the INTERREG and REGIS, which target inter-state co-operation and the financial support of the geographical isolated islands of the Community’s periphery respectively. In 1992 a new financial framework for the period 1993-1997 was adopted. This framework introduced substantial increases of the funds for investments which are provided by the supranational EU institutions. Moreover, it instituted the Cohesion Fund, an initiative that had been agreed in the Maastricht Treaty and

provides resources to cover of the infrastructural needs of the lagging (Objective 1) EU regions.¹

Still, the financial requirements to modernise transport infrastructure and avoid its saturation are estimated at over ECU 220 billion for the period up to 1995 and ECU 400 billion by 2010, but the total investment involved for transport infrastructure projects by the end of the century amounts only to ECU 82 billion.² As sufficient financial sources had to be at least two times the current resources, it is fairly obvious that the possibility for the European Union to replace the national governments or the private sector as the main financial source of funding the improvement of transport infrastructure is not feasible.

However, even if the EU had the necessary sources, this would not be desirable. After the entry into force of the Maastricht Treaty the goal of the EU financial intervention is the coordination of the local, national, and regional policies and in line with the principle of subsidiarity.³ Through the interconnection and the interoperability of the transport networks, EU targets the integration of the Community’s transport system in a multimodal and sustainable perspective. The contribution of the EU initiatives is the identification of the missing network links in the lagging EU-regions, the support for the launching of major projects, and the supply of a financial impetus to the national investment programmes pursuing the development of the transport infrastructure. The significant capital mobilisation through the provided EU funding investments, either loans or grants, is a significant requirement to accomplish the aforementioned EU objectives.

4 Greece and investments in ports’ infrastructure

The absence of the basic sea or river ports’ infrastructure is not a generalised problem within the EU. Largely because of the competition that takes places even among ports within the same Member State, most of the European ports have the ability of covering their basic infrastructural needs, at least at the moment. This is not case in some Community regions especially Ireland and the south periphery like the case of Greece. Out of date infrastructure is not uncommon in the latter cases.

Contradicting the experiences of other EU-ports, the construction, and renewal of the infrastructure, even the efficient maintaining of the current facilities, have been problematic in the case of Greek ports. The Greek ports have serious shortcomings particularly as regards internal facilities (i.e. container terminals and roll on/roll off facilities), transhipment installations, electromechanical equipment, skilled personnel, and inland transport infrastructure inside the ports.


³Commission of the EU (1992b), op. cit.
Notably, the lack of connections with the inland transport networks is a regular port deficiency in Greek ports. Investments to overcome this lack have been delayed, especially in the cases of adequate infrastructure to respond to the growing demand for port services that meet the just-in-time logistic requirements. The demand for fast and reliable services is reflected in the continuous trend to replace the traditional forms of cargoes' distribution through intermodal transportation.

To satisfy the continuous growth of this demand, major infrastructural improvements are essential. Moreover, administrative and operating changes are necessary. They would facilitate the maximisation of the benefits from the present and the future infrastructure. Consequently, Greek ports would serve efficiently the demands for modernised and reliable short-sea shipping services, contributing in this way to the more balanced distribution of the traffic within the single market. This policy implicates significant volumes of investments.

4.1 Investments in ports' infrastructure

The investments in Greek ports remain insufficient, although ports are critical for the re-loading of cargoes and the distribution of the short-sea transported goods in the mainland and in the islands. This happens although the dominant view in the country is that whereas the ports are included in a reliable transport system they contribute substantially in the decreasing of the country's core-periphery imbalances.

A major justification for the absence of the necessary investments in ports' infrastructure is the generalised limited investments in infrastructure projects, mainly because of the difficulties to realise the precise socioeconomic benefits of such investments. While the forecasts suggest a significant increase of the demand for transport services, in particular for new type port services, the development of the infrastructure is delayed as a result of environmental concerns and financial restrictions. Pressure on constrained national budgets make allocation of capital in long-term investments more problematic.

The investments in transport infrastructure which are executed by the M.E.FP.PW were 0.66% of the GDP for the period 1981-1985. They decreased to 0.56% for the second half of the 1980s but they were increased to 0.82% the period 1991-1994. Antithetically, the investments in ports' infrastructure as a percentage of the GDP have decreased continuously. They were 0.033% the first five years of the 1980s, they decreased to 0.030% the period 1985-1990 and to 0.026% the period 1991-1994.

It is characteristic, and is illustrated in Figure 1 (Source: Compilation of data supplied by the Ministry of National Economy, Recorded by the Ministry of Environment, Fiscal Planning, and Public Works), that the investments in ports' infrastructure as a share of the total investments in transport infrastructure is

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progressively declining. This share had an increasing trend the period 1981-1988, with a peak in 1982. During the second phase, the period 1989-1994, a profound decline is observed. Remarkably, in 1994 the share returned to significantly lower levels than the respective share of 1981. This highlights the hierarchy of the investment priorities in the transport sector, especially the national choices in regard of a strategic interest field, the development of the short-sea shipping networks. These negative indicators of the investments in ports contradict the trends of the EU financial support policies. As Table I suggests, in 1988 the share of the EU-level financial contribution devoted to port infrastructure in Greece was higher than the respective share in the total investments in the transport sector. While the contribution of the EU in investments in ports’ infrastructure the period 1988-1990 has fluctuated between 12.36 and 21.52% of the total, the analogous EU contribution in the total of the investments in the transport sector has been in the lower span between 4.35% and 7.94%. The rest of period (1991-1994) the contribution is balanced as EU contributes 55-62% of the investments in both cases.

<table>
<thead>
<tr>
<th>Years</th>
<th>EU Contribution in the Investments in Ports’ Infrastructure</th>
<th>EU Contribution in the Total of the Investments in Transport Infrastructure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1988</td>
<td>16.02</td>
<td>5.33</td>
</tr>
<tr>
<td>1989</td>
<td>12.36</td>
<td>4.35</td>
</tr>
<tr>
<td>1990</td>
<td>21.52</td>
<td>7.94</td>
</tr>
<tr>
<td>1991</td>
<td>21.50</td>
<td>57.69</td>
</tr>
<tr>
<td>1992</td>
<td>59.71</td>
<td>58.12</td>
</tr>
<tr>
<td>1993</td>
<td>60.59</td>
<td>61.68</td>
</tr>
<tr>
<td>1994</td>
<td>58.74</td>
<td>58.13</td>
</tr>
</tbody>
</table>

Table I: Share of EU contribution in investments in transport infrastructure

All these hint at the wider importance that is addressed to the development and modernisation of Greek ports by the EU policies. The corresponding indicator of the EU participation the total of the investments in all the transport modes in Europe during the period 1982-1992 has been 6.5%. In short the EU financial support has been notably high in the Greek case.

During the years 1988-1994 the financial contribution of the EU to the investment in transport infrastructure was Drachmas (Drs) 288.634.997 thousands. This sum created the mobilisation of total investments in transport infrastructure of only Drs 610.822.483 thousands, representing a capital mobilisation ratio (CMR) of equal to 2.1.¹ In the case of the investments in ports’ infrastructure and for the same period the corresponding indicator is of the same volume. The total of the EU financial contribution has been Drs 9.552.860 thousands and the mobilised capital

¹Capital Mobilisation Ratio = (Total of the Investments) / (EU financial contribution)
Investment Policies in Ports' Infrastructure

Figure 1: Share of investment in port infrastructure/total transport infrastructure

was Drs 21,208,301 thousands representing a CMR of 2.2.

Compared to the average CMR in the EU the CMR in the Greek case is remarkably small. The period 1982-1992 the EU provided ECU 702.7 million for investments in transport infrastructure and the total capital which was invested was ECU 11,167 million which results a CMR of 16.

Based on the difference between the CMR in these two cases it is concluded that whilst the financial intervention of the EU in the transport sector was successful - at least in terms of the mobilisation of financial sources - this success has not been reflected in the case of the Greece, whereas the ratio is smaller, whether the investments in transport infrastructure or the investments in ports' infrastructure are considered.

The volume of the national-level contribution in the financing of the investments in ports' infrastructure the period from 1988 to 1994 remains stable (Figure 2, Source: Compilation of data supplied by the Ministry of National Economy). The investments in the total of the transport infrastructure, follow a similar trend (Figure 3, Source: Compilation of data supplied by the Ministry of National Economy). Higher investment volumes have been resulted solely by the increase of the EU financial intervention. The latter happened without mobilising significant more sources than those of the past. Close attention of the investments in ports' infrastructure suggests that the actual level of the Greek investment payments has decreased.
Figure 2: Investment in ports’ infrastructure in Greece

Figure 3: Total investment in transport infrastructure

4.2 The case of the port of Thessaloniki

The Port of Thessaloniki is one of the two ports which are directed by a port authority, the Port of Thessaloniki Authority (PTA). It is the second biggest port of
the country and of particular importance for the single market as the modernisation of the motorway infrastructure is a part of the Christophersen Group's priority projects. The question is whether a different pattern has been followed by this Authority in the perspective of integrating the short-sea shipping in an all mode transport network.

In Figure 4 (Source: Port of Thessaloniki Authority) the development of the total of PTA investments in transport infrastructure is presented. It is fairly obvious, that the trend of their volume investments does not differ from of the total of the country’s investments in ports' infrastructure. Neither the share of the EU funds as a percentage of the total PTA investments contradicts the conclusions of the national level cases which have already been examined.

In regard of the mobilisation of capital sources the effects of the EU financial support remain insignificant. The volume of the allocated by the public sector capital has increased but the level of that increase has been limited. Furthermore, except of the usage of capital which had been provided through the Public Investment Programme and the EU funds, no other contribution took place during the period 1990-1994. The total PTA investments have been Drs 7,841 millions with the EU contributing Drs 3,060 millions. The participation share of the EU is 39% approximately, and significantly higher than the 6% participation of the EU funds in the total of the investments in transport infrastructure in Europe the period 1982-1992. The CMR is 2,57, it does not differ from the corresponding Greek level ratio but contrast the average EU level which has been 16 for the period 1982-1992.

Figure 4: Total investment port of Thessaloniki in infa- and suprastructure
5 Characteristics of the ports' infrastructure and its financing

In recent years governments attempted to find alternative or complementary capital sources as a mean to overcome the burdens of fulfilling the essential infrastructural adjustments. Many EU Member States have introduced privatisation policies in many sectors of the port economy. Through these policies the public sector expects to share the risks of building the adequate infrastructure in economic sectors which operate in an international competitive environment. On the other hand, the private sector demanded a wider role. This of an investor and, at least, co-responsibility in the administration of ports. It requested a new approach of the role of the administrative activities in a sense that the sector would not operate as a public utility but in a format which will secure the returns of the invested capitals.

However, linking the theory of public goods to the economic role of the ports' infrastructure we have to consider the latter as a public good which should be provided by the public sector. As public goods and according to economic theory¹, the ports have the following characteristics:

- The use of their infrastructure by one user does not detract from the benefits simultaneously accruing to other user from the use of the same port (non-rivalness); and
- It is impossible, or at least too costly, to exclude particular users from the use of the existing infrastructure (non-excludable).

Though the capacity of the ports' infrastructure is not unlimited, an opportunity cost is involved when the use of the specific infrastructure increases and results in a reduction in benefits to those already use it. This opportunity cost is a part-rivalness phenomenon and is typically called "congestion" of the infrastructure. Moreover, the public good assessment challenge the view that the port services are produced by an industry (the port industry) which exploits as a basic factor of production its infrastructure.

These points led scholars to think about transport infrastructure as a mix of merit, public and club goods.² Merit goods are a category of publicly provided goods on the paternalistic grounds that the potential consumers or users would not act in their self interest without substantial subsidisation. The club principle arise because specific transport infrastructure projects can also serve purely private needs. They are required, or by only some users and the exclusion of any user is possible as long as they are not willing to pay the price for its utilisation.


The contribution of private capital favours the realisation of investments in infrastructure. Therefore, and to accelerate the competition of the Community interest projects, among the EU objectives is the involving of the private sector in a public/private partnership which would take into account the inherent in transport public good aspect. Still, and despite the considerable scope for making more use of private capital, finding the essential sources to cover the costs of building port infrastructure remains problematic and interdependent with a wide range of variables. This is evident in the Greek case where major obstacles for the private sectors involvement are identified. Apart from the inflexible institutional framework which governs the ports' operation wider constraints exist. Among them are the complex non-transparent rules, regulations, and procedures, applied in the planning, evaluation, and construction of all the infrastructure projects. An additional obstacle is the lack of incentives as most ports' infrastructure projects have features that are unattractive to the private capital. Few projects are profitable enough to generate a cash flow that will serve loans and pay the return on equity capital. Some of the most important characteristics of these projects highlight the problem:¹

- The long or very long lives of infrastructure;
- The relative low operating costs;
- The need to attract substantial amounts of capital; and
- The long construction period.

Infrastructure is both a long and a short term investment. When priorities are being established a distinction must be made between long term objectives and medium term projects as they have different financial perspectives. Long-term projects result a continuum of expenditure and a continuum of possible benefits often exceeding a generation. In the case of such tasks a long-term planning is required. Moreover, the sources devoted to such systems should therefore not be orientated solely to present demand but also consider the dynamic development of the transport network. It is, at least, questionable if private sector strategies can invest today a large capital amount to serve future needs. The need for substantial amounts of capital poses one more constraint which is further emphasised by the very substantial time lag between the start of capital formation and the beginning of financial returns. Financing ports’ infrastructure ends up being too expensive, if the private sector is interested at all. In addition, there are problems from the society’s point of view as the market forces do not operate in a way that necessarily satisfies public needs such as safety and environmental protection. The choice between similar projects must be made in favour of the one that has an immediate safety effect but under certain circumstances society as a whole attaches greater importance to future effects than individuals do, as private capital is more attracted by profitable projects. Under these circumstances there is a need for re-thinking the application of the user pays principle. Apart from the benefit of transferring a share of the social cost to private cost, the introduction of a system which charges, direct or

¹European Conference of Ministers of Transport (1990), "Summary of the Round Table debate", in European Conference of Ministers of Transport op. cit., pp 93-103.
Section 111 - Shortsea Shipping and Ports

shadow, the user of the port infrastructure will increase the volume of the available capital. This would make possible the financing of new projects by using some of the capital generated by the infrastructure in service. Furthermore, if the result would be the existence of profitable infrastructure projects, the cross-subsidisation between profitable and non-profitable projects could be possible. This view is challenged by the problems inherent in the principle itself, like the need of a long-term forecast of the demand for transport services, the possibility of users to shift to different modes of transport, or the fact that such scheme should leave any user who is in a position to meet his share of costs with the incentive to use the infrastructure, complicate the application. Likewise, such schemes require much work and long term planning, especially as regards the best way for their application (i.e. through the use of telematics). Still, the current state and the prospects of the investment policies demands the re-consideration of this policy as a mean to overcome the current budgetary constraints.

6 Conclusions and policy recommendations

The development of the trans-European transport networks is a vital support of the operation of the Single Market. The state of the infrastructure in European ports is critical in any attempt to integrate the various transport modes in a multi-modal perspective. Recognising their importance, the EU institutions provide financial support to the national investment policies in ports' infrastructure. The volume of the EU contribution in investments in ports infrastructure is higher in the cases of the less favour peripheral regions of the Union, one of them is Greece.

Evidence suggest that the use of the EU funds in Greece has not been exploited in the best way. The national level investment policy does not implicate a selective choice of infrastructural projects, neither the best combined use of the available capital sources, nor a sustainable development planning. On the other hand, the modernisation of the short-sea shipping networks needs to be conceived at a time when the budget is very tightly stretched. Yet, alternative ways of financing infrastructure projects are obscure, for example private investments are either limited or unknown.

The result is that investment policies in transport infrastructure neglect the importance of the ports' modernisation and the completion of the missing short-sea shipping links. Moreover, they have failed to maximise the potential of the EU financial support. The capital mobilisation ratio in the Greek case is significant lower than the corresponding EU ratio. The investment policy which has been followed by one of the two autonomous port authorities in Greece, the Port of Thessaloniki Authority, does not differ from the national government's policy. The public sector, therefore, has to develop creative financing strategies. National administrations need to develop flexible approaches to the design planning and development of projects if they are to succeed in integrating the ports in a multi-modal perspective. Given the constraints of the Greek budget the challenge is to re-examine the possibility of the user pays policy and the feasibility of an effective, both social and economic, public/private partnership. The Greek authorities have to take up these challenges if there is to be any real chance of integrating
short-sea shipping in a modern and reliable transport network which will promote the country's cohesion and economic development.
Appendix

Table A.1: GDP, Greek investments in Ports Infrastructure, and the Total of the Investments in Transport infrastructure as they recorded by the M.E.FP.PW. (in current prices-million Drs)

<table>
<thead>
<tr>
<th>Years</th>
<th>Total of the Investments in Transport Infrastructure</th>
<th>Gross Domestic Product</th>
<th>Investments in Ports' Infrastructure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1981</td>
<td>14023</td>
<td>1859971</td>
<td>487</td>
</tr>
<tr>
<td>1982</td>
<td>10063</td>
<td>2310688</td>
<td>823</td>
</tr>
<tr>
<td>1983</td>
<td>17982</td>
<td>2731903</td>
<td>845</td>
</tr>
<tr>
<td>1984</td>
<td>22895</td>
<td>3361607</td>
<td>1234</td>
</tr>
<tr>
<td>1985</td>
<td>31913</td>
<td>4135387</td>
<td>1568</td>
</tr>
<tr>
<td>1986</td>
<td>33036</td>
<td>4894781</td>
<td>2130</td>
</tr>
<tr>
<td>1987</td>
<td>27801</td>
<td>5478103</td>
<td>1530</td>
</tr>
<tr>
<td>1988</td>
<td>37384</td>
<td>6619583</td>
<td>2483</td>
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<td>7838252</td>
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<tr>
<td>1990</td>
<td>42401</td>
<td>9212908</td>
<td>1683</td>
</tr>
<tr>
<td>1991</td>
<td>101523</td>
<td>11071526</td>
<td>2372</td>
</tr>
<tr>
<td>1992</td>
<td>96089</td>
<td>12531000</td>
<td>3976</td>
</tr>
<tr>
<td>1993</td>
<td>138655</td>
<td>14422533</td>
<td>6182</td>
</tr>
<tr>
<td>1994</td>
<td>145928</td>
<td>23196000</td>
<td>2387</td>
</tr>
</tbody>
</table>

Source: Compilation of data provided by the Ministry of National Economy

Table A.2: Investments in Infrastructure in the Port of Thessaloniki (in current prices-000 Drs)

<table>
<thead>
<tr>
<th>Years</th>
<th>Total of the National Contribution</th>
<th>EU contribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>1981</td>
<td>179108</td>
<td></td>
</tr>
<tr>
<td>1982</td>
<td>132832</td>
<td></td>
</tr>
<tr>
<td>1983</td>
<td>84043</td>
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</tr>
<tr>
<td>1984</td>
<td>238826</td>
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<td>1985</td>
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<td>1986</td>
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<td>1987</td>
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<td></td>
</tr>
<tr>
<td>1994</td>
<td>950485</td>
<td></td>
</tr>
</tbody>
</table>

Source: Port of Thessaloniki Authority
Soviet Port Policy and the Present Geopolitical Situation

The Soviet Union’s policy with respect to ports was influenced by the following facts:

- The most important sectors of the economy and foreign trade were subordinated to central ministries in Moscow. Ports operated under the direction of the Ministry of Merchant Shipping.

- Transport infrastructure was developed as a totality. The general outlines to be followed in its development were defined by the State Planning Committee Gosplan, which reported directly to the Soviet Government.

- Under a system of centralised planning, new port capacity was primarily located in those places deemed most favourable in the geographical sense and from the perspective of navigation. This meant that it mainly went to the Ukraine and the area that now comprises the three Baltic States. There were also other factors in the background, such as a perceived need to integrate peripheral regions more firmly into a coherent political and economic system. Considerations of military strategy likewise had an influence.

- Transport infrastructure and services were developed in Estonia, Latvia and Lithuania. For many reasons, railways capable of carrying very large volumes led eastwards from these republics, whilst railways running north-south were less developed. In the circumstances of a centralised state and economy, ports were highly specialised.

As a consequence of that development, the Soviet Union’s most important ports on the Baltic were (Figure 1):

- Tallinn (old port) (General cargo and dry bulk);
- Tallinn (new port) (Grain terminal, cold stores; the first phase of the port was completed just before the collapse of the Soviet Union);
- Riga, the Soviet Union’s biggest container port;
- Ventspils, a Soviet export harbour for oil, liquid chemicals and dry bulk (mineral fertilisers);
Figure 1: Important ports and sea routes in eastern Baltic
Cooperation and development of ports in Eastern Baltic shipping

- Klaipeda, oil products, chemicals. In the 1980s, when the collapse of the former system in Poland was beginning, a massive train ferry link between Klaipeda and Mucran was established to facilitate the logistics of supplying Soviet forces in East Germany.

No new port projects were commenced along the Russian Baltic coast during the final years of the Soviet era. There were likewise few improvements to existing Russian ports during the period.

The breakup of the Soviet Union left 58% of its port capacity in newly independent states outside Russia. Much of this capacity had traditionally been used for handling cargo flows to and from Russia.

In the new situation, only 43% of the terminals for oil products remain in Russian ports (and Russia has no capacity for this cargo at all in the Baltic). The figure for container terminals is 61%, and for grain imports 46%. Russia has practically no terminals for importing perishable foodstuffs. Terminals for exporting ammonia, methanol, liquefied petroleum gas and potassium fertilisers are now located in other independent states. Russia's own ports lack the capacity to handle equipment of large dimensions and weight, e.g. 40-feet containers and unit goods.

This situation is, in a certain sense, a traumatic one for those who decide on Russian transport policy. Every state and local authority undoubtedly welcomes port revenues, and ports create employment. Therefore, Russia's goal of increasing its own ports' share of its foreign trade cargo flows is understandable. At the same time, however, it must be conceded that companies have been able to continue to operate through ports in the Baltic States even in the new circumstances. What is important is to find a strategy in which a rational and economically effective balance is struck between the interests of all in the region. Efficient use of the existing port capacity and infrastructure is also desirable from a general European perspective, provided national interests are taken equitably into consideration.

The foreign-trade routes running through the Baltic have traditionally been important for Russia, because its major export markets and sources of imports are around the shores of the sea. In the new geopolitical situation the significance of the Baltic for Russia's foreign trade has increased compared with the situation before the collapse of the Soviet Union. Baltic Distances to important ocean ports are also short. Now more than 40 per cent of Russia's foreign trade flows are directed through the Baltic (see Figure 2). Transferring the volumes that now flow through the Baltic onto railway lines leading to ports in the north or the south would not make sense, because of increased costs. Ships are the most appropriate mode of transport for about 90% of Russian foreign trade within the Baltic region.
Section I - Shortsea Shipping and Ports

Development of Russian foreign trade cargo flows

As a consequence of past development in the eastern Baltic ports, the flow of foreign trade cargo totalled 90 million tonnes in 1988-89. Goods were destined primarily for northern and western Europe, North and South America, and West Africa. They included about 40 million tonnes of crude oil and other liquids, 28 million tonnes of dry bulk (fertilisers, concentrates and grain). The cargo flow subsequently declined and was down to 40 million tonnes in 1992. Now it is slowly increasing again.

An examination by cargo category reveals that the biggest reductions have been in the amounts of oil, liquid chemicals and dry bulk transported. Export shipments of those three categories of goods declined by a total of 41.7 million tonnes over the period 1989-1992 (see Figure 3). Since then, export shipments of liquid bulk cargoes through Baltic ports have increased, whilst dry bulk shipments have further declined.

Russian ports have slightly increased their share of foreign trade cargo since the year 1991 (see Figure 4). However, it is estimated that the capacity utilisation rate in Russian Baltic ports is not higher than 60%. This gives a significant impetus for Russia's transport policy to increase the volume of foreign trade cargo flows through its own ports.

How Russian foreign trade cargo flows are distributed among Baltic countries is shown in Table I. Latvia and Estonia have been able still to increase cargo flows from 1993 to 1994.
Cooperation and development of ports in Eastern Baltic shipping

Figure 3

Breakdown of Russian foreign trade through the Baltic

![Graph showing breakdown of Russian foreign trade through the Baltic](chart)

Figure 4

Development of Russian foreign trade through his own ports of Baltic sea

![Graph showing development of Russian foreign trade through his own ports of Baltic sea](chart)

Breakdown by country of Russian foreign trade cargo flows through the Baltic 1993-94 (millions of tonnes).
Transport experts in Russia and other countries do not expect the country's foreign trade cargo flow to return to the 1988-1989 level before the year 2005. A detailed forecast of the development of these flows has been made by the Scientific Centre of Complex Transport Problems.

The forecast outlines two possible scenarios - one based on a slow development, the other on a fast one. The underlying assumption in both is that peace will prevail in the region and clearly neither will hold if any greater national or international crises occur.

Both forecasts are based on the premise that the foreign trade flow through eastern Baltic ports will grow over the next ten years to between 1.7 (slow scenario) and 2.1 (fast scenario) times its 1994 level, i.e. to between 77 and 95 million tonnes (see Figure 5).

The forecasts assume that major investments in the oil, gas and chemical process industries will yield results and stimulate growth in exports of crude oil, refinery products, liquefied gas and derivatives as well as of other liquid chemicals from regions that have traditionally used Baltic ports. Relocation of certain flows will also contribute to increasing the volume of transport via the Baltic, because Turkey, for example, wants to restrict shipments of hazardous cargoes through the Bosporus. The capacity of Black Sea ports may also be taken up by exports of oil from Kazakhstan and Azerbaijan. It should, however, be borne in mind that there are also other alternative transport routes for oil from those CIS countries.

Bulk goods and general cargo volumes are growing more slowly, because there are also problems in maintaining existing production capacity. Growing purchasing power in Russia will increase imports of consumer goods. Exports of metals will depend quite a lot on demand in world markets and how prices develop in Russia. Industrial development and reforms may be factors that make it possible in the future to export products with a higher value-added content. In the present conditions, the likelihood of growth in exports of coal for use by power stations is not great.

Table I: Russian foreign trade cargo flows through the Baltic (million of tonnes)

<table>
<thead>
<tr>
<th></th>
<th>Lithuania</th>
<th>Latvia</th>
<th>Estonia</th>
<th>Russia</th>
</tr>
</thead>
<tbody>
<tr>
<td>1993</td>
<td>15.9</td>
<td>26.0</td>
<td>16.0</td>
<td>12.4</td>
</tr>
<tr>
<td>1994</td>
<td>15.0</td>
<td>32.4</td>
<td>17.0</td>
<td>11.8</td>
</tr>
<tr>
<td>1994 compared to 1993 (%)</td>
<td>94.3</td>
<td>124.6</td>
<td>106.3</td>
<td>95.2</td>
</tr>
</tbody>
</table>
Cooperation and development of ports in Eastern Baltic shipping

Figure 5: Estimated Russian foreign trade cargo flow through Baltic ports

- Development
- Slow scenario
- More optimistic

Millions of tonnes
The forecast is based on the assumption that the economies of Russia and the other CIS countries will develop in a more open direction, that the conversion of military industry will succeed and that conditions will remain stable. This development will increase economic dealings with other countries and primarily with Russia’s traditional foreign trade partners in Northern and Western Europe and North America. The natural route for the flow of goods is through ports on the Baltic. This development is one reason why Baltic ports’ share of Russia’s foreign trade is on the rise. There is also a third possibility: Russian reform could encounter difficulties, resulting in even slower growth.

If we consider decided or planned investments in Russian regions which are naturally dependent on Baltic ports, the greatest growth can be expected in shipments of oil, refinery products, other bulk liquids, fertilizers, roundwood and products of the mechanical and chemical forest industries. It is thought that most of the capacity of the Black Sea ports will serve exports of oil from Kazakhstan and Azerbaijan. The Bosphorus Straits also place their own restrictions on shipments of oil and other hazardous substances. Foodstuffs and valuable goods will to a large extent continue to travel through Finland using combined transport.

River-sea vessels play an essential role in Russia’s international traffic. At present 674 river-sea vessels with a tonnage of 1.7 million tonnes are in use in Russia’s international traffic. These vessels are operated by 20 shipping companies between Russia and foreign ports in the Caspian Sea, the Black Sea, the Mediterranean, the North Sea and the Baltic, and in the Far East to Japan, Korea and China. Russia’s inland waterway network makes it possible to build logistic chains direct from production plants. A good example is Cherepovets, from which bulk cargo is transported in the summer direct to buyers in Western Europe.

Around 50 vessels of this type are in year-round use between ports which are not subject to winter restrictions or are subject to such restrictions for only a short time (Kaliningrad, Astrakhan and Yeysk for example).

The Baltic is quite suitable for this type of vessel, since wood and other forest products, oil, liquid chemicals and metals can be exported from Russia, grain can be imported, and building materials, fertilizers and coal can be transported from northern Russia, central Russia and the Volga area using inland waterways. These goods are destined for Northern and Western Europe. The inland waterways and ports in the European part of Russia from which the above goods can be shipped form a relatively extensive network (Figure 6).

Russia’s river-sea vessels have problems which essentially restrict it:

- Russia’s inland waterway network is closed to foreign vessels;
- The long winter shortens the shipping period;
- Russia’s river-sea fleet is growing old and Russia has no possibilities to modernize it in the near future. Old vessels increase the risk of accidents. A bottleneck for this type of traffic is the bridges over the Neva in St Petersburg, which can only be opened at night. Transporting hazardous materials through cities is also a problem.
Figure 6: Russian inland waterways and ports import for river-sea type transport
According to the Scientific Centre of Complex Transport Problems, Russia, the growth trend for this mode of transport is still positive, however. By the year 2000 transport volumes may grow by about 10 - 15%. After this development can change in either direction.

Ports and railways in the Baltic States are vitally dependent on transit cargo flows to and from Russia and CIS countries.

Foreign trade transport flows between Western Europe and Russia and the other CIS countries are obviously an important source of revenues for ports and railways in the Baltic States (for railway cargo see Table II).

<table>
<thead>
<tr>
<th></th>
<th>Lithuania</th>
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<th>Estonia</th>
</tr>
</thead>
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<tr>
<td>Total cargo</td>
<td>37.95 26.95</td>
<td>30.57 27.80</td>
<td>24.20 22.60</td>
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<tr>
<td>Transit</td>
<td>17.30 13.40</td>
<td>22.80 20.28</td>
<td>9.80 8.90</td>
</tr>
<tr>
<td>Share of transit cargo (%)</td>
<td>45.60 49.70</td>
<td>74.60 72.90</td>
<td>40.40 39.40</td>
</tr>
</tbody>
</table>

Unit: million of tonnes

Table II: Total and transit cargo carried by railways in the Baltic states

The importance of transit flows to and from Russia and other CIS countries is greatest in Latvia, mainly due to the handling facilities for crude oil, refinery products and dry bulk goods which the port of Ventspils possesses. In Estonia and Lithuania, flows other than transit consist largely of internal transport of oil shale in Estonia and of crude oil to the Mazeikiai refinery in Lithuania. The flow of goods to and from Russia and the other CIS countries in the ports in the Baltic states is on the order of 90 - 95%. If transit traffic from Russia and the other CIS countries did not exist, a large portion of the port and railway capacity in the Baltic states would have to be closed.

National port strategies in the Eastern Baltic region

Russia’s programme for the development of its ports and merchant shipping fleet envisages increasing efficiency in the country’s existing Baltic ports and building new ports in the eastern part of the Gulf of Finland (see Figure 7). The intention is to effect a considerable increase in the country’s own ports’ share of foreign trade transport flows, to as much as 75 - 80%. Problematic from Russia’s point of view is also the fact that there is an increasing amount of free capacity in its own ports. Whether or not Russia’s own and Western suppliers and buyers of goods will wish to use Russian ports will depend largely on the operating environment.
<table>
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<td>More optimistic</td>
<td>Slow</td>
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<tr>
<td>TOTAL CARGO</td>
<td>44,2</td>
<td>67,6</td>
<td>55,6</td>
<td>76,5</td>
</tr>
</tbody>
</table>

Estimate based on data compiled by the Scientific Centre of Complex Transport Problems.
Whether or not Russia's own and Western suppliers and buyers of goods will wish to use Russian ports will depend largely on the operating environment that they offer and how it compares with conditions in neighbouring countries' ports.

Russia's new port-building programme contains the following projects:

(i) The Ust Luga port for general cargo. The first phase is intended to provide capacity of 17 million tonnes and 35 million tonnes is envisaged as the ultimate capacity;

(ii) Terminals for crude oil, refinery products and other liquid chemicals are planned for Primorsk and Batareinya Bay. The latter is intended to handle dry cargo as well. The combined capacity of these two ports is intended to be 62 million tonnes.

(iii) A port in St. Petersburg will specialise in dry cargo, mainly general, and is planned to have a capacity of 15 - 16 million tonnes per year.

(iv) It is planned to develop the port of Vyborg to handle timber and general cargo. When the extension has been completed, capacity will be 4.5 million tonnes.

(v) There are also plans to develop the port of Kaliningrad to serve flows of goods to and from Belarus and other CIS countries. Here, the capacity envisaged is nearly 6 million tonnes.

If this programme is implemented, it will have a major effect on railways and ports in the Baltic States, because it will provide port capacity, which is more than enough for the forecasted Russian trade flow through the Baltic ports (compare with Table III).

The Baltic States are also developing their ports and transport infrastructure. The ports of Ventspils and Riga are being developed in Latvia and Klaipeda in Lithuania. In Estonia, a development programme exists for transit traffic centres mainly on upgrading tracks and frontier stations and improvements at the port of Muuga.

If we look at forecasts regarding the development of Russia's foreign trade, we see that up to 2005 the growth in the flow of goods through ports in the Baltic may be about 30-50 million tonnes. At the same time 80-90 million tonnes of new capacity has been planned for Russia's own ports, even according to cautious estimates. This is a question which must be taken into consideration in planning new port investments in Russia and the Baltic states.
Cooperation and development of ports in Eastern Baltic shipping

Figure 7: Ports in eastern part of Gulf of Finland
The Role of Finnish ports

Finland's opportunities in relation to facilitating Russian foreign trade flows are supported by existing, long-term experience and the possibility of using Finnish logistical support services. However, the share of Finnish ports is minor compared to that of the ports in the Baltic states; only 5 million tonnes yearly.

Some ongoing infrastructure improvements (for example completion of the Ljetmajärvi - Kotchkoma railway line) may in a modest way improve the position of Finnish ports. The Finnish ports like Kokkola, Kotka, Hamina, Helsinki and Hanko have actually the capacity to handle 10 - 11 million tonnes of Russian foreign trade cargo.

Finnish ports have been used - because of high quality logistical services - for transport of valuable general cargo (containers), easily perishable goods, expensive chemical products, certain types of bulk cargo, timber and scrap metal (for competitive indicators see also VTT & NEA, 1994).

Strategy for cooperation

It is important to ensure that cooperation in the region proceeds in such a manner that an equitable balance is achieved between neighbours' national interests and the international considerations relating to the overall evolution of traffic infrastructure in Europe (see also Himanen et al., 1995). Cooperation of this character will also promote political balance and trust in the region.

Since the proposed infrastructure projects will require international funding, and often from the same sources, it is important that investments made be appropriate and profitable.

This means that the choice of transport route would be made solely on the basis of cost and efficiency. Security and environmental factors will have to be taken into consideration by all actors involved. A competitive edge can not be gained at the expense of safety and the environment.

In formulating the principles to be followed in future development, the following aspects should be taken into consideration:

- The efficiency in existing ports can be improved. In conditions of free competition abolishing of political and legislative barriers between ports would be a tool for improved efficiency;

- It is reasonable to expect that the share of Russia's foreign trade flows handled by its own ports will increase;
Cooperation and development of ports in Eastern Baltic shipping

- Ports and railways in the Baltic States and Finland have traditionally been used for transit transport to and from Russia and other CIS countries. Operators in those countries have experience of handling such cargoes and their experience is an important factor in choosing transport routes.

Investments in Russia could reduce the flow of goods through the Baltic States, to a level of 12-14 million tonnes according to the calculations made by the Scientific Centre of Complex Transport Problems. In the light of the principles outlined above, such a major reduction would not be the correct solution. Russian companies have been using the Baltic States' advantageously-located ports continuously. The right solution will be found, provided - in conditions of free competition, with the positive contribution of the authorities and with the environment and safety being taken into consideration - companies themselves are able to choose the optimal route.

As a conclusion it can be stated that the major increase in efficiency ought to be searched through the improved management of logistical services in the existing ports. Major long term investments in ports will probably lead to excess capacity. The growth in Russia's foreign trade is uncertain as well as the share of its own ports. Because of this the amount of transit goods through the ports in the Baltic States and Finland is even more uncertain.

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THE MARINE MOTORWAY: OPPORTUNITIES FOR COASTAL FREIGHT FERRY SERVICES

By A. Braird

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2 Analysis of a coastal freight ferry service .................. 316
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6 Ship specifications and service timetables .................. 321
7 Service viability .............................................. 321
8 Conclusions ..................................................... 323
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1 Introduction

This paper summarises findings from a study completed in 1995 on behalf of Scottish Enterprise {1}, the government agency responsible for economic development in Scotland. The study investigated the potential viability of operating freight ferry services between Scotland and England as an alternative to long-distance road haulage. A key part of the study consisted of an investigation and analysis of a recently introduced coastal freight ferry service which competes directly with trunk road haulage, vis the Viamare operation linking Genoa with Sicily. The study then considered the nature of the long-distance trunk road haulage market in the UK, in the process identifying factors influencing the competitiveness of the trunk haulage industry in general. Based on analysis of existing interregional goods flows between Scotland and England, three specific ferry routes were identified. After discussions with potential shippers, shipowners and shipbuilders, ideal ship specifications and service timetables were proposed. Finally, the study estimated the potential financial viability of all three routes.

2 Analysis of a coastal freight ferry service

In 1992, the Italian state-owned shipping organisation Finmare established a subsidiary company, Viamare, to operate a new coastal freight ferry service between Genoa and Sicily. The new service was designed to offer freight operators an attractive and economical alternative to the motorway trip across Italy. The fundamental objective of Viamare was to transfer heavy goods traffic from road to sea. The new service was consistent with Italy’s General Transport Plan which outlined specific guidelines for the expansion of maritime transport.

It was intended to operate the new service with four freight ferries, allowing Viamare to offer two sailings each way every day. Ships of 7,323 DWT were ordered, each with a capacity of 136x12m trailers. Accommodation was provided for up to 50 drivers in 25 cabins. The ships were conventional ferries offering a service speed of 19.4 knots, allowing a trip time of 24 hours, and built for a quick turnaround of 3-4 hours. Competitive advantage of the service was based on its lower costs per km vis-a-vis road haulage. This enabled Viamare to set freight rates at approximately one third less than road haulage. The by-sea alternative also benefitted from a distance advantage over road; by sea the distance between Genoa and Sicily is just 935 km, against 1,540 km by road (including a ferry crossing).

Considerable attention was given to setting up the terminals at each end of the route. New terminals were built in Genoa (Voltri) and in Sicily (Termini Imeresi, 35 km east of Palermo). Both terminals are directly linked to the motorway network;
Viamare believed it was essential for hauliers to avoid driving through the towns if the service was to attract traffic from the road. Of all European countries, Italy is said to have progressed furthest in establishing a network of intermodal terminals \( {2} \). Sailings were specifically timed to meet the needs of hauliers, and a custom-built computer system was designed in order to reduce check-in time to around 1.5 minutes per vehicle. The terminals are open 24 hours a day and have constant security. It was also important that the terminals offered quick and easy access from the sea and to ensure that ships could enter in all sea conditions.

Viamare believed that if the service was to be a success, hauliers would need to feel comfortable using it. To this end the company sought to ensure that when a trailer was delivered to the terminals, the driver had a return load to take away. For the benefit of the mainly Sicilian padroncini (owner drivers) who tended to accompany their vehicles on-board the ships, Viamare provided chefs who specialised in making favoured regional dishes.

Southbound, traffic carried on the ferries includes supermarket products, medical supplies, foodstuffs, mineral water, furniture, clothes and leather goods. Northbound, traffic consists of fruit and vegetables, various other foodstuffs, salt, chemicals, and plastic products. The service also carries large numbers of new and second-hand cars. Fiat cars manufactured in Torino are shipped from Voltri; Fiat also provide good return loads from their plant situated near Termini Imeresi.

The trade is imbalanced 2:1 in favour of southbound traffic, resulting in significant numbers of empty trailers being carried northbound.

By 1994 Viamare had secured approximately 16% of the by-road market. The service was expected to be profitable with a 19% share. In spite of this growth, the Viamare service experienced a number of difficulties, including: competing subsidiary requirements within the Finmare Group meant that Viamare was only given two ships, barely enough to provide a daily service; devaluation of the Lira resulted in the company paying much more for its ships than intended; road haulage legislation in Italy is not sufficiently enforced - if it was, more road vehicles would be pushed onto the ferries, and; trailers (in Italy) are not of uniform dimensions, making vessel stowage problematic.

In hindsight, Viamare believe that faster ships would provide for a more attractive service. The company were confident that ships offering a service speed of 24 knots or above would be much more competitive. Notwithstanding these difficulties, the Viamare experience demonstrates a number of important issues (i.e. vessels, terminals, and the specific needs of service users) which shortsea operators must take into account when considering introducing freight ferry services in direct competition with trunk road haulage.

### 3 Long-distance trunk haulage in the UK

The study considered key competitive dynamics facing the UK trunk road haulage industry. In the UK long-distance (i.e. over 200 km) trunking sector, the majority of freight is carried by public haulage contractors (hire and reward), using articulated vehicles \( {3} \). General haulage contactors account for over 80% of all long distance articulated vehicle trunk movements. The general haulage sector is characterised by low rates, and zero or negative margins. Increasingly, the basic
The Marine Motorway: Opportunities for Coastal Freight Ferry Services

trunk haulage part of distribution is being contracted out to owner-drivers. P&O, Wincanton, and other large distribution companies are moving to an all owner-driver trunk haulage operation (4). However, large distribution companies are increasingly demanding a high degree of sophistication in IT from their suppliers, and small family haulage firms are unable to fund the scale of change. Moreover, there is evidence to suggest that in order to hold down costs, some hauliers have infringed regulations on vehicle weight, maintenance standards, and drivers' hours (5).

Road haulage costs are forecast to rise significantly within the next few years due to the introduction of a variety of regulatory measures such as restrictions on drivers' hours, reduced speed limits, motorway tolls, and increased fuel duties (6). An additional factor to consider is congestion; congestion is estimated to cost the UK economy £15 billion a year. Moreover, it is becoming increasingly evident that new roads are not the answer to traffic congestion. The recent SACTRA report (7) argued that new roads "induced" more traffic. The Government has since cancelled several new road schemes.

Given that heavy goods traffic is forecast to rise by 20-38% between 1992-2002, and that the UK's major motorways are operating over their designed capacity limits every day, there is therefore a clear imbalance between forecast road traffic growth and existing or planned road capacity. Both the UK Government and the European Commission accept that existing over-dependence on road transport will have to be addressed. Intermodal and combined transport alternatives are viewed as possible solutions. EC initiatives in particular will concentrate on providing support for improving the interface between modes in order to ensure a rapid and reliable transfer of goods (8). The EC also recognises the potential opportunity afforded through the application of new technologies such as higher performance ships.

4 Estimating the UK coastal freight ferry market

In identifying potential freight ferry routes between Scotland and England, it was first of all necessary to disaggregate traffic flow data (by region) from the Department of Transport's "Continuing Survey of Road Goods Transport 1993" (3). Initial analysis of this data led to the conclusion that there are significant quantities of freight moving by road between Scotland and three broad areas of England/Wales: (1) the North West, West Midlands and Wales, with potential access via a port in the North West; (2) the North East, Yorkshire & Humberside, with potential access via a port in the North East; and (3) the South East, Greater London, East Anglia and parts of East Midlands, with potential access via a port in East Anglia. After analysis of this data, the view was taken that there was scope for further general examination of all three potential coastal routes between Scotland and England.

The study then sought to identify ports which could effectively cater for high-speed ferries. Ports would be required to provide adequate access to and from each pre-defined traffic generating port hinterland. Thus, on the basis of the existing traffic flow analysis and after identification of existing and planned ferry terminals, the following three routes were selected for further investigation (see
Figure 1: Greenock-Birkenhead (a distance of 375 km); Rosyth-Harwich (690 km); and Rosyth-Teesport (320 km). The port selection decision was also based on criteria laid down for the Viamare service, in particular, direct connection to the motorway network (or at least dual-carriageway), avoidance of towns, and ease of (24-hour) access from the sea.

The market for each route was then estimated in terms of the number of 12 metre (equivalent) trailers. The estimated number of empty vehicles is also included in the total figure given in Table I which outlines the total (by-road) market in respect of each route. A further point worth considering is that, unlike the Italian experience, Scotland-England goods flows northbound and southbound tend to be relatively well balanced.

<table>
<thead>
<tr>
<th>Route</th>
<th>Tonnes</th>
<th>Trailers (1,000s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greenock-Birkenhead</td>
<td>10.0</td>
<td>783</td>
</tr>
<tr>
<td>Rosyth-Harwich</td>
<td>5.3</td>
<td>367</td>
</tr>
<tr>
<td>Rosyth-Teesport</td>
<td>14.5</td>
<td>1,165</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>29.8</strong></td>
<td><strong>2,315</strong></td>
</tr>
</tbody>
</table>

Table I: Estimated transport market for proposed Scotland-England ferry routes

5 Potential customers

The study consulted a range of potential coastal ferry service customers in an effort to establish likely demand, and to gain some idea of perceptions and views. Based on information received from Viamare, potential customers were assumed to include general haulage firms, logistics and distribution specialists, wholesalers, retailers, and car manufacturers.

Long-distance haulage firms questioned were concerned that ports might be too distant from vehicle loading/delivery points. They were also of the view that vehicle transfer at the terminals would not be fast enough. Their main concern, however, was that ferries would be too slow. Logistics and distribution companies also stressed speed as being vitally important, in addition to cost. Because distribution firms already contract out trunk haulage to owner-drivers, a coastal ferry service is viewed as a substitute supplier, and would therefore be regarded as being of a complementary nature to their existing activities. Wholesale and retail firms contacted suggested that for the coastal service to be successful, it would need to guarantee that goods delivery times were maintained, that the service was reliable, and that costs were competitive. Car manufacturers (comprising as much as 20% of total Viamare traffic volumes) also argued that costs would need to be competitive with road, and stressed additional factors including attractive sailing times, service frequency, maintained transit times, and no increase in
The Marine Motorway: Opportunities for Coastal Freight Ferry Services

1. Greenock - Birkenhead (375 KMS)
2. Rosyth - Harwich (690 KMS)
3. Rosyth - Teesport (320 KMS)

Scotland - England Coastal Freight Ferry Network - Proposed Routes

Figure 1: Proposed Scotland-England coastal freight ferry routes
vehicle damage. A common view among all users of trunk haulage was that ships would need to be very fast to compete with road.

6 Ship specifications and service timetables

On the basis of views expressed by potential users of a UK coastal freight ferry service, particularly regarding service speed, conventional ferries were discounted as impractical; for the specific routes under consideration, conventional ferries would take twice as long as trunk haulage. Viamare employ conventional ferries but that service differs in the sense that it enjoys a significant distance advantage over road and the Italian road network is less sophisticated than the UK. Yet even with a distance advantage, Viamare management still consider the speed of their ships to be a real weakness. Thus, for UK coastal routes, only high-speed ferries could effectively compete with road.

After consultation with ferry operators and shipyards, and taking into account goods flows, the study sought to establish an appropriate high-speed vessel specification for each of the three coastal routes, particularly in respect of vessel speed and capacity. It was subsequently decided that an appropriate ship would be of catamaran design, with a carrying capacity of 100x12m trailers (plus 50 passengers), and a speed of 35-40 knots. Shipyards consulted estimated that a high-speed freight ferry corresponding to the suggested design and capacity, would cost between $35-45 million (Viamare's conventional ferries cost approximately $47 million each).

With two high-speed freight ferries operating on each of the three proposed routes (6 ships in total), an attractive service timetable could be offered. As an example, Table 11 illustrates the proposed Greenock-Birkenhead sailing schedule. On this route, voyage time is estimated to be 6 hours, with port turnaround of 2 hours. Each vessel would offer three trips per day, providing a sailing every 8 hours. The subsequent financial analysis assumed each vessel would operate the equivalent of 6 days per week, 48 weeks a year, leaving sufficient time for maintenance and service downtime. The same service timetable could be offered on the slightly shorter Rosyth-Teesport route, with concurrent fuel savings (due to slight speed reduction). For the longer Rosyth-Harwich route, each ship would undertake one round voyage per day (port-port sailing time 10 hours), providing for two daily sailings from each port. All sailing and arrival times were set in order to avoid peak road congestion periods, and to cater for specific local needs.

7 Service viability

Given higher operating costs, due in the main to an increase in fuel consumption compared to conventional ferries, a high-speed coastal ferry service would be unable to offer any price advantage over current low trunk haulage rates. The service could, however, be offered at a price equivalent to trunk haulage, and forecast revenues were assessed on this basis (taking into account different haulage rates in respect of each route). On each of the three routes considered,
The Marine Motorway: Opportunities for Coastal Freight Ferry Services

Table II: Proposed Greenock-Birkenhead sailing schedule

<table>
<thead>
<tr>
<th></th>
<th>Ship 1</th>
<th>Ship 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>sail Birkenhead</td>
<td>2300</td>
<td>2300</td>
</tr>
<tr>
<td>arr Greenock</td>
<td>0500</td>
<td>0500</td>
</tr>
<tr>
<td>sail Greenock</td>
<td>0700</td>
<td>0700</td>
</tr>
<tr>
<td>arr Birkenhead</td>
<td>1300</td>
<td>1300</td>
</tr>
<tr>
<td>sail Greenock</td>
<td>1500</td>
<td>1500</td>
</tr>
<tr>
<td>arr Greenock</td>
<td>2100</td>
<td>2100</td>
</tr>
<tr>
<td>sail Greenock</td>
<td>2300</td>
<td>2300</td>
</tr>
</tbody>
</table>

door-door transit times via the ferry (including terminal transfers) would be equivalent to those offered by trunk haulage. Given equivalent price and transit times between modes, a high-speed freight ferry operator would therefore have to stress other advantages to potential users of the service. These advantages would include: less wear and tear on trucks and trailers; the freeing up of trucks and drivers for other work (the study assumed 25% of vehicles on the ferry would be driver accompanied, compared to 40% in Italy), and; access to a frequent, reliable, high-quality transport system.

Operating costs for each service were assessed based on information provided by both conventional and high-speed ferry operators. Assuming each service experienced a utilisation factor of 65% (the Viamare service breaks even at 65% utilisation), the feasibility analysis found that: Greenock-Birkenhead would make a loss of £0.36 million (with 14.3% market share of by-road traffic on that route); Rosyth-Harwich would make a profit of £0.27 million (20.4% market share), and; Rosyth-Teesport would make a loss of £0.49 million (9.6% market share). As Table 3 demonstrates, all three services, assuming they attracted a combined 14.8% market share of all Scotland-England trunk road traffic (1993 levels), would generate estimated total revenues of £68.83 million, resulting in an operating loss of £0.58 million. It is estimated, therefore, that each service would more or less break even when operating at 65% capacity utilisation.

Table III: Estimated revenues, operating costs and profit (loss)

<table>
<thead>
<tr>
<th></th>
<th>Gra-Birk</th>
<th>Ros-Har</th>
<th>Ros-Tees</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>12m trailers (000s)</td>
<td>112</td>
<td>75</td>
<td>112</td>
<td>299</td>
</tr>
<tr>
<td>Market share (%)</td>
<td>14.3</td>
<td>20.4</td>
<td>9.6</td>
<td>14.8</td>
</tr>
<tr>
<td>Total net turnover (£m)</td>
<td>23.06</td>
<td>24.13</td>
<td>21.64</td>
<td>68.83</td>
</tr>
<tr>
<td>Total operating cost (£m)</td>
<td>23.42</td>
<td>23.86</td>
<td>22.13</td>
<td>69.41</td>
</tr>
<tr>
<td>Operating profit/loss/EBIT (£m)</td>
<td>(0.36)</td>
<td>0.27</td>
<td>(0.49)</td>
<td>(0.58)</td>
</tr>
</tbody>
</table>
8 Conclusions

Three potential coastal freight ferry routes between Scotland and England were identified in the Scottish Enterprise study. However, conventional ferries would be uncompetitive on such routes; only high-speed vessels would be able to effectively compete with long-distance road transport in the UK. Intensively operated high-speed freight ferry shuttle services would offer a comparable product to trunk road transport, vis-a-vis price and transit time. Assuming ferry operators charged door-door rates broadly equivalent to current road haulage prices, it is estimated that all three proposed high-speed freight ferry services would break even operating at 65% capacity utilisation. 65% capacity utilisation would represent approximately a 15% market share of total Scotland-England trunk traffic.

These findings should be regarded as unsurprising given the relative sophistication of the UK road haulage industry and the lack of any significant distance advantage of sea routes over road. It is therefore inevitable that the technology and operations of shortsea shipping will need to be fundamentally changed before any meaningful modal shift from road to sea can take place \(^9\). However, vessel technology is changing, with high-speed ferries offering freight carrying capacity now in service and shipyards promoting new designs of high-speed ferries in pure freight configuration. In addition to the issue of port-port transit time and hence vessel speed, other critical factors include the need for fast terminal transfers and suitable terminal locations. A further challenge relates to the need to change the attitudes and prejudices of today's transport and distribution managers, most of whom are heavily road oriented.

References


The Marine Motorway: Opportunities for Coastal Freight Ferry Services


Section IV - Forecasting, Logistics and Safety

FORECASTING THE FLEET TO SERVE THE SHORTSEA TRANSPORT IN THE SOUTHEASTERN EUROPEAN REGIONS

By G. Trincas and R. Nabergoj

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FORECASTING THE FLEET TO SERVE THE SHORTSEA TRANSPORT IN THE SOUTHEASTERN EUROPEAN REGIONS

Abstract

The present study forms a part of a techno-economic project for selecting optimal ro-ro ship concepts to submit to a long-term planning process of expansion of the shortsea shipping fleet operated over the inter-Mediterranean and Black Sea corridors. A huge potential exists to develop a sea highway for freight and vehicles trade over the Trieste-Constantza connection, eventually through a centered feeding service linking up some ports of the Black Sea area. By using a nonlinear dynamic programming consistent fleet forecasts for different expected trades are provided. A set of innovative ro-ro designs is evolved for operation. Formulation of the mathematical design model is outlined. To understand the economic potential of these vessels, specific attention is given to the effect of ship size and speed, load factor, frequency of service, and cost level, also to quantify the relative significance of the different variables, goals and constraints, in the transport system.

1 Introduction

The considerable political changes that have taken place in former Yugoslavia have accelerated the strengthening of the maritime transport between Central Europe and the countries of the Black Sea region. The road transport sector has been largely penalized since the vital overland route has been blocked. Therefore, also to provide an economical alternative, overcoming the Balkan problem has become the main target for transport companies which have been and are obliged to consider the Adriatic-Ionian-Aegean corridor as the main access to the regions of Central Europe. The ability to accurately forecast the fleets that should support this seaborne commerce is becoming increasingly important.

The underlying demand for moving cargo and passengers over the Adriatic corridor towards the Black Sea regions will continuously change the product requirement of transport. The quality of service factors, such as frequency, regularity and punctuality, as well as incorporation in multimodal transport chains, probably are still more important than technical improvements of ships. Nevertheless, a correct definition of the fleet forecast in different operational scenarios can facilitate port authorities to better link future transport investments with transport policy, shipyards to better evaluate marketing strategies, national agencies to allocate research and development funds properly, and ship designers to anticipate the main technical problems related to innovative ships.
In spite of its potential, shortsea shipping has attracted relatively limited attention from Italian maritime operators and policy makers, probably because the Adriatic corridor is not ready yet to take on the challenges implied by the recent developments and the ambitious goals set forth by the European Union. The main problems that await solutions are:

1. The precise role of Adriatic shortsea shipping within an integrated Trans-European Network structure;
2. Identification of cargoes having the greatest potential to be shifted from land to sea;
3. The potential role of fast specialized ships;
4. How shortsea shipping can influence the industrial and commercial relationships with Eastern Europe and the Middle East.

In view of long-term investment planning the fleet optimization problem can be addressed through decision-making theory applied to seaborne transport. Reliable fleet forecasts are still lacking in the geographic area of interest. Some previous studies have emphasized single aspects of the future, such as maximum physical size of vessels or innovative concept designs \((6, 7, 12)\). In order to have an effective tool for evaluating possible investment policies, a simple mathematical model based on cost-effectiveness evaluation has been developed.

2 The present scenario

2.1 Trends in Southeastern European shortsea shipping

When considering the door-to-door traffic, the road transport mode is predominant, although statistical data show the increasing importance of the seaborne transport mode. As regards maritime traffic in the Mediterranean sea, a volume of about 600 million tons is moved of which 450 million tons correspond to solid and liquid bulk while 150 million tons correspond to general cargo. In particular, 53 million tons are moved by containerships and more than 21 million tons by ro-ro ships \((8)\).

Although ferry capacity from Italy to Greece and Turkey has doubled during the last years, the services are insufficient, especially during the peak season. Indeed, demand for the seaborne transport of lorries/trucks has increased about three times since 1991. To provide a way of overcoming the negative impact of the Balkan conflict and to shorten transit times at reduced costs, new ro-ro services to Trieste have been opened, which are forecast to become daily. Ships now in operation have a capacity of up to 125 trailer units with an average load factor of about 90 percent. But they are tremendously slow and perhaps expensive.

Congestion of roads and growth of intra-European interchanges show that shortsea shipping has to grow its share also in these regions. A growth of seaborne transport in the direction of Turkey of about 9 percent per year is ex-
Forecasting the Fleet

pected up to year 2000. It is authors' opinion that it would be reasonable to suppose the growth of liner services from 2 to 3 times by 2004. Such a forecast is based on the fact that realization of the internal market in Eastern countries, creation of an European economic space, and transition of Central and Eastern European countries towards a market economy will provide a fast increment of intra-European interchange volume.

2.2 The liner traffic in the port of Trieste

Since shortsea shipping is necessary for Europe, it must be examined if it is important for a port like Trieste which is a leader port for transoceanic traffic and an almost obliged passage point for seaborne highways towards Central and Eastern Europe. In recent years, overall maritime freight traffic in the Port of Trieste has reached a constant level with an upward trend in the commercial port, due partly to specialized traffic, but also to ferry boats and ro-ro's. During the last year, the trend in the specific sectors was as follows: the sector of specialized traffic shows constant growth in ro-ro cargo and passenger traffic (+50.57%), while there is a smaller negative difference in container traffic (-1.43%) and the number of TEUs handled (-1.57%). A new liner service for Israel and the Near East started in February 1996 through two units running weekly and capable of carrying about 500 TEUs.

The upward trend affecting in 1995 both goods carried by traditional ships (+34.17%) and specialized traffic (+24.08%) is detailed in Table I. The main routes are those for the Far East, the South and South East Asia and the Americas. As far as shortsea shipping is concerned, ro-ro traffic to and from Greece shows an increase of 10.80% in passengers, 78.86% in trucks, 47.04% in cars, and 38.30% in goods transported.

<table>
<thead>
<tr>
<th>Ship type</th>
<th>Loading (t)</th>
<th>Unloading (t)</th>
<th>Difference (t)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1995</td>
<td>1994</td>
<td>1995</td>
</tr>
<tr>
<td>Colliers</td>
<td>2,306,516</td>
<td>1,739,767</td>
<td>57,386</td>
</tr>
<tr>
<td>Combined carriers</td>
<td>5,565</td>
<td>1,410</td>
<td>3,564</td>
</tr>
<tr>
<td>Container ships</td>
<td>580,417</td>
<td>600,270</td>
<td>819,834</td>
</tr>
<tr>
<td>Ro-fo ships</td>
<td>971,522</td>
<td>676,833</td>
<td>1,116,714</td>
</tr>
<tr>
<td>Ore carriers</td>
<td>284,301</td>
<td>469,167</td>
<td>0</td>
</tr>
<tr>
<td>Barges</td>
<td>28,805,076</td>
<td>30,598,140</td>
<td>74,108</td>
</tr>
<tr>
<td>Barges</td>
<td>0</td>
<td>0</td>
<td>1,963,197</td>
</tr>
</tbody>
</table>

Table I: Cargo traffic in the port of Triest, by ship type

The Port of Trieste disposes of well-equipped ro-ro terminals of which the last one was designed to cater for the most modern and sophisticated ships. Nevertheless,
Section IV - Forecasting, Logistics and Safety

despite the efforts from the new Port Authority, there still remain some efficiency problems mainly due to cumbersome documentary and procedural requirements, and restrictive labour practice.

As more accurate trade forecasts would resolve problems with the predictability of the demand for shipping, windows of opportunity are to be identified. To this end, Table II summarizes regular shortsea shipping lines sailing from Trieste towards the Southeastern Mediterranean and Black Sea. Analysis of age composition of the ships operated shows that in the near future, e.g. by the year 2004, when all cabotage rights are expected to be abolished, many of these ships should be laid up. Thus, if during the next years the liner fleet will not be expanded, there will be no possibility to satisfy the primary Community goal to shift transport of goods from road to sea. Only by solving the problem of liner fleet renewal and expansion, it will be possible to create a stable transport link between Central Europe, Mediterranean and Black Sea regions. A bulk of research is necessary to put forward the proposals of numerical reinforcement and qualitative improvement of the fleet, determining the ship main characteristics, their types and quantity.

<table>
<thead>
<tr>
<th>Ports</th>
<th>Ship type</th>
<th>Freq. (days)</th>
<th>Shipowner</th>
</tr>
</thead>
<tbody>
<tr>
<td>Durres</td>
<td>Conventional</td>
<td>10</td>
<td>Dreyflot</td>
</tr>
<tr>
<td>Durres</td>
<td>Ro-ro</td>
<td>7</td>
<td>Losinjska Plovida</td>
</tr>
<tr>
<td>Zadar-Split-Dubrovnik-Durres</td>
<td>Ferry</td>
<td>3</td>
<td>Adriatica</td>
</tr>
<tr>
<td>Rijeka-Split-Durres</td>
<td>Ferry</td>
<td>7</td>
<td>Dalmacija Kvarner Express</td>
</tr>
<tr>
<td>Split-Makarska</td>
<td>Ferry</td>
<td>7</td>
<td>Sem Maritime Co.</td>
</tr>
<tr>
<td>Ancona-Corfu-Igoumenitsa-Patras</td>
<td>Ferry</td>
<td>3</td>
<td>Anek Lines</td>
</tr>
<tr>
<td>La Valletta</td>
<td>Full Container</td>
<td>7</td>
<td>Norasia Shipping Sea Land</td>
</tr>
<tr>
<td>Piraeus</td>
<td>Ro-ro</td>
<td>15</td>
<td>Black Sea Shipping Co.</td>
</tr>
<tr>
<td>Izmir-Istanbul-Samsung-Trabzon-Hopa</td>
<td>Conventional</td>
<td>10</td>
<td>Turkish Cargo Line</td>
</tr>
<tr>
<td>Haifa-Shod-Limassol-Constantza-Odessa</td>
<td>Full container</td>
<td>7</td>
<td>Zim Israel Navigation Co.</td>
</tr>
<tr>
<td>Beirut-Lakakia-Izmir-Istanbul</td>
<td>Full container</td>
<td>7</td>
<td>Atlantica Nav.</td>
</tr>
<tr>
<td>Mersin-Izmir</td>
<td>Ro-ro</td>
<td>14</td>
<td>Mediterranean Shipping Co.</td>
</tr>
<tr>
<td>Haifa-Ashdod-Limassol</td>
<td>Full container</td>
<td>7</td>
<td>Turkish Cargo Line</td>
</tr>
<tr>
<td>Patras-Hodi-Thessaloniki-Limassol-Piraeus</td>
<td>Conventional</td>
<td>12</td>
<td>Borchard Line</td>
</tr>
<tr>
<td>Alexandria-Ashdod-Haifa-Mersin-Izmir</td>
<td>Full container</td>
<td>7</td>
<td>Gerassimos Kavadas</td>
</tr>
<tr>
<td>Istanbul</td>
<td>Ferry</td>
<td>2</td>
<td>Atlantica Line</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Turkish Cargo Line</td>
</tr>
</tbody>
</table>

Table II: Liner services from the port of Trieste
2.3 The Black Sea area

The countries in the neighbourhood of the Black Sea offer a favourable frame to construct an economic space ensuring continuity and extension of the trading exchanges with direct implications over waterborne transports. Laying at the confluence of some traditional regional markets (Levant, Balkans, Middle East) and some different national economies, which are partially complementary, the Black Sea area may facilitate development of waterborne transport, provided some specific facilities are improved.

Romania can play the role of a hub area generating important material flows, provided the logistic support of all riverain regions is activated. Premises already exist such as ferry services, large harbours among which Constanza is the most important, the new Danubian bridges, several railways, free trade areas in Constanza and Sulina, the Danube-Black Sea channel, the river fleet, and also an attractive legislation for foreign investors. There are also many other logistic objectives already achieved or under work in the other riverain countries: bridges over Bosphor, the European high-speed railway through the southeastern side of Romania towards Odessa, road transport services through Ukraina and Russia, shipping companies, container terminals, etc. The cooperation intentions of the riverain countries have been pointed out by the agreement for creation of a regional Black Sea Transport Center (2).

Ro-ro vessels operating between Turkish and Romanian ports are used by vehicles at nearly 100 percent. The fact that the vessels operating in this link are old and slow causes the trips to be painful and intermittent. Thus, one of the key features of the Romanian shipping over the coming years is likely to be efforts to modernize the fleet.

2.4 Demand projection

Market research plays an essential role in determining a long-range development strategy. The main goal is to identify the different segments of the market, e.g. the products, the routes, the demand of new ships, which could afford the maximum yield. To this end, an important task is to develop a theoretical model for the analysis of alternative solutions in fleet planning.

Estimates of shipping criteria are made by forecasting future commodity flows offered for Eastern Mediterranean shipment. Recent demand statistics show an upward trend likely to continue in the near future. According to the Commission (9) a transfer of up to 6 percent of the total traffic volume or 1.4 million tonnes (0.4 eastbound and 1.0 westbound) from Italy to Black Sea countries is expected to shift from land to sea in the next five years. Romanian ship experts raise this share up to 10 percent endowing ro-ro transhipment. In any case, an important growth opportunity is expected also for feeder container services, provided some obstacles related to delivery times are removed. The latter can be identified in
transhipment delays in ports, long sailing times, and poor handling capability for containers in several Black Sea ports.

An important function to be fulfilled is identification of features of vessels which are likely to be the most suitable in planning the future ro-ro fleet. Transport demand projection expresses the fleet demand year by year. By assuming that 70% of offered cargo could be transported by ro-ro ships and by making reference to the records of past five years and abovementioned projections, the transport capacity required has been extrapolated up to 2004 for this liner shipping. In Figure 1 two alternative demand projections are depicted, where (C) and (R) curves denote the quantity of cargo to be transported according to the medium-term forecasts by the European Commission and Romanian experts, respectively.

Figure 1: Demand forecasts

These projections should not be considered too optimistic as the total transport volume usually increases when new, good and fast ship concepts enter a route. Moreover, a certain percentage of the scrapped capacity is likely to be assigned to larger sizes. The high-speed vessels will run in competition with traditional ships and take cargo even from land-based transport. Obviously, the ro-ro market has to speed up to be competitive with the trailers on the road.

3 The fleet forecast methodology

The selection of the most appropriate process to project the optimal fleet has to be based on its economic effectiveness. The construction and operation policies in the long-term planning concept can be determined according to the selection of
optimal ships to be operated in certain shipping lines. Cost of transport forms the controlling point in evaluation of profitability of shipping services. Design of the fleet requires a comprehensive mathematical model which has to generate an optimal allocation of ships to the cargo offered for transport. The current model which forecasts the number, type, and size of vessels required to serve the South-eastern Mediterranean seaborne trade is based on design, operational, and commercial determinants. The relationships between these factors are extremely complex. Thus, a model's most important use is its ability to quickly evaluate the sensitivity of a forecast to changes in assumptions. The appropriate selection of ships is performed on the basis of designs stored in a knowledge data base in a form suitable to evaluate immediately their performance, efficiency, acquisition cost and annual operating costs. All selected ship designs compete in the decision-making process to yield their most appropriate combination to constitute the fleet.

The model has to match and integrate a range of disciplines among which ship-building and shipping economics, computer technology and mathematical methods, shipping technology, naval architecture and marine engineering are relevant. A flow-chart of the fleet forecast model is shown in Figure 2. It is structured through a set of modules in such a way that it can be used at different design stages with minor modifications. Replacement is not considered for the time being, since it is evident that the tonnage demand exceeds the supply, causing deferring of laid-up tonnage. By consequence, the level of freight rates has the tendency to rise, and the exploitation of less economical ships could be still profitable.

The maritime transport data base contains data of cargo to be transported, information about ports, costs of entering the port per ship type, distance between ports, data influencing the time needed for loading or discharging a ship, etc.

Existing ships, their variants and new designs are stored in the knowledge data base. They are described through their main dimensions, hull form geometry, hydrodynamic and structural characteristics, machinery, weight breakdown, deadweight, etc. Main characteristics of some Italian designed and built ro-ro ships that are still operated, as well as some variants fitted with different engines are reported in Table III. In the legend, \( T \) is the draught in the trailer full load condition, \( P_b \) represents the total installed power rounded according to catalogues of a diesel-engine factory, \( V \) is the service speed under sea state 3 at 85% MCR, while the number of trailers denotes the maximum carrying volume.

The voyage simulation module determines the physical transport data and the financial results of a planned voyage, mainly depending on trip time schedule. It can be used to judge the effects of changes expected for alternative voyages.

The forecast methodology uses trade routes because it was felt that this is the maximum level of aggregation at which meaningful analysis can be completed. In order to reflect a reasonable level of detail as well as to take into account the impossibility to forecast very large numbers of independent variables, the methodology selects previously defined vessels to categorize fleet demands and
Section IV - Forecasting, Logistics and Safety

Figure 2: Structure of the fleet forecast model

<table>
<thead>
<tr>
<th>Ship</th>
<th>Lpp (m)</th>
<th>B (m)</th>
<th>D (m)</th>
<th>T (m)</th>
<th>Cb</th>
<th>Pb (kW)</th>
<th>V (kn)</th>
<th>No of 40' trailers</th>
</tr>
</thead>
<tbody>
<tr>
<td>P006</td>
<td>136.00</td>
<td>22.70</td>
<td>12.70</td>
<td>5.40</td>
<td>0.544</td>
<td>9600</td>
<td>18.00</td>
<td>96</td>
</tr>
<tr>
<td>P008</td>
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<td>22.70</td>
<td>12.70</td>
<td>5.50</td>
<td>0.545</td>
<td>13440</td>
<td>20.00</td>
<td>96</td>
</tr>
<tr>
<td>P011</td>
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<td>5.30</td>
<td>0.538</td>
<td>9600</td>
<td>18.40</td>
<td>118</td>
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<tr>
<td>P012</td>
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<td>24.40</td>
<td>13.20</td>
<td>5.36</td>
<td>0.539</td>
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<tr>
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</tr>
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<td>14.40</td>
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<td>0.608</td>
<td>11240</td>
<td>18.85</td>
<td>154</td>
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<tr>
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<td>P026</td>
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<td>14.40</td>
<td>5.45</td>
<td>0.609</td>
<td>17160</td>
<td>21.85</td>
<td>154</td>
</tr>
<tr>
<td>P028</td>
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<td>25.20</td>
<td>14.40</td>
<td>5.50</td>
<td>0.611</td>
<td>21280</td>
<td>23.20</td>
<td>154</td>
</tr>
<tr>
<td>P031</td>
<td>164.30</td>
<td>22.30</td>
<td>13.60</td>
<td>5.30</td>
<td>0.569</td>
<td>14280</td>
<td>21.00</td>
<td>142</td>
</tr>
<tr>
<td>P032</td>
<td>164.30</td>
<td>22.30</td>
<td>13.60</td>
<td>5.40</td>
<td>0.570</td>
<td>16320</td>
<td>21.85</td>
<td>142</td>
</tr>
</tbody>
</table>

Table III: Main characteristics of some sailing ships

trade routes, without loosing the possibility to quantify the necessary operational relationships between the vessel types and trade routes. The criterion used in optimal allocation of ships is in principle based on a multiattribute function aiming at minimization/maximization of the average annual cost/yield for the fleet. The final results produce reports of the performance of the whole fleet on an annual basis.
4 Design of innovative ro-ro ships

The fleet forecast procedure requires as inputs a set of vessel designs categorized for size groups. To gain insight into design parameters, a flexible comprehensive procedure is used, namely, a multicriteria decision-making (MCDM) support system [13]. A mathematical ro-ro ship design model determines which technically feasible designs are capable to carry trailers with an efficiency superior to the one offered by road trucks. These ships are then refined through design synthesis to reach an efficient compromise for multiple goals both of technical and economic nature. The necessity to produce optimal designs based on engineering economics to forecast the fleet instead of relying on extrapolation to the future of current average ships is due to the utmost importance of life-cycle costs of the ships in making decisions. In European pretty stable economy, the projection of these costs can be done with a large degree of confidence.

4.1 The ship costs estimating tool

A perfect market competition is assumed to exist, which, of course, is not true of liner companies belonging to conferences. A key ingredient in creation of the competitiveness of a fleet on freight market is cost control of ship operation. Cost minimization strengthen the competitive position of a ship against her competitors and allow more flexible tariff or freight policies to attract services offered. The detailed make-up of the costs of a ship varies quite markedly with the builder, the standards to which the ship is built, and the efficiency of production as well as many other factors. Here the economic model is detailed at a level sufficient to ship conceptual design and fleet management decision-making. Since income is difficult to be predicted free market conditions are assumed for the time being.

Once main characteristics of a non-dominated ship has been set up, the economic model is capable of computing the cost of investment in the ship herself covering capital repayments, bank interests on borrowed capital, her total operating cost over some specified lifetime, and finally her salvage value. The model used is an additive cost type, giving reasonably good results with minimal input information.

General equations in simplified form are utilized based on continuous cost driver parameters (e.g., labour man-hours, steel weight, installed power and generator capacity, outfitting density, etc.). While all relevant aspects of these elements of life-cycle cost are covered, concentration is given to the acquisition cost and the operating costs as these are usually of prime consideration in the purchase of any particular ship. They have been partly based on confidential information from an Italian private shipyard.

The timings of the cash-flows are allowed for in discounted cash flow calculations, where all expenditures are converted to an annual basis. The resulting required freight rate is used as an economic merit index, with the speed offering the lowest value for any ship being regarded as the optimal economic speed. The
annual required freight rate on an after income tax basis for alternative ships sailing on the same link is calculated as:

\[
\frac{(aIP,i,nP-(A/F,i,n))S_y(1-t) + (P/A,i,n) - (A/P,i,n)P_y - t - (YfA_y)(1-t)}{O_y}
\]

Where:
- \(A_c\) = annual administration costs
- \(P\) = ship acquisition cost
- \(O_y\) = average annual cargo available
- \(S_y\) = scrap value of ship
- \(Y\) = annual operating costs
- \(i\) = relevant discount rate
- \(n\) = ship age
- \(t\) = corporate income tax rate
- \(t_{cg}\) = capital gains tax rate
- \((A/F, i, n)\) = capital recovery factor, given the future value
- \((A/P, i, n)\) = capital recovery factor, given the present value
- \((P/A, i, r)\) = equivalent present amount, given a constant annual amount for \(r\) years

The previous equation is solved by a series of discontinuous functions, where all cost contributions are expressed in terms of the physical, financial and transport system environment variables. It has then to be minimized with respect to all variables simultaneously.

### 4.1.1 Construction cost

The ship construction cost is assessed on the basis of the procedure proposed by Carreyette {1}, here updated for ro-ro ship types according to input data made available to the authors by private sources. Based on that information, an approximate cost-check equation was developed by splitting acquisition cost into total labour cost and material cost concretized under the form of reliable formulae. The categories of steel, outfitting, and machinery costs are related both to material and man-hours. The total first cost is calculated on the basis of actual figures (average wage rates of direct labour, overheads, price of materials, wastage rates, profit rates, etc.) specific to an Italian shipyard. The cost per ton of outfitting is independent of size.

To this end, preliminary weight estimate is performed for each candidate ship based on weight breakdown adapted for the purpose of concept design model. In particular, hull structure weight is determined by finding the surface area of the various parts of the hull and then multiplying by the specific weight of the structure. Superstructure weight is estimated on the basis of cubic number of its different layers. The cost of main engines is given as a function of engine power. Electric, electronic and auxiliary systems are given as input lump weights.
Forecasting the Fleet

Deadweight is divided into different groups where fuel oil weight is considered as the deviation variable in the MCDM procedure.

4.1.2 Operating costs

The operating capacities and patterns of ships greatly affect their annual carrying capacity. There are four key factors affecting annual ship carriage, namely, ship capacity, operating days per year, sea time per round trip, and port time per round trip. Different combinations of sea time, port time, cargo handling time, and port conditions can result in substantial changes over a ship's actual annual capacity on different trade routes. The modelling of the complex relationships between these factors is at the heart of the forecast methodology.

The annual operating costs are based on the sum of single costs derived from formulae based on figures supplied by different companies whose data are in close agreement. The factors influencing the operating economics are functions mainly of size and/or installed power. In the present model, annual operating costs are expected to rise arithmetically by the same percentage that the construction costs increase, except for the crew costs which rise geometrically with an annual real rate of 4%.

Deadweight

The deadweight is taken as the gross weight of cargo (24-30 tons per trailer) plus weight of miscellaneous items. The latter include consumables, stores and provisions, crew and effects, sludge. The total weight of such items is estimated as a linear function of round trip time. The weight of fuel oil and lube oil consumed at sea by main engine(s) and diesel generator(s), is estimated on the basis of the amount and type of use for which the ship is intended. Ships are designed up to 1500 nautical miles in range plus a 20 percent margin. Oils used during dock and repair periods are added as a lump sum. Fuel and lube oil rates are introduced as derived from engine manufacture companies' programmes. The fuel price is assumed to be the average Rotterdam bunker market price in 1995.

Maintenance and repair

The maintenance and repair costs are mainly comprised of engine (fuel injectors, cylinder heads, exhaust valves & seals, elastic bands, bearings, etc.) and hull costs which are functions of material, manpower and overhead figures supplied by repair yards. As regards engine maintenance cost an average value of 150 DM/kW each 24,000 working hours is taken on the basis of information from 'Fincantieri-GMT'. A 50 percent of this cost is equally distributed in the period up to the general revision, whereas the remaining part is added as a peak value. Hull maintenance costs of a ship are expressed as a stepwise function of her acquisition cost where the growth percentage factor varies as reported in Table IV.
Table IV: Hull maintenance cost factor

Drydock costs depend on the ship’s wetted surface with a unitary cost of 45 DM/m² and on the period in the dock, here assumed to be 7 days at a daily cost of 30,000 DM. Time out for drydock is 4 years.

Overhead costs

An average annual figure for overhead and miscellaneous costs, inclusive of property tax, is approximated to a semi-log function of lightship weight.

Crew wages

Annual expenditure for crew wages in Italian flag ships is derived from agreements between Trade-Unions and 'Confitarma', the Italian shipowners' syndicate. A total cost of 1.64 * 10^6 DM is set for each ship, assuming a basic complement of 18 crew members according to Italian legislation.

Port fees

They depend on port expenses per call (pilotage, mooring/unmooring, anchorage, custom clearance) and number of calls per year.

Trailer handling cost

The level of costs in the Port of Trieste is applied. These costs depend on the unitary cost per linear metre of trailer, the number of trailers per voyage, and the number of calls per year.

The total cost of hull and machinery insurance is calculated under total loss and particular average conditions. On the basis of tables issued by 'Assicurazioni Generali', the total loss cost is approximately established as a linear function of the ship’s acquisition cost depending on a total loss rate \( f_m \) whose range varies depending on the age of the ship (Table V). The particular average cost is established by the insurance company, depending on the so-called 'deadweight formula' with a unitary cost between 2.5 and 6.0 DM. A protection and indemnity insurance is calculated on the basis of GRT and added to previous costs.
Forecasting the Fleet

<table>
<thead>
<tr>
<th>Ship age</th>
<th>1-8</th>
<th>9-10</th>
<th>11-12</th>
<th>13-14</th>
<th>15-16</th>
</tr>
</thead>
<tbody>
<tr>
<td>$f_m$ (%)</td>
<td>0.435</td>
<td>0.443</td>
<td>0.452</td>
<td>0.460</td>
<td>0.467</td>
</tr>
</tbody>
</table>

Table V: Insurance cost factor

Sea speed

In keeping with regular commercial practice, the mean speed is taken as the service speed at 90 percent of maximum continuous power. It is calculated under sea state 5, because this stringent assumption allows margin to periodically adjust ship speed to arrive on time at the destination port catching up some hours for possible delays in port service. The rated speed is applied to the cycle distance and so covers both full load and partially load conditions. When operating at less than design displacement small increase in speed might be expected; but since the gains are not large, they are ignored in future cost analyses.

Operating schedule

Once schedule times are established, figures giving total distances between the principal ports in the Upper Adriatic - Black Sea links allow to estimate required service speed for each ship. Loading and unloading speeds are assumed uniform throughout the various ports and equal to present average values in the Port of Trieste. The same holds for port charges although they may vary widely. Since sea state 6 causes an involuntary speed reduction of about 3-4 knots, modelling of the fleet assumes that the ships do not operate during the corresponding days which statistically amount up to 14 days per year in the Eastern Mediterranean Sea [4]. Since a chain reaction type of events is possible involving delayed arrivals and excessive buffer stocks, the average annual number of operating days is assumed to be 340 over the 15 year economic lifetime of each ship.

4.2 Generation of feasible ships

Although the number of ro-ro specialized ships is not sufficient for the existing routes, the main market is developing new routes and services also because the truck/trailer capacity offered by the present ro-ro ships is far behind the transport demand. The specialized ro-ro ships are opening a new market, as demonstrated by the new links Genoa-Tunis and Marseille-Tunis covered twice per week by ships P020 and P024. The patterns of recent orders and newbuildings of ro-ro ships show a distinct bias in favour of larger ship sizes with highly sophisticated cargo handling facilities, resulting in a high degree of operational flexibility. In addition, IMO has established requirements to upgrade safety of the existing traditional ferry and ro-ro ships, thus forcing most of the liner operators to reconsider their plans for newbuildings of monohull displacement ships. One should
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expect an increase of the number of large ro-ro ferries to be built in the near future, running at service speed higher than 23-24 knots with a medium-term goal up to 28 knots.

In the present model, ro-ro ships are considered to operate at constant service speed since they have to run on a fixed time schedule. The average round voyage time is a function of trade route distance and vessel speed. The total amount of annual port time depends on many factors, namely, the time spent entering and leaving the port, waiting for pilotage and for a berth, berthing and unberthing, loading and unloading cargo, and the number of port calls per round trip. In order to find a simple way to express cargo handling rates for all ship sizes, a straight line was developed relating ship size to cargo handling rate as an average of both loading and discharging rates. It was assumed that the cargo handling rate increases as the size of the ship becomes larger. In order to better estimate total port time for vessels for the next 15 years, it would be necessary to develop a methodology which could adapt to technological advances and other factors affecting future port time.

Design of a fast ro-ro ship with high payload is a complex task of both technological and commercial aspects. Numerical procedures used for calculating attributes and constraints are divided into a set of groups under headings of hull form, general layout, light ship weight, structure, subdivision, intact and damage stability, seakeeping, powering, engines, manoeuvring and vibrations. The economic efficiency of a technically feasible ship is controlled through construction cost, operating costs, and minimum required fare per trailer through lifetime. Unless otherwise stated, the ships here generated for fleet expansion are fitted with diesel engines plus a single or a twin shaft alternator set for electric load and two air conditioning units. They are also provided with bow-thrusters for assuring manoeuvring of the ship in port by her own means, without applying to port services. Drivers are accommodated in two- and four-berth cabins.

Before a design is judged on its economical merits, it has to be verified whether it complies with technical requirements as regards the carrying capacity and limitations imposed by regulatory bodies. Significant are those features with great influence on main aspects of ships quality. Therefore, a cross-impact analysis \{11\} was applied to identify the critical and significant features of each ship type to be then submitted to a multicriteria design procedure to optimize several, often conflicting, objectives subject to constraints. Non-dominated designs in the Pareto sense were then generated. For practical reasons, the number of free variables is kept to a minimum, i.e. only those which are expected to have a significant effect upon the measure of merit. In the model, prime variables such as length, breadth, depth are taken into account as well as less obvious parameters such as number of propeller blades and propeller revolutions. Draught is also considered as a free variable, though a dependent one following the law of Archimedes to balance the optimization procedure, while complying with freeboard requirements at the same time. Another important variable is the vertical center of gravity, to establish the most onerous loading condition. Subdivision is considered important because of its effect on building costs (steelweight, production labour, coatings). It resulted that
there is a strong constraint relationship between subdivision and main dimensions as a result of damage stability requirements. Another relevant design variable is the service power as it affects both construction and operating costs. The amount of fuel and stores is calculated on a round basis. The last critical parameter is the lightweight because it affects simultaneously the carrying capacity and construction cost. All other weight items are estimated from empirical data available from literature and shipyards. The model is then balanced through the ship's operating cycle to be thought of as the sum of activities of the ship between subsequent refuelling.

As regards economic analysis of alternative designs, no subsidies from the Italian government are introduced. The financial framework for all ships is typical of a private Italian shipyard where 70% percent of the total investment is usually borrowed capital. All non-dominated designs are candidates for final design selection based on RFR economic criterion. Cash-flows suitable for trade-off comparisons are calculated on an after-tax basis. The internal rate of return is stipulated to be 13%. A 52.3% corporate income tax rate is applied. The loan period is 10 years with an interest rate of 10%. Capital charges have been evaluated for uniform cash flows and single payment acquisition. Inflation is not taken into account.

Some non-dominated designs generated by MCDM approach are reported in Table VI, where ships P055, P071, and P078 were generated from the 'Futura' project.

<table>
<thead>
<tr>
<th>Ship</th>
<th>L (m)</th>
<th>B (m)</th>
<th>D (m)</th>
<th>T (m)</th>
<th>C_x</th>
<th>P_s (kW)</th>
<th>V (kn)</th>
<th>No of 40' trailers</th>
</tr>
</thead>
<tbody>
<tr>
<td>P046</td>
<td>184.00</td>
<td>27.30</td>
<td>15.40</td>
<td>6.45</td>
<td>0.481</td>
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<td>22.00</td>
<td>13.50</td>
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<td>0.533</td>
<td>32580</td>
<td>26.90</td>
<td>150</td>
</tr>
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<td>13.70</td>
<td>5.97</td>
<td>0.462</td>
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<td>154</td>
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<td>P075</td>
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<td>15.30</td>
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<td>13.40</td>
<td>5.72</td>
<td>0.493</td>
<td>21840</td>
<td>24.10</td>
<td>102</td>
</tr>
</tbody>
</table>

Table VI: Main characteristics of some ro-ro prototypes

An economic analysis was then performed to individuate the optimal operational speed of each non-dominated ship over different links. A computer program makes evaluates all the factors involved in such a decision by gathering information about the system environment (borrowing rate, tax rate, round trip mileage, oils cost, etc.) and calculating both investment and operating costs on the basis of collected information (cost per hour of manpower, crew wages, insurance costs, etc.). The program then systematically evaluates all required costs and ship performance to represent RFR as a function of ship speed.
The transport part of the model was applied with ro-ro ships' capacity varying between 90 and 195 trailers and speed between 16 and 29 knots over routes ranging from 1000 to 1500 nautical miles. The ships are supposed to be Italian-built and operated. Figure 3 gives a sample output from the program for five different ro-ro/trailer prototypes. The results do not take into account any delay in sea time and/or in port service. All the alternative ships have equal economic lifetime (15 years) and the same operating capabilities, e.g. 340 average deployment days per year.

![Image](image.png)

**Figure 3: Required freight rate versus ship speed for some ro-ro ships**

The figure shows clearly that as the size of the ship increases the profitability of the ship increases too. Also, as the size and speed increase, the curves flatten out, so that for bigger ships there is larger room to individuate the optimal operational speed point. The effect of varying the trailer handling rates is also illustrated: heavy lines and dashed lines refer to an average charge/discharge rate of 30 and 40 trailers per hour, respectively (see Figure 3). The corresponding optimal economic speeds are given Table VII.
Forecasting the fleet by dynamic programming

The main goal of the transport system forecast is to efficiently transfer cargoes at minimum cost. The optimal ships for selected trades can be found by means of a fleet optimization model to properly select the number of ships, their size and speed, simulating the total carrying capacity. This approach gives the opportunity to take full advantage of the economics of scale. Assuming that the total demand for transport capacity is known, it is possible to calculate various fleet constictions providing approximately equal transport capacity with maximum earning.

Planning a fleet involves decision making on the basis of information that should be made available and also with respect to effects of alternative decisions. When the demand on a single route is considered to be known, the task is to decide and allocate the optimal ship types and their numbers from S different ship types in order to fulfil the required total transport capacity Q with maximum yield J for the whole fleet. Among different approaches the optimal allocation year by year is performed by using the method of mathematical programming based on the cargo flow quantities available.

Expansion of a fleet is a typical serial multistage decision problem for which dynamic programming is a well suited mathematical technique which allows to make optimal decisions year by year. The problem is decomposed into subsystems to be analysed separately. The candidate ships must be determined before allocating them on the basis of the MCDM procedure described above. The state of the system, e.g. the economic indicators of the ships to be allocated and their competitors must be known before making a decision about allocation at any stage of the planning period. The N-dimensional state vector, x, consists of the number of the state for each of the j ships. The N-dimensional control vector, u, specifies the performance of a ship on the basis of quantities not directly measured by the cost function. The system equations of the dynamic programming then take the form:

\[ x(y+1) = g[x(y),u(y),y] \]

The formulation of the fleet forecast in terms suitable for application of dynamic programming proceeds as follow. First the time interval over which the optimization is to be performed is quantized into increments. The state variables for the system are then taken to be the techno-economic capabilities of each of the non-
dominated ships identified through the Pareto multicriterial design procedure. This information is conveniently summarized in a state diagram.

A computer program using discrete dynamic programming to determine the optimal sequence of decisions has been implemented. One input to the program is the performance of each candidate ship over the planned time period, including estimates of the number of trailers on each voyage. The present state of each ship constituting the fleet is also given. Finally, the constraints are specified. The program then determines the type and order of ships that would enter the fleet in order to optimize the global economic criterion within the given constraints.

It is possible to print out the best S ship types in order to compare the related performances on the basis of quantities not directly measured by the yield. Also, sometimes during the years different constraints can arise; these can be entered into the program and a new optimization performed over the rest of the lifetime of the fleet, starting at the present state of the ships. Moreover, the program can be expanded to include other constraints, other performance criteria, more ships, more ports, etc. Then the optimum transport pattern and the corresponding required ship type and numbers are determined. The general form of the multicriterial problem can be stated as follows:

\[
\begin{align*}
\text{Maximise} & \quad J = \sum_{i=1}^{N} \sum_{j=1}^{S_i} C_j(x_j(y),u_j(y),y)S_j \\
\text{Subject to} & \quad \sum_{j=1}^{S} V_jS_j = Q_y \\
& \quad G(g) \leq b
\end{align*}
\]

Where:

- \( C_j \) = discounted cash-flow of ship type \( j \)
- \( S_j \) = number of ship type \( j \) to be introduced
- \( V_j \) = annual transport capacity of ship type \( j \)
- \( Q_y \) = annual total cargo available
- \( G \) = technological, capital, and other constraints imposed in the short term

The equation addresses the economic objective of capital investment and the strategic objective of proper allocation of ships for the selected route. The first constraint imposed upon the fleet refers to its mission, namely stating that the amount carried by all the ships should at least satisfy the transport demand.

Fleet operation depends on the number, type, size and speed of ships in a certain shipping line. Thus, the annual cash-flow is maximized by optimizing simultaneously the size of ships selected and the frequency of service, i.e. the maximal achieved transport volume between two ports, as well as the handling and accumulating conditions of cargo. If the annual transport capacity of a ship and the annual operational costs are both constants, that is, if they are both independent of the decision variable \( S_j \), the mathematical expression in Equation (2) may be solved by linear programming for fleet planning \{3\}, \{4\}. But in practice \( C_j \) and \( V_j \) are both functions of the decision variables \( S_j \) and \( n_p \), which denote the composi-
Forecasting the Fleet

tion and employment of the optimum fleet, respectively. The annual round voyage number \( n_j \) depends on the round trip time \( t_j \) of ship type \( j \). In this case, the solution obtained by a linear programming model often deviates from the practical conditions. A new mathematical model of fleet planning is obtained by substituting \( V_j \) into the mathematical model (2) and expressing \( C_j \) in terms of \( n_j \). This results in a nonlinear dynamic programming model under constraints. In this multiattribute dynamic programming, the criterion optimization is replaced by a Pareto optimization, and the set of Pareto-optimal decisions for each state is selected.

The cash-flow of the fleet is evaluated by combined application of a Jelen's modified method \( \{5\} \) to allocate candidate ships. This method is based on the annual inferiority cost of each candidate ship, obtained by considering the net sale value at the end of each year as part of the income for that year, and treating it as the new investment. The annual after-tax cash flow, \( C_j \), corrected for inferiority is derived as follows:

\[
C_j = (1 - 6)(A - Z) + tD
\]

Where:
- \( A \) = return before tax to be gained through one more year of operation
- \( D \) = tax depreciation allocation at the end of the year
- \( Z \) = inferiority cost which mainly considers deterioration of the old ship in producing income due to higher operating costs
- \( t \) = income tax rate

6 Application of the ro-ro forecast model

The problem which is faced now is to select the appropriate new ships and to determine the numbers of each ship type to be operated in the Trieste-Constantza link, in order to maximize the net profit of the fleet after fulfilling the transport mission.

The fleet is assumed to be dedicated in an exclusive trade, which is a classic mode of operation from the system analysts' viewpoint. The service is designed to link very few ports; practically only two. Since liner service companies have to provide constancy of sailings, the concept of fixed sailing intervals is assumed. The traffic volume between the two ports and weather at sea are deemed to have the most persistent influence on schedule maintenance, according to which it is possible to determine the capacity and load of each feasible ship, as well as her speed and power. Different assumptions on cargo flows may result, sometimes wrongly, in more or fewer vessels, but not necessarily different sizes and speeds, when these latter variables are likely to be driven by techno-economic considerations of competing ships only. One major task was to gather the cost information. Since a mere comparison of alternative allocation of ships into the fleet is sought for, it does not matter if the cost data are outdated as long as the correct relativity is maintained. In any case, the following assumptions and constraints are set in the forecast model:
A 70 percent of the acquisition cost is paid by securing a loan;

A straight-line depreciation enters the calculations;

Round trip time for a ship is assumed constant in all voyage legs;

The on-time arrival at a certain port and port time are assured;

The design problem is centered on a 15 year contract, e.g. the fleet is assumed to be sold 15 years after the first ship is built;

The salvage values of the ships are related to this 15 year lifetime of the fleet; for instance, the salvage value of a ship entering the fleet in the 3rd year is approximated by 20 percent of her initial cost;

The construction cost is accrued at year $y$ taking into account an average annual rate of cost growth.

The fleet of ro-ro/trailer ships to be designed according to the economic criteria stated above, has to deliver a total transport capacity either of 1 million tons of cargo (scenario C) or 1.65 million tons of cargo (scenario R) in a 15 year period. The required rate of return is still 13% and the loading factor is 70%, being the latter obtained by averaging eastbound and westbound demand projections.

Whenever possible, it was aimed to introduce sister ships in order to reduce construction cost and lead times. Benefits accrued from multiple ship construction have been estimated by evaluating ship construction cost as

$$P_j = \frac{(P_j)_{n-1}}{(1+g)^n}$$

where $P_j$ denotes the construction cost of the j-th sister ship, $n$ is the number of years from the entrance into service of the first ship built, and $g$ is the annual rate of cost growth (say 5%) in real terms.

As a first case study, application of the dynamic programming has been performed to forecast the optimal fleet constituted by existing ships, to be operated on the selected route where the total demand for transport capacity is assumed to be known. Various fleet constitutions which satisfy this level of demand year by year with maximum yield can be calculated. Results of this optimization are illustrated in Table VIII and in Table IX for the two scenarios (C) and (R), as defined in above stated demand projections, respectively. A constant average round trip time has been imposed for each ship from outside in order to assure fixed sailing intervals, so avoiding mistake made by 'Viamare' project where the schedule is different every day in whichever direction. Due to the limited amount of cargo, under scenario (C) no ship is introduced in the fifth year. The after-tax cash-flow in the 15 year period is higher in case 'a'. Its absolute value is translated into a value $J^* = 100$ for sake of normalization. The required freight rate is too high in both
Forecasting the Fleet

cases since a minimum fare of 0.040 DM/(km * t) is required to comply with the expected rate of return.

<table>
<thead>
<tr>
<th>Years</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>J'</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ships (case 'a')</td>
<td>P024</td>
<td>P006</td>
<td>P006</td>
<td>P024</td>
<td>-</td>
<td>P006</td>
<td>P006</td>
<td>100.0</td>
</tr>
<tr>
<td>Ships (case 'b')</td>
<td>P008</td>
<td>P012</td>
<td>P024</td>
<td>P006</td>
<td>-</td>
<td>P008</td>
<td>P024</td>
<td>90.6</td>
</tr>
</tbody>
</table>

Table VIII: Existing ships entering the fleet (Scenario C)

<table>
<thead>
<tr>
<th>Years</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>J'</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ships</td>
<td>P012 + P024</td>
<td>P012</td>
<td>P012</td>
<td>P024</td>
<td>P012</td>
<td>P024</td>
<td>P008</td>
<td>103.2</td>
</tr>
<tr>
<td>Ships</td>
<td>P065</td>
<td>P065</td>
<td>P070</td>
<td>P070</td>
<td>P082</td>
<td>P082</td>
<td>P082</td>
<td>113.0</td>
</tr>
</tbody>
</table>

Table IX: Existing ships entering the fleet (Scenario R)

Under scenario (R) it appears that the best size fleet is that of eight vessels which are on average larger and faster than the previously introduced under scenario (C), also because the amount of available cargo allows to introduce the more profitable P024 ships. In this case a higher value of J' and a lower ticket fare, e.g. about 0.035 DM/(km * t), have been derived (Table IX). A drawback in planning such a fleet through existing ships is that these ones cannot allow for fixed schedule times since some ships (P008, P012) require 3.5 days for half-cycle and others (P006, P024) 4.0 days.

The J' values at each year were then retained for comparison with the values to be obtained by application of dynamic programming to fleet expansion when introducing innovative and faster ships in the planning horizon. These larger ships are characterised by a low block coefficient and a high speed-length ratio (see Table VI). In this case a ticket fare below 0.030 DM/(km * t) was set as a constraint, when maintaining a 13% internal rate of return. Although a heavier initial investment is needed in this case (about 561 millions DM versus 502 millions DM at present values), the discounted cash-flow is tremendously higher. The percentage difference in annual cash-flow of the innovative fleet with respect to the traditional one indicates that the former fleet starts to be more profitable after the ninth year.

Also ships like P057 and P075 fitted with gas-turbine engines have been considered by imposing total sailing times of 60 hours between Trieste and Constantza, which requires an average service speed between 27 and 28 knots. This solution is technically feasible, but would demand a much more higher investment.
and a ticket fare of 0.045 DM/(km * t). This possibility has been discarded for the time being, although it could be taken into consideration would a due amount of high-value cargo be offered for seaborne transport.

7 Concluding remark

A low frequency service using ports with high labour costs and stevedoring charges has little chance of attracting customers away from the roads. Unfortunately, in Mediterranean ports ro-ro ships are charged on the basis of their high GRT in contrast with the ultra low freeboard feeder containerships which carry many tiers of containers on deck. Thus, until suitable economic freight ro-ro vessels are built, shortsea shipping will not take off. Nevertheless, forecast of a new Mediterranean ro-ro fleet encourages and requires innovation.

One of the major problems encountered by shippers is to formulate a successful investment policy for the fleet. The maritime decision makers and shipyards could be significantly aided by a detailed forecast methodology helping them to better evaluate future marketing strategies. Without the use of a fleet forecast model it is impossible, because of the complex relationships that exist, to understand the detailed effects of shifts in trading patterns and changes in trade volume. The methodology developed in this paper, in the form of the existing model or an improved interactive one, can provide a useful tool for policy-makers to plan some segments of the maritime industry.

Admittedly, the authors realize that the forecast procedure developed by no means can represent the final step in perfecting forecast techniques. The applications presented are very limited and help to highlight only some elements of decision-making process. The methodology needs upgrading and the structure can be better streamlined for improved performance in practice. Although the objective function used in allocation of ships to cargo-lots serves the aim well, it is expected that it needs some more attention to be applied in confidence. The mathematical procedure must be completed by introduction of a realistic demand forecast model. Future sensitivity analysis will give special attention to variables which appear to have considerable influence on the final results of the appraisal. The conclusions of such a monitoring will allow the methodology to be adapted and reformulated as far as the impact of some variables on profitability of seaborne transport investment will be significant. It is authors' hope, however, that this paper will help to stimulate further interest, research and applications in this area, all to the benefit of the European maritime industry.

Acknowledgements

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References


INTEGRATING SAFETY INTO THE SHORTSEA SHIPPING SYSTEM

By J.A. Stoop, S. Hengst and C. Dirkse

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INTEGRATING SAFETY INTO THE SHORTSEA SHIPPING SYSTEM

Summary

Aggregated accident data indicate an overrepresentation of shortsea vessels in accidents on inland waterways in The Netherlands. An analysis by the Delft University of Technology, applying an accident scenario approach instead of a statistical analysis, indicate that such an observation is not correct for all segments of the shortsea fleet. Two 'zero accident scenarios' could be derived for high quality vessels and several scenarios reveal the importance of port and fairway authorities as stakeholders in a safety enhancement strategy. Although scenarios could be successfully applied, the approach is open to further development, especially with respect to the linkage between various data sets related to other systems performance parameters. The approach supplies a basis for further research into a limited number of bottlenecks and may require additional techniques such as in-depth casuistic and simulation. In such analysis the importance of higher systems order influences should be taken into account because they have a strong and often indirect impact on the decision making of the man on the bridge. Future developments in the shortsea sector will put even more emphasis on the role of the captain as the man who has to take the final responsibility for a safe, efficient and cost-effective operation of the vessel.

1 Introduction

A survey of historical data from Dutch maritime accident data bases seem to indicate that shortsea vessels are overrepresented in accidents on inland waterways. To verify this indication and to reveal relevant accident causation factors and circumstances, in-depth analysis of accidents is helpful. Such analysis should not only identify the factors which contribute to accidents, but should also establish the relations between these accident causation factors and the systems characteristics and dynamics. By the use of accident scenarios the relative importance of certain types of accidents can be established as they occur in specific systems operational contexts and external, aggravating conditions. Selection of critical accident scenarios enables a refined decision making with respect to preferences in remedies and resolutions for the enhancement of safety in shortsea shipping on inland waterways.

Such specific contexts and conditions usually do not have a direct visible influence during operational practice, but may have their influence at higher systems levels by their technical, organisational, legislative and procedural constraints which all together define the 'safe operating envelope' in practice. The analysis therefore does not only focus on the deviations from operational practice on the man-ship-environment level, but also takes into account the systems structure with respect
to traffic flow, fleet composition, logistic requirements, the technical and nautical characteristics of the vessel, crew and fairway. The risk taking behaviour may be considered as a component of the decision making of the operator on strategical and tactical level. Eventually, the captain is and will remain the final responsible person in the operational decision making and therefore has to be able to balance all these aspects against each other.

Current operational practice may impose requirements on the behaviour of the operator due to the navigation and limited manoeuvrability in constraint waterways, the interaction with other traffic participants, the consequences of restricted liability or cost reduction considerations.

The safety analysis therefore focuses on three premises in the analysis:

- Current operational practice. Accidents may be considered undesirable deviations from current operational practice which lead to damage or injuries. Causation factors may origin from various components in the control loop of the operator, especially under constraint navigational conditions. In the control loop emphasis is put on the interactions between the manoeuvrability of the vessel, the judgement and mission of the navigator and the undisturbed flow and geometry of the channel. Analysing the systems operational characteristics as well as the accident data supplies an inventory of all possible causation factors on the operational level;

- A systems approach. Conventionally, accident causation factors are described on the directly visible level of the navigator, since they are derived from police reports and data registration system operated by fairway authorities. A survey of scientific maritime literature, contents analysis of maritime newspapers and magazines, interviews with other stakeholders in shortsea shipping such as ship owners, pilots, governmental agencies, insurance companies and port authorities revealed systems characteristics and additional factors which may contribute to risk inducing situations and risk taking behaviour in decision making of the navigator;

- Multicausality. Accidents and incidents are the result of a multi-causal phenomenon in which a time-dependent sequence of events and decisions may be triggered and result in an accident. Breaking up of the chain of events will bring the process to a halt and thereby prevent the undesired event. The resilience of a system is based upon a timely detection and correction of such undesirable events. The level of safety performance may be defined in terms of safety management systems, technical and nautical support systems, quality of crew and equipment or professional skills, experience or risk awareness of the navigator.

In the near future, changes in operational practice may occur for the shortsea shipping on inland waterways. In an internal European market, changes are expected with respect to cabotage, hinterland connections, multimodal transport and logistic networks. The introduction of new types of vessels such as high speed vessels is possible and further implementation of electronic data communication systems, VTS and traffic surveillance systems will takes place. However, the effect of these changes on the safety level and resilience of the shortsea shipping
system is yet unknown. A qualitative insight into these effects is desirable as far as they can be singled out in the analysis of accidents and detailed description of the present shortsea shipping system.

2 Structure of the shortsea sector

2.1 Market structure, origins and destinations

The shortsea sector in West-European inland shipping comprises 536 vessels with an average loading capacity of 2000 dwt. German registered vessels contain 34% of the fleet, while The Netherlands cover 12%, Cyprus 11%, the United Kingdom 11%, Antigua and Barbuda 11%, with a remainder of 12% for Scandinavian vessels and vessels registered in flag of convenience states. Many of the foreign registered vessels prove to be owned by Dutch captains. Many of the Dutch captains own their vessel and have a sustainable and often exclusive relation with a limited number of charterers on long-term contracts in specific market niches. The crew consists of 4 to 5 members, dependent of the length of the vessel, the type of trade and qualification of the crew. Shortsea vessels on inland waterways have equivalent requirements as inland vessels have for their international trade on the Rhine. Many crew members originate from the Dutch inland shipping trade and are well qualified, in contrast with foreign crews. Most cargo consist of steel products (from the Ruhr area in Germany) and paper or forestry products (mostly from Scandinavia). Origins and destinations vary considerable over the various flag states and are dominated by segmentation and specialisation. The Ruhr area is connected by shortsea line services directly to Scandinavia, The United Kingdom, Ireland, Portugal, Spain and the Mediterranean. About 50% of the travelling time is spent on inland waterways. The increase in scale makes the vessels less suited for inland shipping, although the design and equipment of more recently built vessels is increasingly adjusted to inland shipping situations.

A detailed insight in the fleet composition could not be acquired due to privacy reasons and therefore a link with the contribution to the traffic density, fairway and weather conditions was not possible. With respect to the routing of the vessels four main groups could be discriminated:

- Occasional traffic to Scandinavia take the inside route through the Northern part of The Netherlands due to their restrictions for sailing in open waters, the absence of pilot due and harbour dues. These vessels sail from Harlingen or Delfzijl and head for Rotterdam or Germany. They represent a small segment of the fleet;
- Directly sailing from seaports such as Terneuzen heading for Antwerp or Gent, Flushing heading for Rotterdam or IJmuiden heading for Amsterdam. In many cases they do not penetrate deep into the hinterland and stay in the immediate surroundings of the seaport;
- Rotterdam-Antwerp. A limited segment shuttles between Rotterdam and Antwerp by the inside route along Oude Maas, Dordtsche Kil, Volkerak and Kreekrak;
Integrating Safety into the Shortsea Shipping System

- Rotterdam-Germany. The final destination into Germany comprises about 90% of all shortsea trips on inland waterways. Most relevant fairways are Nieuwe Waterweg, Nieuwe Maas, Oude Maas, Noord, Merwede, Waal and Boven-Rijn.

Due to the limited number of vessels involved an analysis over the years 1987-1994 gives no clear indication of a trend.

Shortsea vessel are coded in the accident data base due to their cargo characteristics as:

- code 50; freighters for general cargo
- code 51; container vessels, ro-ro and lash vessels
- code 52; bulk carriers
- code 53; tankers for oil and other liquefied cargo
- code 54; tankers for pressurized gas.

The preparation of a journey is an important part of the voyage for shortsea vessels on inland waters. During loading the shallowness of the fairway has to be taken in account in detail in advance because the draught of the vessel and the shallowness have to be matched very accurately. A maximum draught benefits the cost-effectiveness of the voyage because the payload is directly related to the cargo fare and water level. A detailed knowledge of the fairway is considered a challenge to the skills of a captain, shipowner and pilot. Shortsea vessels may encounter critical situations and therefore have to calculate their allowable draught very accurately by applying official listings and guidelines.

2.2 Manoeuvring shortsea vessels

Factors influencing the behaviour of vessels in constraint navigation channels can be represented by a double control loop problem, involving judgement and mission of a navigator, the manoeuvrability of the vessel and flow disturbances and fairway geometry. In the control loop problem three levels of navigator behaviour are defined with respect to manoeuvre, tactical and strategic decision making. Each of these factors may represent typical accident causation factors, such as vessel handling characteristics or traffic image processing. The risk perception and acceptance, overall judgement and balancing of aspects of different nature may include a wide variety of aspects such as logistic and economic demands, operational costs, liability, training and experience or cultural differences between fairway users. To facilitate the growth of waterborne transport in The Netherlands, the waterway geometry of the principal transport corridor Merwede-Waal-Bovenrijn is modified with respect to width, depth, curvature and the installation of vessel and shore based navigation support and surveillance systems.
Vessel characteristics

A comparison between inland vessels and shortsea vessels on inland waterways indicates several differences with respect to technical and operational data, organisation and rules. Although more than 80% of the existing vessels is shorter than 80 m, the length of newbuilt vessels exceeds 90 m in almost every case, with a legal limit of 110 m. This legal limit is under pressure and the first exemptions to 125 m have been issued in Germany and The Netherlands. On a short notice the maximum length of self-propelled vessels will be increased to 135 m. The distribution of the maximum draught of inland vessels differs from the maximum draught of shortsea vessels. Assuming that the average operational draught is 10% below the limits, a comparison (Table I) demonstrates that the operational draught of shortsea vessels is larger than inland vessels with an increased variance.

<table>
<thead>
<tr>
<th>d (m)</th>
<th>&lt; 2</th>
<th>2-2,5</th>
<th>2,5-3</th>
<th>3-3,5</th>
<th>&gt; 3,5</th>
</tr>
</thead>
<tbody>
<tr>
<td>percent.</td>
<td>8,3</td>
<td>38,2</td>
<td>44,3</td>
<td>7,2</td>
<td>2,0</td>
</tr>
</tbody>
</table>

Table I: Operational draught of shortsea vessels on the Boven Merwede 1994

<table>
<thead>
<tr>
<th>d[m]</th>
<th>&lt; 2</th>
<th>2-2,4</th>
<th>2,4-2,8</th>
<th>2,8-3,2</th>
<th>3,2-3,6</th>
<th>3,6-4,0</th>
<th>&gt; 4,0</th>
</tr>
</thead>
<tbody>
<tr>
<td>East(%)</td>
<td>1,6</td>
<td>11,9</td>
<td>25,9</td>
<td>31,1</td>
<td>19,4</td>
<td>6,6</td>
<td>3,5</td>
</tr>
<tr>
<td>West(%)</td>
<td>1,3</td>
<td>5,5</td>
<td>11,4</td>
<td>29,8</td>
<td>28,6</td>
<td>14,2</td>
<td>9,2</td>
</tr>
</tbody>
</table>

Due to this larger draught shortsea vessels have a decreased keel clearance and increased suction passing shallow waters and other vessels. In combination with larger masses, lower propulsion efficiency and smaller rudder deflections than inland vessels, shortsea vessels are less manoeuvrable and posses a slower response than inland vessels on inland waterways. In general shortsea vessels are equipped with one propeller and one rudder. Modern shortsea vessels however are equipped with 'flap-type' or 'flanking-type' rudders. Shortsea vessels which spend the majority of their time on inland waterways are designed for these river conditions and are installed with two propellers, often in tunnels, two rudders and an optimized bridge layout including double navigation systems or anchoring equipment. The installed engine power of shortsea vessels with limited certificate is restricted to 750 kW and due to the limitations in draught the propulsion efficiency will be low.

With respect to routes and frequencies a distinction should be made between North-South and East-West bound vessel movements. In the North-South bound movements the majority of the vessels sails under Dutch flag, covering approximately 80% of the vessel movements at two pivotal points in the network.
Integrating Safety into the Shortsea Shipping System

with small contingents of German, English and Cypriot vessels. For the East-West bound traffic one crucial point in the network is analysed (Boven Merwede 1993 hm 9569).

<table>
<thead>
<tr>
<th>Shortsea on inland waterways - Boven Merwede</th>
<th>1993*</th>
<th>1994</th>
<th>1995**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eastbound</td>
<td>819</td>
<td>43,5%</td>
<td>1931</td>
</tr>
<tr>
<td>Westbound</td>
<td>1063</td>
<td>56,5%</td>
<td>2287</td>
</tr>
<tr>
<td>Total and per week</td>
<td>1882</td>
<td>72/wk</td>
<td>4218</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>code</th>
<th>Nationality</th>
<th>1993*</th>
<th>1994</th>
<th>1995**</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Germany</td>
<td>62,3%</td>
<td>50,5%</td>
<td>41,2%</td>
</tr>
<tr>
<td>600</td>
<td>Cyprus</td>
<td>17,6%</td>
<td>22,4%</td>
<td>26,6%</td>
</tr>
<tr>
<td>3</td>
<td>The Nederlands</td>
<td>4,8%</td>
<td>6,5%</td>
<td>7,2%</td>
</tr>
<tr>
<td>28</td>
<td>Norway</td>
<td>4,4%</td>
<td>6,5%</td>
<td>6,3%</td>
</tr>
<tr>
<td>459</td>
<td>Antigua</td>
<td>4,2%</td>
<td>7,0%</td>
<td>8,7%</td>
</tr>
<tr>
<td>6</td>
<td>Great Britain</td>
<td>2,4%</td>
<td>2,0%</td>
<td>0,9%</td>
</tr>
<tr>
<td>Other countries</td>
<td>1,1%</td>
<td>3,7%</td>
<td>6,5%</td>
<td></td>
</tr>
<tr>
<td>Unknown</td>
<td>3,2%</td>
<td>1,4%</td>
<td>2,6%</td>
<td></td>
</tr>
</tbody>
</table>

*) 2nd halfyear
**) up to August

Table II: Shortsea vessels on transportation corridor Boven Merwede 1993

When a flag of convenience is used, cheaper and mostly less qualified crew may be signed on from countries without an inland shipping tradition. Communication problems caused by language differences between bridge and deck personnel may result in incidents especially during mooring. This communication problem is mentioned as a major cause for accidents with shortsea vessels in inland waterways.

Fairway geometry

Design standards for inland waterways and harbour entrances exist, based on nautical characteristics of the vessels which operate on these waters. To standardize these dimensions in 1992 the PIANC has drawn up international preliminary guidelines for these waterways. These guidelines are applied to an inland vessel.
Section IV - Forecasting, Logistics and Safety

and a shortsea vessel of 11.40m width and 3.95m draught on a two-way traffic situation in a sloping-edged channel, resulting in a 45% width difference for the shortsea vessel compared to the inland vessel under similar conditions. With other words: for an equivalent fairway width a shortsea vessel has less manoeuvring margins compared to an inland vessel.

Operational behaviour
The technical equipment of modern shortsea vessels has improved considerably. Up to the eighties the presence of old and poorly equipped vessels was problematic. Nowadays shortsea vessels are certified with respect to their technical equipment, communication and navigation and crew requirements. Safety of shortsea vessels on inland waterways has improved considerable, although a small portion of flags of convenience vessels is present. There is an impression that foreign vessels are inspected less frequent due to language problems, vessel dimensions and aberrant documents. Their frequent presence makes the vessels well known by the fairway authorities and seem to have a positive influence on their behaviour.

In critical conditions the operational behaviour of the captain has a dominant influence on speed, manoeuvring and the passing of bridges and locks. The permanent presence of a pilot or a qualified crew member on Dutch, English and German vessels has a favourable influence. Loading conditions of the shortsea vessels differ from the inland vessels. The draught is increased, the average speed is higher and the vessels are less manoeuvrable. During stopping less power is available and the low propeller efficiency causes larger stopping distances. Also the limited rudder deflection reduces the manoeuvrability. Shortsea vessels are less manoeuvrable at low speed, inducing a higher average cruising speed. The negotiations between captain and charterer to maximize the payload will invite the captains to accept an increased draught and tight sailing schedule. The captain will not be inclined to refuse the requests of the charterer and consequently adjusts his sailing behaviour to deal with the limitations of the fairway. This may cause risk for the operational behaviour, but at the same time is a challenge to the professional skills of the captains and pilots. These conditions however forces the captain to prepare his voyage very carefully on a short as well as a long term.

Mutual interference of operational conditions
The previously identified factors can be related with each other by an influence diagram, focussing on the operational performance of the vessel with respect to safety, efficiency and cost-effectiveness. On the level of the market the performance is dominated by the qualifications of the stakeholders in the market and governmental authorities. At the level of the operational management of the voyage, draught, route and voyage information and adaptations to the conditions of the fairway are relevant. On the level of the operational management of the crew factors such as turnaround times and working schedules, staffing and communication are dominant. The qualifications of the sailing vessel are influenced by crew requirements and the equipment on board. Finally, the vessel performance is influenced by external aggravating conditions such as weather, vision and illumination. Whether these factors play a positive or a negative role in the operational
Integrating Safety into the Shortsea Shipping System

performance depends on the nature and extend of their influence on the safety of the operational performance and highly depends on the available safety management systems which have to support the captain in his ultimate decision making responsibility.

![Influence diagram](image)

Figure 1: Influence diagram

3 Safety management and safety perception

IMO and CCR regulations
Safety management systems for the shortsea sector comprise of a number of elements which are particularly focussed on the safety requirements in this sector. With respect to safety regulations both the IMO and CRR regulations are in force. The IMO regulations deal with seagoing vessels which occasionally sail the inland waterways as the CRR deals with the safety of all vessels of any nation participating in the river Rhine traffic with respect to vessels, crew, equipment and cargo. In case hazardous goods are involved, the ADNR regulations have to be met as well. The most important developments deal with the equivalence in requirements posed upon inland and shortsea vessels, the time-lags in transition of rules, the tuning of ADNR and IMO regulations, the minimum manoeuvring requirements and the equivalence in crew qualifications for inland and shortsea vessels.

Traffic surveillance systems
With the increase in traffic on inland waterways the interest for capacity optimisation is increased. Because the modification of fairways and the network is a time consuming and expensive effort, the attention has been focussed on the possibilities which are available on the short term. Next to the traditional aids to
navigation such as buoys, surveillance by police and fairway authorities, pilots and communication systems, modern information technology systems are implemented for tracking and tracing of vessels and hazardous goods. The IVS 90 system is operational for some years and covers a number of objectives among which safety issues.

Pilotage
By October 1995 the pilotage of shortsea vessels on inland waterways is modified. For the benefit of competitiveness, vessels between 40 and 60 m are exempted from pilot due by a declaration, which eliminates a cost recharge for these vessels. After this date the required frequency of visits for these vessels is reduced to 18 times a year and for smaller vessels even 6 times a year. The pilot organisation fears that these vessels will tend to sail on a short reckoning and that the declaration, small crew, long working hours and the neglect of pilot due will turn out as potential hazards. A proper anticipation on the traffic flow includes experience and proficiency. Because there is a difference between sailing at sea and in constraint waters or ports, an additional crew might become necessary with sufficient expertise with respect to vessel handling, nautical knowledge and skills for manoeuvring during mooring.

Loading of vessels
The loading of shortsea vessels is of major importance in the prevention of groundings in shallow waters and manoeuvring in constraint waters. An accurate preparation of the voyage is important to deal with the available water levels. Already during the loading of the vessels in the port of departure a detailed forecast must be made of the available keel clearance on critical spots in the waterway. During the voyage a careful navigation must be maintained on these spots, which requires a detailed knowledge of local situations and which leaves little tolerance for interaction with other traffic participants.

Risk perception and awareness
The perception of risk proves to be determined by the risks of the transport of hazardous goods and the effects of economy of scale. Conditions of a social and financial-organisational nature may induce risk taking behaviour for the benefit of efficient and Cost-effective performance. Developments in crew size, sailing schedules, working hours and cost control considerations are recognised as potentially risky. Traffic surveillance bears a potential risk element because responsibilities may become diffuse. Captains and navigators may rely unconditionally on the information supplied by shore based traffic information centers during dense traffic and aggravated conditions. Such an attitude contains elements of loss of vigilance and situation awareness and may cause accidents.

The self image of safety awareness and risk perception in the shortsea branch is analysed by means of interviews and contents analysis of maritime magazines and newspapers. In general, the judgement of the situation over the last ten years is positive. Progress has been made with respect to navigation, communication, crew qualification, technical equipment and the presence of additional bridge equipment for sailing on inland waterways. Shortsea vessels are no longer perceived as a risky segment of the fleet and a number of risk inducing characteristics are recognised as potentially hazardous, inducing a high risk awareness and risk avoiding behaviour.
A number of interviews with pilots, port authorities and branch organisations revealed a difference in risk perception for the Rotterdam port area and the river Waal as a principal transportation corridor.

In the Rotterdam port area the impression exists that smaller vessels and vessels sailing under flags of convenience may be discriminated in a negative sense. On smaller vessels the small crew, long working hours and fatigue are mentioned as dominant accident causation factors, while less qualified shipowners suffer from proper bridge and crew management. A high cost awareness of the captain may lead to a rejection of port services such as tugs, pilots and oarsmen. During mooring a deficiency in equipment and qualified deckhands may occur and communication problems may interfere with a bridge-deck coordination. Communication problems mainly occur with cheap shipowners and flags of convenience. Flagging out procedures are relatively easy and several Dutch vessels sail under Cypriot flag.

Technical failures of engines, rudder and variable pitch propellers frequently occur and the use of low grade fuel is observed increasingly. Shortsea vessels may run into problems in the approach and passage of bridges and locks by rapid increase of the traffic density, relatively tight dimensions of the infrastructure and effects of local currents and wind. Due to their loading characteristics the need for tugs and pilots is increased.

On the river Waal the risk perception is different. On this river no serious risk problems have occurred in the past. Shortsea vessels are known as safe for their experienced and qualified crew, qualified vessels with high technical standards and acquaintance with the sailing area. This group of 'target vessels' are frequent users of the fairway and frequently have the same pilots on board which therefore are well acquainted with the bridge equipment and vessel characteristics. The less qualified shortsea segment is not present in this sailing area due to the high probability of inspection. A mechanism of self-selection seems to be effective.

Specific safety issues which are mentioned are low water levels which may introduce suction, groundings and limited manoeuvrability in the fairway and high water levels where reduced bridge crossings and loss of orientation on the fairway may contribute to accidents. Inland vessels carefully take shortsea vessels in consideration because of their robustness, fitted with a bulb. In case of a collision a complicated assurance liability situation may occur due to the 'abandonment' of liability of the shortsea vessel. A complex situation may occur because various parts of the vessel and cargo will be covered by different insurance companies. The fairway authorities do not perceive shortsea vessels as a risky segment of the fleet because of their 'target group' qualifications and their sailing position in the middle of the fairway.

4 Accident analysis

The analysis of accidents was performed in two phases. A first phase deals with establishing generic accident types. For the analysis of accidents with shortsea vessels accident data were supplied by a governmental data base and an insurance company data base. Comparing these data bases single accidents with a
damage between NLG 2,500 and 10,000 are underrepresented, while the coverage reaches its maximum above NLG 64,000. The governmental database covers about 18% of all the accidents and the insurance company data cover about 10% of all inland shortsea vessel accidents. The governmental data base registers 65% of damages over NLG 100,000 with an estimated overall of NLG 95 million. For an additional analysis of the accidents in the Port of Rotterdam the accident data base of the port authority was available. According to the impressions of pilots, fairway authorities and insurance companies shortsea vessels are no longer a risky segment of the fleet on inland waterways. The data bases have been analysed over the years 1984 until 1994. Between 1984 and 1989 the percentage fluctuates from 5% to 14%, but after 1990 the percentage is high and relatively constant at approximately 23.5%. Loaded vessels are involved relatively frequent in accidents and the amount of single accidents is higher than can be observed at an aggregated data level. At some local spots in the Waal river accident data cumulate due to shallow or narrow passages.

A preliminary survey of the accident data indicates a decreasing trend in absolute numbers. The number of accidents decreases from 190 in 1987 to 64 in 1990. A clear difference between various fairways is discernible, which selected six fairways for further analysis due to their relative importance for shortsea vessels. The accident proneness of these fairways is compared with the accident frequency of inland vessels on all Dutch waterways. There proves to be a difference in ranking of the fairways, only Nieuwe-Maas/Nieuwe-Waterweg ranks high in both listings (see Table III). This result leads to the conclusion that shortsea vessels represent a specific problem area in inland waterway accident analysis.

<table>
<thead>
<tr>
<th>no</th>
<th>fairway</th>
<th>Inland ranking order</th>
<th>Shortsea ranking order</th>
</tr>
</thead>
<tbody>
<tr>
<td>102</td>
<td>Nwe Maas/Nwe Waterweg</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>101</td>
<td>Boven-Rijn t/m Noord</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>118</td>
<td>Maas, Bergse Maas, Amer</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>233</td>
<td>Noordzeekanaal</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>116</td>
<td>Calandkanaal</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>21</td>
<td>Prinses Margriek kanaal</td>
<td>7</td>
<td>-</td>
</tr>
<tr>
<td>103</td>
<td>Pannerdens Kan en Lek</td>
<td>6</td>
<td>-</td>
</tr>
<tr>
<td>139</td>
<td>Volkerak t/m Keeten</td>
<td>7</td>
<td>-</td>
</tr>
<tr>
<td>111</td>
<td>Oude Maas</td>
<td>-</td>
<td>7</td>
</tr>
<tr>
<td>131</td>
<td>Westerschelde</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>130</td>
<td>Kan Gent-Terneuzen</td>
<td>-</td>
<td>4</td>
</tr>
</tbody>
</table>

Table III: Ranking order fairways for inland and shortsea vessels

This preliminary analysis concludes with the definition of 5 accident types which will be placed in their context during the second phase of the analysis. These 5 accident types are: Mooring activities, manoeuvring near bridges and locks on inland bound arrival from sea, overtaking of vessels in regular traffic situations, breaking adrift of moored vessels by suction or other vessels and solitary sailing in constraint waterways in the smaller hinterland waterways.
Integrating Safety into the Shortsea Shipping System

The second phase consists of identification of additional accident causation factors which are specific for the various types of accidents and which put the accidents in a systems perspective. A number of location and context specific accident causation factors are analysed such as the fairway, the extend and nature of the damage, the types of vessels, the distribution over flag states and external conditions with respect to wind, current, vision and illumination. For each fairway specific bottlenecks are indicated for a limited number of locations and routes, due to specific conditions as current, wind, fairway geometry, vessel manoeuvring activities or traffic density. Shortsea vessels encounter only little material damage and no personal injuries to crew members, but fairway authorities suffer from incidentally high material damage due to collisions with expensive infrastructure elements. Some vessel codes are highly underrepresented in accidents such as container vessels, gas tankers and tankers carrying hazardous goods. The distribution over flag states indicate an overrepresentation of flags of convenience in the port areas, but not on the principal transportation corridors. All fairways indicate a constant decrease of accidents, which support the impression that the improvements in this fleet segment pay off the investments during the previous years. In the Rotterdam area the vast majority of accident are single vessel accidents especially during mooring activities and passage through infrastructures such as bridges and locks.

However, due to the complexity and variety of the shortsea sector, a refined image of the accident sequences is required to supply the annalist with a valid interpretation of the accident patterns and causal relations between the accident factors. Within the context of this research project some vital data were not available such as a detailed insight in destinations and origins, fleet composition, insurance structure, risk taking influence of market mechanisms, line services, working conditions and workloads. A further research into these factors requires detailed analysis of singular accidents and therefore is beyond the scope of this type of accident analysis.

In this accident analysis an intermediate level between statistical accident data analysis and in-depth analysis of singular accidents is performed, based on a scenario approach. The accident types defined in the first phase are linked to contextual and situational factors as well as systems variables, combining into specific patterns called accident scenarios. Based on the analysis 7 scenarios are defined:

1. transportation of hazardous goods.
   In this scenario hardly any accidents occur, although the transportation of hazardous goods is considered a potentially high risk activity. Current operational practice, high standards and safety management systems enhance safety effectively and guarantee a very high safety level. This scenario is a 'no accident scenario'

2. high quality management.
   There are hardly any accidents with vessels sailing under high quality standard flags and shipowners. This scenario also can be described as a 'no
accident scenario'. Sailing relatively large container vessels on principal transportation corridors is considered a potentially high risk activity due to draught limitations, limited manoeuvrability and reduced vision lines. The accident analysis on the Waal and Merwede river indicate a well-established mechanism of self selection.

3. manoeuvring at mooring sites.

The activities at mooring sites lead to a considerable number of accidents, related to reduced manoeuvrability at the destination due to low speed and some influence of wind, current and visibility. This scenario frequently occurs in the Rotterdam port area and is related to the use of tug assistance, qualification of deck personnel and communication between deck and bridge crew. There are indications of flag state involvement. Damage to the vessels is limited, but port authorities suffer the burden of material damage which may be considerable due to the high frequency.

4. passages at bridges and locks.

Manoeuvring at bridges and locks on the inbound voyage from sea frequently leads to accidents with a relatively serious nature due to the considerable damage on the infrastructure. This scenario occurs at seaside ports where a sudden increase in traffic density occurs under conditions of wind and current which hampers the stopping of the loaded vessels. Limited manoeuvrability, combined with too little tug assistance and constraint dimensions of the infrastructure may cause serious damage of vital components of the infrastructure and may block the fairway for a considerable time.

5. disturbance by vessel movements.

Breaking adrift of moored vessels by suction or violent waves caused by other vessels often occurs. This scenario deals with vessel-fairway interactions in constraint waters and frequently occurs in the Rotterdam area. Because of their limited manoeuvrability at low speed shortsea vessels sail slightly faster than the average. If vessels are not moored tight, lines may rupture and the adrift vessels may cause minor damage to other vessels or the infrastructure.

6. participation in traffic on corridors.

On the principal corridors the participation of shortsea vessels in overtaking activities may cause accidents due to suction, judgement of the traffic situation, the sailing speed, the level of attention of the navigator and the communication between the man on the bridge and his shore based support. This scenario mostly occurs on the Nieuwe Maas, Nieuwe Waterweg, and the Rhine-Waal-Merwede corridor. The majority of the singular in-depth accident analysis has paid attention to this scenario because of the major effects that may occur if an accident happens. Serious material damage may occur and the potential for environmental damage is considerable although such damage has been absent almost completely in the past.
7. sailing in constraint waterways.

    This scenario occurs with a low frequency in the hinterland waterways with
    solitary vessels in the Northern parts and the Zeeland area. The accidents
    are single type collisions with the infrastructure due to suction, and rudder
    deficiencies. Most common mentioned failures are engine trouble and rudder
    problems.

    These scenarios can be ranked to their frequency although by the limited period of
    registration only qualitative indications of this frequency are given (Table IV).

<table>
<thead>
<tr>
<th>Year</th>
<th>Scenario 1</th>
<th>Scenario 2</th>
<th>Scenario 3</th>
<th>Scenario 4</th>
<th>Scenario 5</th>
<th>Scenario 6</th>
<th>Scenario 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>1994</td>
<td>0</td>
<td>0</td>
<td>23</td>
<td>17</td>
<td>13</td>
<td>13</td>
<td>0</td>
</tr>
<tr>
<td>1993</td>
<td>0</td>
<td>0</td>
<td>26</td>
<td>13</td>
<td>18</td>
<td>24</td>
<td>5</td>
</tr>
<tr>
<td>1992</td>
<td>0</td>
<td>0</td>
<td>45</td>
<td>19</td>
<td>9</td>
<td>24</td>
<td>4</td>
</tr>
<tr>
<td>1991</td>
<td>0</td>
<td>0</td>
<td>50</td>
<td>29</td>
<td>13</td>
<td>26</td>
<td>0</td>
</tr>
<tr>
<td>1990</td>
<td>0</td>
<td>0</td>
<td>62</td>
<td>23</td>
<td>17</td>
<td>28</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>0</td>
<td>0</td>
<td>206</td>
<td>101</td>
<td>70</td>
<td>115</td>
<td>12</td>
</tr>
</tbody>
</table>

Table IV: Number of shortsea vessel accidents per scenario over 1990-1994

Related to the fairways scenario 1 and 2 hardly occur and therefore cannot be
allocated to any fairway. Scenario 3 most frequently occurs in the Rotterdam area
and clearly connects the phase of the voyage, the manoeuvring of the vessel and
the location. Scenario 4 and 7 frequently occur in seaside ports outside the Rot-
tterdam area. Scenario 5 occurs on the Nieuwe Maas with moored vessels and the
Western Scheldt with anchored vessels. Scenario 6 occurs on the Nieuwe Maas
and Western Scheldt and to a lesser extend on the Merwede-Waal-Bovenrijn.
Generally spoken the frequency of the scenarios is: scenario 1, 2 and 7 very low,
scenario 3 high but decreasing, scenario 4 and 5 moderate but constant and
scenario 6 low.
On a limited number of fairways more scenarios exist: on the Merwede-Waal-
Bovenrijn scenario 5 and 6 occur, on the Nieuwe Maas 3, 5 and 6 occur and on
the Calandkanaal and IJmuiden locks scenario 3 and 4 occur.

5 Conclusions

The initial motive for this accident analysis was the observation that from ag-
gregated accident data base information, shortsea vessels were overrepresented in
accident data. The question to be answered was: is it a correct observation that
shortsea vessels are involved more frequent in accidents than might be expected
from their contribution to the traffic volume, and if so, what causes and cir-
cumstances contribute to these accidents.
The preliminary answer to this question is that although in itself correct, the observation does not give a correct image of the situation. For a better understanding of the situation a discrimination should be made into the types of accidents, the sailing areas, the composition of the fleet, and the conditions which may lead to accidents. The analysis fuels the notion that specific situations may occur in which certain segments of the fleet are overrepresented in the safety of shortsea vessels, while other segments represent relatively less safe situations. Such a distinction can be demonstrated by the use of a scenario approach. Accidents in which shortsea vessels are involved cause little damage to the vessels and even less damage to the cargo, but the damage may be considerable for the fairway and port authority. For a better understanding of accident causation, the accidents must be analysed in the context of a systems approach, including situational factors and specific circumstances. In this respect a scenario approach discriminates from a statistical approach by taking into account multicausal relations beyond the level of statistical correlations. Not every causal factor will lead to accidents because a proper safety management system will enhance the safety of a system.

Sailing shortsea vessels on inland waterways may encounter critical situations since these vessels sometimes operate at the limits of their 'safe operating envelope' with respect to control loop characteristics, fairway geometry and flow characteristics or navigator performance. A safe operation can be guaranteed if adequate safety management systems are deployed and safety enhancement measures are taken into account. In such situations, 'no accident scenarios' can be derived from accident data bases.

This mutual dependence of systems performance and safety management systems can be pictured in an influence diagram, expressing the mutual interference between the two systems. Safety enhancement measures can be selected for a specific scenario and therefore become more cost-effective. However, the implementation of such measures should be based on a detailed knowledge of the causal relations between all systems components. In this research project the linkage of accident data to other systems performance parameters such as traffic intensity, fleet composition, ship owners, origins-destinations matrices, draught and loading or manoeuvring characteristics was limited. Therefore, the accident scenarios are open for further refinement and development and the data structure of shortsea data systems can be improved.

Finally the research project has demonstrated its potential for further development of the scenario concept, not only for shortsea vessels, but for other inland shipping segments as well.

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A MODEL FOR OPTIMAL SEA-RIVER SHIPPING MANAGEMENT

By J. Marchal and Z.M. Zhang

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Abstract

A computer model, which could be implemented in optimally planning and organizing of sea-river shipping, is presented in this paper. This model is derived from a research project for Belgian Ministry of Public Works. Highlights are focused on: (1) optimal routing for sea-river going vessels when taking into account of river infrastructure constraints and sea going safety restrictions, (2) optimal transport scheme under the known demands, (3) suggestions on optimal sea-river going vessels according to their main dimensions for specific transport tasks.

1 Introduction

Sea-river shipping is a special transport mode, which has attracted more and more attentions of authorities, companies, and researchers. Because of its two merits, (1) making use of the extended short sea transport network (short sea network + inland waterway network), (2) avoiding transit costs from river barges to sea going vessels, its importance has increased in recent decades.

Two kinds of rules and regulations (for maritime and inland navigation) should be respected in the construction of sea-river going ships, so that they are able to sail both in inland waterways and on short sea lines. Some normal sea going ships can reach inland waterway ports, in this case, sea-river shipping could be realized directly by employing these vessels. While in other cases, due to the water depth constraints on inland waterways, swallow-draft vessels have to be constructed for the sea-river shipping.

Following the conventional tendencies and ideas, shipping by big ships are more economic than by small ships for waterway transportation. Sea going navigation requires large ships for the purposes of safety and sea keeping. However, the usable ships' dimensions are restricted by the river infrastructures. The determination of right sea-river going vessels and their lines for transport demands become an important work in planning sea-river transportation.

For a study on the sea-river shipping possibility with a single origin and destination, it is not difficult to find out suitable sea-river going ships and the optimal transport scheme. Nevertheless, to study sea-river shipping and its optimal scheme on the extended short-sea transport network (on large scale, such as,
A Model for Optimal Sea-River Shipping Management

Europe scale), new methodologies and the computer models should be introduced. The reasons are:

1. There is more activity space for sea-river going ships to sail on short sea lines and inland waterways. They are not bounded to a single origin and destination ports but active in certain regions of the network regardless of time and space. This is caused by (a) the limited amount of demands on the inland ports and (b) the developed waterway transport network. It is not easy to analyse this situation by the conventional methods. Computer models are better tools to present these activities and to analyse the possibility of the sea-river shipping.

2. There are lots of infrastructure constraints on inland waterway sections. It is difficult to consider the routing possibility of a sea-river going vessel without computer tools.

3. Due to the fact that sea-river going vessels are not always fixed in a transport line, the transport cost will be various between inland section and short-sea section, between the round trips and loop trips. New methods should be introduced to estimate the sea-river transport cost.

Application of modelling technologies in the study of sea-river shipping is a good way towards the systematic analysis and organization of shipping to improve the transport efficiency. With the modelling tools, it is easy to understand the relationships between transport demands, waterway infrastructures, and sea-river going ships.

Practically, developments on the sea-river shipping will stimulate transport demands in waterways by its lower transport cost and better services. Conversely, the increment in the transport demands will promote sea-river shipping developments.

This paper deals with a computer model, which is based on the systematic analysis of sea-river shipping on the extended short sea transport network. The model was designed to simulate sea-river shipping and to find out the optimal transport scheme in the network system.

The model could be used as a management tool in optimally planning and organizing sea-river transportation, evaluating the impacts of the inland waterway projects on sea-river shipping, and analysing polices of promoting sea-river going shipping.

This model is derived from a research project for the Belgian Ministry of Public Works (1995). The main theme of the project is to analyse transport infrastructures & materials and their adequacies to the transport demands (Inland waterway section) by means of models, which were developed in the research.
2 Sea-river shipping modelling

The essential of the modelling is to simulate the ships' routing in a transport network. This simulation requires the considerations of inland waterway infrastructure constraints and short sea navigation safety restrictions. Besides these, the simulation should reflect differences of transport costs between short sea sections and inland waterway sections.

The models should be so sophisticatedly developed that they are able to consider much more factors and to acquire necessary information from a large amount of data, which specify the ships, freights, infrastructures, waterways and their relations in the transport system.

A new method, which combines the database modelling technologies and the network algorithms, was suggested by ANAST in its studies on waterway transport modelling. This method was proved to be an effective way to cope with restricted routing problems in the waterway transport modelling by the traffic study on the Belgian inland waterway network. In the present model, the method is used to simulate sea-river shipping.

The references {1, 3, 4} give the detailed descriptions about the method and its applications. Here, only the general considerations and specifications are explained.

2.1 Sea-River Transport Network

A sea-river transport network is an extended short-sea transport network, which is composed of the short-sea network and the inland waterway network. The level of extension depends on the dimensions of sea-river going ships. Apparently, the smaller the sea-river going ships are, the larger the available transport network should be. Figure 1 shows the possibly extended parts of the short sea network near Belgium.

This geographical presentation of the transport network is certainly not enough for the requirements of the modelling. More parameters should be attached to each link of the networks that the characteristics and specifications could be identified. Database technologies and data modelling methods are the right solutions to the presentations of those parameters by the computer languages.

The main constraints and restrictions could be specified as:

(1) River infrastructure constraints

When a sea-river going ship navigates on the inland waterways, the main limitations for the navigation are:

   a. Waterway depth and width;
b. Highs of the bridges;
c. Main dimensions of locks.

These are the infrastructure constraints, which indicate the possibility of the sea-river going ships to pass certain sections of inland waterways.

In addition to the limitations, there are restrictions for the navigation on inland waterway section. The most significant one is the navigation speed limitation for the safety and the protection of river banks. Navigation rules and regulations make up restrictions for the sea-river shipping too.

(2) Sea-going restrictions

For the purpose of the navigation safety, sea-going ships are restricted to sail only within the allowable navigation zones, which are defined in the design and construction stages of the ships. To present these constraints, the navigation zones should be specified in the sea-going lines.
2.2 Routing

A core part of present model is the simulation of sea-river going ships' routing, which is based on the criterion of the minimum path cost between two ports. The complex of the routing simulation comes from the considerations of the constraints & restrictions on every section of the waterways. Namely, the navigation resistance (costs), which is determined by the infrastructures and their parameters, should be estimated in the process of the network operation.

To deal with the problems, the cost calculation sub-modules were developed to evaluate the transport cost. These sub-modules act as the functions to return the cost values between two nodes based on the constraints and restrictions, which are presented in the extended short sea transport network. Combined with the network algorithms (5), the present model could simulate the ships' routing.

The actual routing operations in the present model could be concluded as the following steps:

a. Definition of a sea-river going ship and its main parameters;
   b. Definition of the network suitable for its navigation;
   c. Call of cost sub-modules to calculate cost on waterways and infrastructures;
   d. Applications of network algorithms to find out the shortest path.

Once the shortest path is found, its path cost, which is frequently used in the optimization modules, could be easily obtained.

3 Optimal scheme

Optimal schemes are based on the modelling of sea-river shipping described in the previous section. It is an optimization on the waterway transport section with assumptions that the market situation is known. Namely, the optimization is performed on the conditions of known transport demands and known waterway infrastructures. To obtain the optimal shipping scheme, technical solutions were introduced as that explained in the following sections.

3.1 Global Optimization

Suppose, the \( f_{ij}^{(k)} \) is the tonnage of the product \((k)\) that should be transported from node \(i\) to \(j\). It is an element of the O-D matrices, which are the presentations of transport demands. If the average loading capacity of the ship category \((s)\) for the product \((k)\) is \(C_{aq,s}^{(k)}\) (which is equal to that the deadweight tonnage times the charge coefficient of the freight), then the required number of the ships to fulfil the transport task is:
A Model for Optimal Sea-River Shipping Management

\( N_{ij}^{(a)} = \frac{f_{ij}^{(a)}}{\text{Cap}_{ij}^{(a)}} \)  

(1)

Because it is impossible that the trip number is a fraction, the \( N_{ij}^{(s)} \) value should be rounded to the nearest integer after the above calculation.

The minimum transport cost in the whole system could be expressed as:

\[
\begin{align*}
\text{Min } Z &= \sum_{i=1}^{N} \sum_{s=1}^{M} (C_{\text{loaded}_{ij}}^{(s)} f_{\text{loaded}_{ij}}^{(s)} + C_{\text{empty}_{ij}}^{(s)} f_{\text{empty}_{ij}}^{(s)}) \\
&\quad \text{subject to:} \\
&\quad \sum_{s=1}^{M} f_{\text{loaded}_{ij}}^{(s)} \leq N_{ij}^{(a)} \\
&\quad \sum_{s=1}^{M} f_{\text{empty}_{ij}}^{(s)} \text{Cap}_{k}^{(a)} = f_{ij}^{(a)} \\
&\quad \sum_{i=1}^{N} \sum_{s=1}^{M} \left( f_{\text{loaded}_{ij}}^{(s)} \right) = \sum_{i=1}^{N} \sum_{s=1}^{M} \left( f_{\text{empty}_{ij}}^{(s)} \right)
\end{align*}
\]

(2)

where:

- \( Z \) is the total transport cost
- \( f_{\text{loaded}_{ij}}^{(s)} \) is the loaded trip number for the ship \( (s) \) from node \( i \) to node \( j \)
- \( f_{\text{empty}_{ij}}^{(s)} \) is the empty trip number for the ship \( (s) \) from node \( i \) to node \( j \)
- \( C_{\text{loaded}_{ij}}^{(s)} \) is the cost per loaded trip for the ship \( (s) \) from node \( i \) to node \( j \)
- \( C_{\text{empty}_{ij}}^{(s)} \) is the cost per empty trip for the ship \( (s) \) from node \( i \) to node \( j \)
- \( N \) is the total number of nodes in the network system
- \( M \) is the total number of ship categories

Apparently, it is a linear programming problem. The first constraint represents that the loaded trips for the ship \( (s) \) should not be over the required trip number, which is determined by the transport demands, from node \( i \) to node \( j \). The second constraint represents that transport task should be completed by various categories of ships for the transportation from node \( i \) to node \( j \). The third constraint condition represents the vessel flow conservation on every node. It means that the total number of the ships with the category \( (s) \), which move in the node \( i \) should be equal to the total number of the ships with the category \( (s) \), which move away from the node \( i \).

In the Eq. (2), \( f_{\text{loaded}_{ij}}^{(s)} \) and \( f_{\text{empty}_{ij}}^{(s)} \) are the decision variables. Their values could be got by solving the equations (Eq. (2)). \( C_{\text{loaded}_{ij}}^{(s)} \) and \( C_{\text{empty}_{ij}}^{(s)} \) are the shipping costs from node \( i \) to node \( j \). Their values could be calculated by the models described in previous section. The network specifications and the influences of the infrastructure are reflected on these cost values.

It is possible to account the constraints of the limited ship resource in above equations. For example, when the total number of vessels with the category \( (s) \) in the system is fixed, the additional constraint for the optimization should be added as:

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where:

\[ N_{RS}^{(s)} = \text{required number of ship category (s)} \]

\[ C_{s} = \text{coefficient} \]

\[ N_{\text{total}}^{(s)} = \text{total number of the available ships of category (s) in the system} \]

By the combination of the Eq. (2) and Eq. (3), the optimal traffic and shipping scheme, on the conditions of (1) transport demands (O-D matrices), (2) infrastructure constraints (waterways, bridges, locks, ports), and (3) conveyor resource (ships), could be got.

### 3.2 Computational Approaches

Theoretically, the Eq. (2) could be solved by the normal way for the linear programming equations. Nevertheless, there are difficulties in practical calculation. From the Eq. (3), it could be seen that there are large numbers of decision variables with the maximum number of \(2 \times N^2 \times M\). The minimum computer space needed for the data storage and matrix operation is \((2 \times N^2 \times M)^2\). If node number \(N\) in the network system is big, the computer memory required for the calculation will be too large to be satisfied by a normal computer. It leads to searching for solutions by the computational approaches.

#### 3.2.1 Principles

Many algorithms could be chosen to find out the solutions to equations (2) through computational approaches. The simple one used in the present research is described as follows:

Suppose the \(\lambda^{(s)}\) is defined as the percentage of loaded trip cost in the total trip cost for the ship category \((s)\).

\[
\lambda^{(s)} = \frac{\sum_{i \neq 1}^{N} \sum_{j \neq 1}^{N} C_{\text{loaded}(ij)}^{(s)} t_{\text{loaded}(ij)}^{(s)}}{\sum_{i \neq 1}^{N} \sum_{j \neq 1}^{N} (C_{\text{loaded}(ij)}^{(s)} t_{\text{loaded}(ij)}^{(s)} + C_{\text{empty}(ij)}^{(s)} t_{\text{empty}(ij)}^{(s)})}
\]  

(4)

This coefficient represents weight of the loaded trips in the total trips for the ship category \((s)\). This is a very important index, which influences the transport cost and efficiency. In this approach, this index is taken as the criterion of the circulation equilibrium.

The flow chart (Figure 2) shows the ideas of the computational approach. The first step is to set the initial value of \(\lambda^{(s)}\). Then, the program assigns the loaded
A Model for Optimal Sea-River Shipping Management

trips into different categories of ships according to the cost and convergence rules.

After the calculation of the empty trips, comparison could be made on the $\lambda^{(a)}$. If it is stable, the required number of vessels could be calculated. Otherwise, the loops should be processed.

3.2.2 Empty Trips

In the optimal solution, the total empty trip cost in the system should be minimum. Based on the traffic flow conservation and the cost minimum, the optimal empty trips could be got.

Traffic flow conservation could be expressed as:

$$\sum f_{in(i)} = \sum f_{out(i)}$$  \hspace{1cm} (5)

The number of loaded trips 'sink' at i node is:

$$t^{(a)}_{gen(i)} = \sum_{j=1}^{n} t^{(a)}_{loaded(ij)} - \sum_{j=1}^{n} t^{(a)}_{loaded(ij)}$$  \hspace{1cm} (6)

The number of loaded trips 'generated' at i node is:

$$t^{(a)}_{gen(i)} = \sum_{j=1}^{n} t^{(a)}_{loaded(ij)} - \sum_{j=1}^{n} t^{(a)}_{loaded(ij)}$$  \hspace{1cm} (7)

Where

- $t^{(a)}_{loaded(ij)}$ = number of loaded ships (category s) trips from i to j.
- $n$ = total number of nodes
- $t^{(a)}_{sink(i)}$ = number of loaded trips 'sink' at port i (for ship category s).
- $t^{(a)}_{gen(i)}$ = number of loaded trips 'generated' at port i (for ship category s).

According to Eq. (5), the follows could be got.

$$t^{(a)}_{gen(i)} = \sum_{j=1}^{n} t^{(a)}_{empty(ij)}$$  \hspace{1cm} (8)

$$t^{(a)}_{sink(i)} = \sum_{j=1}^{n} t^{(a)}_{empty(ij)}$$

To minimize the total empty trips costs, the equations could be expressed as:
Min \( T_{\text{empty}}^{(s)} = \sum_{i=1}^{n} \sum_{j=1}^{n} C_{ij}^{(s)} \cdot t_{\text{empty}(i)}^{(s)} \) \( (9) \)

On conditions:

\[
\sum_{j=1}^{n} t_{\text{empty}(i)}^{(s)} = t_{\text{gen}(j)}^{(s)}
\]

\[
\sum_{i=1}^{n} t_{\text{empty}(i)}^{(s)} = t_{\text{sink}(j)}^{(s)}
\]

\[
t_{\text{empty}(i)}^{(s)} \leq 0
\]

Apparently, this is a special linear programming problem (linear programming transportation problem). Several algorithms could be found to get the solutions to the equations. The solution to the equations is the empty trip matrix.

![Diagram](image.png)

Figure 2: An Approach
3.2.3 Required Ship Number

The last step of the optimization process is to calculate the required number of vessels in the transport system. It is useful to analyse the existing ship resource and to make development polices on sea-river going fleets.

Suppose, the $\text{Time}_{\text{empty}}^{(s)}$ is defined as the an empty trip time from port $i$ to port $j$ of the ship $s$ plus the unloading time in port $j$. The $\text{Time}_{\text{load}}^{(s)}$ is defined as a loaded trip time from port $i$ to port $j$ of the ship $s$ plus the loading time in port $i$. The $\text{Time}_{\text{load}}^{(s)}$ is the time waiting for the loading operation and the $\text{Time}_{\text{empty}}^{(s)}$ is the time waiting for the unloading operation.

The total activity time of the ship $s$ in the period is:

$$
\text{Time}_{\text{total}}^{(s)} = \sum (\text{Time}_{\text{empty}}^{(s)} + \text{Time}_{\text{load}}^{(s)}) + \sum (\text{Time}_{\text{load}}^{(s)} + \text{Time}_{\text{empty}}^{(s)}) \cdot t_i^{(s)}
$$

(10)

where:

- $\text{Time}_{\text{total}}^{(s)}$ = total working time of ship $s$ in the network
- $t_i^{(s)}$ = loaded trip number
- $t_i^{(s)}$ = empty trip number

This is required minimum working time of the ship category $(s)$. If the average working time of the ship $s$ in the calculation period is $\text{A Time}^{(s)}$, then the minimum number of the ships required in the period is:

$$
N_{RS}^{(s)} = \frac{\text{Time}_{\text{total}}^{(s)}}{\text{A Time}^{(s)}}
$$

(11)

Where:

- $N_{RS}^{(s)}$ = theoretically required number of ship $(s)$

The loading/unloading time of the freights is determined by many factors, which include the ship deadweight tonnages, the port handing capacity, the kind of freights, etc. In general, it could be estimated by the following equation.

$$
\text{Time}_{\text{hand}} = \frac{Q}{k \cdot \text{Cap}_{\text{theory}}}
$$

(12)

Where:

- $\text{Time}_{\text{hand}}$ = loading/unloading time
- $\text{Cap}_{\text{theory}}$ = theoretical handing capacity of the cranes
- $k$ = coefficient
- $Q$ = freight tons in the ship
4 Conclusions

Sea-river shipping is a prospective transport mode, which considerably decreases transport cost by the way of directly accessing to inland waterway ports. It will be a promising transport mode for the bulk cargoes, as well as the containers in the European short sea shipping network. Good organization of sea-river shipping will certainly encourage freight flows by waterways. Required by the economic, environmental, and social factors, it is expected that the competitive ability of waterway transportation should increase in the future Europe market, which will result in reasonable assignment of traffic into various transport modes.

The present paper deals with the sea-river shipping organization problem with the special emphasises on the modelling and optimal transport scheme. The model was primary designed to study the optimal transport scheme and the transport polices on the inland waterways. Further developments of the model makes itself suit for the studies of the sea-river shipping management.

From the descriptions in the previous sections, it could be found that:

1. Optimally planning and organizing of the sea-river shipping are necessary to increase the transport efficiency and competence of waterway transportation;

2. A model was developed in Dept. ANAST, University of Liege, for the optimal shipping scheme in a waterway transport system. It is a useful tool in the practical shipping scheduling and in the short sea system studies. The applications of the models on the inland waterway polices analysis for Belgian Administrations showed satisfactory results;

3. With this model, it is possible to analyse the sea-river shipping on the extended Europe short sea network with special attentions on:
   a. Feasible studies and technical-economic analysis of sea-river going ships for the transport demands;
   b. Sea-river transport planning with the optimal schemes and solutions.

5 Reference


A Model for Optimal Sea-River Shipping Management


MARITIME POLICIES IN NORTHERN EUROPE - A COMPARATIVE ANALYSIS OF THE NORDIC COUNTRIES AND LITHUANIA

By L.M. Ojala and S. Baciauskiene

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1 Introduction

The purpose of this report is to describe the background of the maritime policy decisions of Norway, Denmark, Finland and Sweden during the end-1980s and early 1990's. These are compared with the maritime policy environment in one of the newly independent Baltic states, Lithuania.

The four Nordic countries have a well-established maritime industry ranging from the Norwegian prominence in virtually all fields of commercial maritime operations to Finland with her technically advanced shipping, which, however, has not developed to a world class industry - except for the Finnish shipbuilding industry.

In Lithuania, however, the national transport policy in general and maritime policy in particular have emerged only very recently. In addition, Lithuania has only one seaport (Klaipeda), and at present, commercial shipping under Lithuanian control is organised mainly under one single shipping company, LISCO.

Consequently, Lithuania and Norway could be said to represent the extremes of shipping nations with direct access to the sea. In this "Norwegian-Lithuanian continuum", Denmark, Sweden and Finland are placed between the two extremes as shown below.

The paper also aims at evaluating the outcome of the pursued maritime policies as to which extent they could be deemed successful. This evaluation of the policy outcome is not limited solely on shipping companies and seafarers affected directly by the pursued policy, but is extended to cover the shipping and maritime industry and related activities in the four countries.


The paper comprises three parts: Part I: The Nordic Countries, Part II: Lithuania and Part III: Synthesis and conclusions.
PART I: THE NORDIC COUNTRIES

2 The Outline of the Maritime Environment in the Nordic Countries

Shipping industry in Norway is the single most important service sector of the country, employing directly some 17,000 Norwegian seafarers and 23,000 seafarers of other nationalities in 1993 (OECD Maritime Transport 1993). In land-based occupations, the number could be estimated to at least some 5,000 in Norway, and at least a few thousand abroad. The overall shipping related industries have a turnover of approximately USD 7 billion excluding shipbuilding. In 1990, the shipyards employed 10,000 Norwegians, with an annual turnover of some USD 2 billion and a value added of some 0.8 billion.

In Denmark, the shipping and maritime related industrial complex, with shipping, shipbuilding and related technical, legal and economical activities employ directly 35,000 Danes, and had an annual turnover of DKK 45 billion, equalling USD 7.6 billion in 1991. Shipping companies share of this is approximately 8,000 employed and roughly USD 3 billion in turnover in 1991. Some 5,000 were employed in maritime related jobs in the public sector. The shipbuilding industry has employed in average 9,000 people in 1987-1990, with a turnover of roughly USD 1 billion in 1990. (Det Blå Danmark 1991).

In Sweden, the shipping companies employ some 15,000 seafarers, of which 11,000 on board. The annual turnover stayed at USD 3 billion in 1993. Due to the fading-out of Swedish large-scale shipbuilding in early 1980s, the industry employed only some 5,000 Swedes in 1990 (Swedish Shipping Gazette 1994).

In Finland in the early 1990s, the shipping companies turned over some USD 1 billion, with a direct employment of some 10,000 people onboard and ashore. The number is high due to passenger ferries’ large share of the tonnage. The value added of Finnish shipping has been in the range of USD 0.6 billion (Ojala and Saarto 1992). The shipbuilding industry employed 9,000 Finns in 1990, but in 1993, the number was close to 5,000. In 1994/95, the order-books were full again thanks to a number of cruise and LNG ship orders. The shipyards’ turnover was around USD 2 billion in 1990, with a value-added content of roughly 0.6 billion.

A typical ferry in the 200-300 NM Swedish-Finnish trade can takes some 2500 passengers and some 80 semi-trailer trucks or 400 cars. It has a crew of 300 onboard, with equally many on leave. The Swedish-Finnish trade is the strongest of the regular passenger trades to and from Finland, taking some 8 million passengers p.a. Smaller passenger ferries sail in the 50 NM Helsinki-Tallinn route, on which some 3 million voyages were made in 1995.
Maritime Policies in Northern Europe

Except for Finland, all of the Nordic countries have been engaged in large-scale international (worldwide) shipping. For Finland, the most internationally competitive sector has been cruise shipping. In 1995, Finnish-owned cruise operations in the Caribbean were, however, sold off.

3 Background on the Nordic Maritime Industries

The Nordic countries have typically had high-quality, high-cost registries, with internationally short total worktime and high social security and pension costs, both in absolute and relative terms.

In the mid-1980s, the international competitiveness of Nordic shipping industries was greatly affected by the very rapid strengthening of the Nordic currencies against the U.S. dollar during 1984-1987. The Nordic currencies remained strong until early 1992. This made investment outside the Nordic area feasible, while at the same time squeezing the competitiveness out of the national fleets in these countries. For example, in 1988-1990, the Norwegian shipping investment amounted to some NOK 44 billion, i.e. roughly USD 7 billion.

At the same time, in 1984-1987, the exchange rate development for many of the emerging shipping nations of the Dynamic Asian Economies (DAE's) and some other Flag of Convenience (FOC) countries experienced a quite opposite tendency.

These developments gave rise to fundamental changes in the maritime policies pursued in these countries - maybe with the exception of Sweden. Considerable attention in maritime policymaking was turned into ship register issues.

3.1 The Nordic Ship Registry Decisions in a Nutshell

The ship registry policies pursued in the four Nordic countries during the past ten years differ from one another in some interesting aspects: Norway introduced at a relatively early stage (1.7.1987) an internationally competitive ship register (NIS), which was open to other nationals, too. Denmark followed the track a year later with the Danish International Ship Register, DIS, but restricted the ownership to Danish nationals, or Danish-registered companies.

The income tax incentives together with lower manning levels and shorter off-duty periods made it possible to keep the Danish fleet manned with predominantly Danish crews, while the Norwegian system was clearly designed to attract already flagged-out vessels. There was also no such reserve of Norwegian active seafarers for deck or engine ratings than was the case in Denmark.

Neither NIS nor DIS vessels could be engaged in domestic shipping. Both countries retained their national registries for domestic and cabotage trades, shortened here as NOR and DEN, respectively.
In Sweden, the government went on to subsidize Swedish-flagged tonnage with direct subsidies in 1988/1989, without *de facto* altering the register arrangement. A condition for the subsidies was, however, a certain increase in effectiveness onboard the vessels, but this was only a marginal condition. Shipowners were also given the possibility to so-called contract depreciations. Still in 1993, there was no credible, long-range maritime policy in Sweden. This was seen as a serious handicap by major shipowners, who did not want to risk their ability to operate in international traffic with the full range of their expertise.

Furthermore, the trade unions’ point of view - especially that of the ratings’ union’s - has adamantly been against any NIS or DIS-like arrangements. The strong position of the trade unions and the related legislation on co-decision as exemplified by the so-called Lex Britannia case in Sweden, for example, are a fact of life to be reckoned with in the country. The center-right coalition government elected in 1992 made some proposals to regain the competitiveness onboard Swedish-flagged vessels, but the negotiations have not progressed very far. No further advancement has taken place since the social democratic government took office in 1995.

In Finland, a separate list for cargo vessels in foreign traffic was established as from 1.1.1992 through negotiations between the employers’ and employees representatives with governmental assistance. The solution had roughly the same effect as the DIS. The outcome was not an independent register, but a separate list along with the existing register. Income taxes and certain social security dues were covered by the State, on condition that the negotiating parties can reduce operating costs by 10 per cent.

Already in 1985/1986 a separate agreement with similar effect had been reached for the so-called “small tonnage”, i.e. vessels under 1600 grt. This boosted newbuildings of such vessels (typically Sto-Ro ships). In 1995, these vessels built after 1985 number more than 20.

In Finland, virtually no re-flagging occurred after the 1992 arrangement, but a potentially sizable flagging out of the remaining fleet was avoided. This was also expressed as one of the main goals with the policy. The system is still in place in 1996.

### 3.2 Outcome after the register decisions

The most remarkable development in reflagging anywhere in industrialized shipping world occurred in Norway after the establishment of NIS (see Figure 1, Source: Yearbook of the Nordic statistics 1993, Copenhagen 1994, Lithuanian Ministry of Transport). This was made possible, among other things, by the following factors:

1. The strong Norwegian krona in the end-1980s made ship investment more interesting for shipowners even though the seafarers on NIS-vessels (or
FOC-vessels, for that part) had their wages paid in dollar terms. Compared to the capital costs of newbuildings, the currency effect on wages was marginal;

2. Norwegian shipowners had a substantial desire to operate under the Norwegian flag as long as the economic disadvantage is not too great;

3. The drafting of the legislation was done in close cooperation with the Norwegian labour unions, which were granted a "supervisory" position for wage negotiations with foreign unions;

4. The fiscal arrangements for K/S-based\(^1\) companies’ encourages the entrance of new investors into the shipping industry and supports the development of ship management firms; and

5. The NIS register is designed to attract Norwegian nationals as well as foreign owners. The share of the foreign owners has, nevertheless, remained marginal, at some 5 per cent of the total deadweight tonnage by 1993/1994.

The DIS register has also been able to attract Danish shipowners, and these vessels are predominantly Danish-manned. From the employment point of view, the DIS arrangement has been rather successful. The arrangement has increased

---

\(^1\)K/S stands for a partnership company form in Norway. The taxation benefits of K/S companies especially for individual partners (physical persons) have been substantially reduced since the mid-1980s.
Danish vessels' competitiveness especially in minor bulk ship and container feeder ship trades in the North Sea-Baltic range.

The Swedish subsidy policy has not been attractive for the major shipping companies, however vital for some individual shipowners. The major drawbacks are the relatively strict trade union induced regulations for work onboard and the lack of continuity in the pursued policy.

In Finland, "The List" prevented further flagging-out of Finnish tonnage, but has not triggered any re-flagging to talk about. The arrangement has been effective since 1.1.1992, but its permanence is not guaranteed, however probable. Tax reductions accords relating to ship investment have also been affective two years at a time. No new subsidies to the so-called small tonnage are planned, but the already awarded interest payment subsidies have been extended successively.

3.3 The scope of Maritime Policy in the Nordic Countries

The weight of the maritime policy in Norwegian policymaking in general is fairly high, reflecting the relative and absolute importance of that industry in the country. International shipping by Danish companies is impressive especially in liner and reefer shipping. These operations - as is the case with Norway- typically take place between third countries.

Thus, the Norwegian and Danish maritime policies are heavily engaged in issues that are dealing with competitiveness of their shipping businesses vis-à-vis that out of low-cost shipping nations and emerging economies. In addition to that, the Norwegian maritime policy is deeply engaged to supporting the domestic cargo and passenger trades, which is mainly done by subsidizing vessel in the national registry.

Swedish shipping is also highly international, and major operations are typically found in highly specialized sectors such as car transport, passenger and reefer shipping. These are mainly engaging ships under registries other than the Swedish. This applies fully to the Swedish-controlled tanker and dry cargo fleet too. Also in Sweden, the domestic shipping has been receiving sizeable subsidies.

Finnish shipping is characterized by a great concern on the country’s foreign trade flows, and in keeping up a tonnage suitable for winter navigation. Coastal or domestic shipping are of lesser importance in maritime policymaking than, for example, in Norway or Sweden.
PART II: LITHUANIA

4 Lithuanian Transport Environment in Brief

In 1995, Lithuania had a population of 3.7 million. According to the Statistical YB of Lithuania, the preliminary figure for GDP was 16.3 billion litas (USD 4.1 billion) in 1994, leaving GDP per capita at a mere 1100 USD/Cap (Not adjusted for Purchasing Power Parity, PPP). Of the three newly independent Baltic states (with Estonia and Latvia), Lithuania has the lowest economic output.

During the Soviet era from 1944 to March 1990, Lithuanian industry received the greater part of their raw materials from within the Soviet Union, which also provided the market for Lithuanian output. The output sold outside the Soviet Union was quite small. All the main commercial and export activities were centralized and ruled by Moscow. Under this system the factories and enterprises did not develop marketing expertise nor knowledge of market economy, commercial arrangements and export procedures. During the period of transition into market economy, these old markets of the former Soviet Union (FSU) no longer were accessible on the same terms and to the same extent as previously.

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<td>2028.8</td>
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<td>51.7</td>
<td>18.6</td>
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<td>Latvia</td>
<td>143.9</td>
<td>171.1</td>
<td>32.7</td>
<td>63.9</td>
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<td>250.5</td>
<td>227.7</td>
<td>160.0</td>
<td>264.3</td>
</tr>
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</table>

Source: Lithuanian Statistical YB 1994/95

Exports cover all goods exported from Lithuania, including exports of previously imported goods in free circulation and exports of goods from customs warehouses. Imports cover goods declared for home use, temporary imports of goods for inward processing and imports into customs warehouses.

Table I: Lithuanian exports and imports in 1993-1994 in million USD

The potential demand for Lithuanian products in the FSU remained high but there were (and still are) serious problems of payment. Lithuanian industries began to look for Western markets exporting even at loss for certain periods. The simpler
products as steel, mineral fertilisers and timber found the easiest markets. In 1994, the value of Lithuanian imports was USD 2.4 billion, half of which came from the CIS\(^1\) states, whereas some 34 per cent originated in EU and EFTA countries. Exports totalled USD 2.0 billion, with 47 per cent coming from the CIS states, and 31 per cent from the EU/EFTA states (See Table I).

The independent transport system of Lithuania was re-established in 1991, when sea, air and railway transport changed their subordination from the ministries of the FSU (in Moscow) to the Ministry of Transport of the Republic of Lithuania (MOTL).

The Lithuanian Government has recognized transport as one of the priority sectors of the national economy, and a series of transport development plans have been adopted. In the 1994 the Lithuanian Government approved the National Transport Development Programme up to the year 2010, and approved the schedule for the implementation of main priorities for the period of 1995-1997:

- Integration of the Lithuanian transport system into the European transport network and transport service market through the international transport corridors, also keeping the traditionally set transport connections with the CIS countries;
- Adjustment of the fundamental transport law to comply with the transport legislation and standards of the EU (harmonisation of the legislative system with those of EU countries);
- Active participation of the State in ensuring the stable activities of strategic transport infrastructure objects, their reconstruction and updating, making the necessary investments for that purpose;
- Demonopolisation and privatisation of the state sector objects in commerce, transport services and promotion of private capital investments into the transport sector.

The first priority in development and modernisation is given to Lithuanian transport infrastructure objects that lie on the corridors defined during the Second Pan European Conference in Crete:

I corridor: (North-South): Tallinn-Riga-Kaunas-Warsaw (with a branch 1A Riga-Kaliningrad-Gdansk).
IX B branch: Kiev-Minsk-Vilnius-Kaunas-Klaipeda.
IX D branch: Kaunas-Kaliningrad.

The main investment projects of these corridors are included into the Lithuanian Public Investment Programme. These are to be financed by using the entities’ budgets, state budget subsidies and loans from the international financial institutions. Definite timetables for most of these projects are still pending.

\(^1\)Commonwealth of Independent States

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The main legal act on the reorganisation of the transport system and its further development is the Law on the Principles of Transport Activities, adopted in 1991. There are the draft laws on Klaipeda State Seaport and on Commercial Navigation (to be adopted in Parliament in early 1996) as well as a draft on the Law on Transport Infrastructure.

In the initial phase, many of these were carried out by Western aid or by Western consortia. For example, the ongoing EU PHARE programmes with a maritime dimension in Lithuania in early 1996 include the following:

- Feasibility study and detailed design of Klaipeda Port Ro-Ro terminal;
- Implementation of Recommendations of Klaipeda Master Plan II;
- Transport of Dangerous Goods in Lithuania.

5 The Lithuanian Maritime Environment

The Lithuanian fleet totalled 0.6 million GT in 1994, of which some 0.4 million GT were cargo vessels. The ships are predominantly Lithuanian flagged, with only a couple of them flying the Panamanian flag. The proportion of national vessels carrying the country’s foreign trade is, however, fairly small, accounting for some 20 per cent in 1995 according to the Ministry. (See Table II)

<table>
<thead>
<tr>
<th>Number of vessels</th>
<th>Gross tonnage ('000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>308</td>
</tr>
<tr>
<td>Merchant fleet</td>
<td>70</td>
</tr>
<tr>
<td>- dry freight</td>
<td>63</td>
</tr>
<tr>
<td>- tankers</td>
<td>7</td>
</tr>
<tr>
<td>- ferries</td>
<td>3</td>
</tr>
<tr>
<td>Fishing vessels</td>
<td>167</td>
</tr>
<tr>
<td>Other vessels</td>
<td>71</td>
</tr>
</tbody>
</table>

Source: Lithuanian Ministry of Transport

Table II: Marine vessels from the register of the Republic of Lithuania

In 1995 Lithuania became an associated member of the EU and acceded to IMO. Lithuania has acceded in 1991 to the following Conventions and Protocols: SOLAS 1974, SOLAS PROT 1978, COLREG 1972, MARPOL 73/78, LL 1966, TONNAGE 1969 and CSC 72.

Shipping consulting, analysis and market research services are not yet really available in Lithuania. However, the Maritime Department at Klaipeda University and Navigation Research Institute (the former branch of the Leningrad Institute) are engaged in economic and technical maritime research.
Trade Union movement is inefficacious and inexperienced. At present, only the Union of Seamen (successor of the former Seamen’s Trade Union) exists.

5.1 The Port of Klaipeda

Klaipeda Seaport is the only seaport of Lithuania. Recently, its freight turnover has decreased, but the volume of goods loaded and unloaded in the port in 1994 was still at some 14.5 million tons.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total-loaded and unloaded</td>
<td>16121</td>
<td>15747</td>
<td>12922</td>
<td>15772</td>
<td>14524</td>
</tr>
<tr>
<td>Goods loaded</td>
<td>8815</td>
<td>12063</td>
<td>11728</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Goods unloaded</td>
<td>4107</td>
<td>3709</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Lithuanian Ministry of Transport

Table III: Good loaded and unloaded in Klaipeda State Seaport (thousand tonnes)

In 1992 by the Decree of the Lithuanian Government Klaipeda Port got the status of Klaipeda State Seaport. The management structure of the port has been fundamentally reorganised during the last two years. The port is gradually changing its orientation towards the technologies of transporting manufactured consumer goods.

In 1995 The Port of Klaipeda (PoK) is a state-owned port: it is located on state owned land with state owned infrastructure. Klaipeda State Seaport Authority (KSSA) is the representative of the State which is in charge of supervisory functions. KSSA fulfills Land-lord functions, deriving income from port dues, wharfage and territorial leases (with a maximum duration of 25 years) for independent economical-commercial entities, is responsible for port development, looks after aids of navigation and navigation safety in the port water territory, organizes search and rescue activities in Lithuanian territorial waters. The land-lease tariff is per square metre. A coefficient is applied to the basic tariff, taking into account the different conditions - the characteristics of the quay, the road and railway facilities etc.

According to a recent Belgian study (Port and Transport... 1995), the general impression of the Port of Klaipeda is one of greater clearliness compared to year ago. Changes are definitely taking place in Klaipeda at a fast pace and mentality of competition and entrepreneurism is developing fast even in the still state-owned parts of the Port. Although separation has taken place between the different entities, de facto ownership by the State will prove to remain a serious hindrance for development of service quality. Productivity increase and tariff competition, cargo safety and quick dispatch of vessels will be too slow to develop as
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long as State approval will be required for elements having commercial influence. Anyway, all companies appear to be doing extremely well and making large profits.

According to another 1995 study (Port of Klaipeda... 1995), a comprehensive EDP-supported port statistics is not yet available. First activities for setting up of a port statistics framework and port management information system in accordance with international requirements have been started. A comprehensive manual of recommendations for a prototype of a collective agreement, including appendixes for technical and commercial staff as well as special groups, examples of agreement between a company and trade union, characteristics on wage groups and wage agreements, prototype of a bonus system and implementation proposals is completed. For the time being, the operating companies in the Port are obliged by the Law of Statistics to provide required data to the Statistical Department and to the municipal Statistical Office in Klaipeda. The Land Leasing Contracts for 1995 comprises a paragraph that the operating companies have to submit its data regarding cargo handling, ship calls etc. to the KSSA.

Regular shipping lines in Klaipeda Port (1995) include the following (in the order of decreasing frequency; “private” after the frequency refers to a non-state-owned shipping company rendering for the service):

<table>
<thead>
<tr>
<th>Route</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Klaipeda-Mukran</td>
<td>Daily (LISCO, Euroseabridge)</td>
</tr>
<tr>
<td>Klaipeda-Kiel</td>
<td>4x p.w. (LISCO),</td>
</tr>
<tr>
<td>Klaipeda-Flensburg</td>
<td>3x p.w. (private),</td>
</tr>
<tr>
<td>Klaipeda-Copenhagen-Malmö</td>
<td>2x per week (private),</td>
</tr>
<tr>
<td>Klaipeda-Hull</td>
<td>2x p.w. (private),</td>
</tr>
<tr>
<td>Klaipeda-Fredericia</td>
<td>2x p.w. (private),</td>
</tr>
<tr>
<td>Klaipeda-Rostock-Sczecin</td>
<td>2x p.w. (private),</td>
</tr>
<tr>
<td>Klaipeda-Århus-Copenhagen</td>
<td>2x p.w. (LISCO),</td>
</tr>
<tr>
<td>Felixstowe-Rotterdam-Antwerp-Klaipeda-Kaliningrad</td>
<td>2x p.w. (private),</td>
</tr>
<tr>
<td>Klaipeda-Ålborg-Gäve-St.Petersburg-Klaipeda</td>
<td>1x p.w. (private),</td>
</tr>
</tbody>
</table>

Port charges for Lithuanian ships port dues are only 25% of those levied on foreign ships (still in 1996). Port dues are approved by the Ministry of Transport and fixed in a 1993 Decree, which will be revised in 1996 in order to increase the dues for Lithuanian flagged ships.

Operators in the Port of Klaipeda

The operators in the Klaipeda Port in early 1996 include the following (in the order of their importance):

KLASCO - Klaipeda Stevedoring Stock Company (includes the former Commercial Port and the International Sea Ferry Terminal - ex Mukran-Klaipeda Terminal). Employees 2150 workers (in 1995). 92,4% of shares belong to the Lithuanian Government (State), 7,6% is owned by the employees. KLASCO’s turnover in
Section IV - Forecasting, Logistics and Safety

1994 was 44.3 mio USD, value added 22.8 mio USD and wages 6.0 mio USD. In 1994 employed 2254 workers. KLASCIO has 12 various special purpose ships.

Stevedoring Stock Company "Klaipedos Smelte" (the former Fishing Port). In 1995, it employed 1243 people. 89.5 % of its shares are government-owned, and the remainder, 10.5%, are owned by the employees. Turnover in 1994 was 9.5 mio USD, value added 3.5 mio USD and wages totalled 3.5 mio USD.

Stock Company "Naftos Terminalas" handles oil products (up to 6 mio tons per year).

Joint Stock Company BEGA Ltd. - a new private company on the premises of the Paper Mill - exports timber props, fertilisers in bulk (incl. liquid) and in big-bags. A new rail crane is installed and a 5000 t capacity tank for export of liquid fertilisers and silos for bulk cement are constructed. The company is planning about 100 million USD investments over the next five years. The Paper Mill is back in operation on a limited scale and will produce small quantities of carton out of waste paper.

Consortium “Klaipedos Terminalas” (a private stevedoring company) handles container and Ro-Ro vessels.

There are also about 50 registered ship management, brokerage, forwarding and chartering agencies in Klaipeda, some of them joint ventures with Russian partners. These are typically small, and they are established mostly after 1992.

5.2 The Lithuanian Shipping Company LISCO

Lithuanian Shipping Company (LISCO), founded originally in 1969, is a joint stock company where 80 per cent of the shares belong to the Government, while 20 per cent are owned by employees of LISCO. A process to decrease government’s ownership in the company is under way. At present (1995) it owns 43 vessels mostly Lithuanian flagged (a couple of them fly the Panamanian flag).

The turnover of LISCO was 79.9 mio USD in 1994. The value added was 29.7 mio USD (wages 5.1 mio USD with 2323 employees). Investments for purchase and reconstruction of ships in 1995 was 22.5 mio USD. For the time being LISCO is still directly linked to the Ministry of Transport with the Lithuanian Government appointing the President of LISCO. In 1995 40% of the staff were Lithuanians by nationality, whereas some 60% had a nationality of the CIS or other FSU States.

1Such a process is generally called privatization in Lithuania, even if it does not necessarily mean listing of the company at a stock exchange in the foreseeable future. In Lithuanian privatization projects, the ownership has typically been shifting to employees rather than private investors.
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Newly built ships have Lloyd’s insurance and classification services, older ships have Russian insurance and Russian classification services. It has ships of the tonnage from 2000 up to 14000 tons (2000-6000 dwt general cargo and container ships, and bulkers of 14000 dwt). Two ferries - “Kaunas” and “Vilnius” work on the line Klaipeda-Kiel-Klaipeda. They carry mainly Ro-Ro cargoes and cars. In addition, “Kaunas” can take 200 passengers per trip, and “Vilnius” 120 passengers.

LISCO with its German partners operates two ferries on the line Klaipeda-Mukran-Klaipeda with daily departures. Ro-Ro ship “Diauliai” (Århus-Klaipeda-Copenhagen line) takes 33 heavy units and 50 cars per trip. The ferry “Vilnius” was converted to a passenger - Ro-Ro/rail cargo ferry and transferred to Lloyd’s Register class in 1993. The ferry “Kaunas” was converted and transferred class at Blohm and Voss, Hamburg, in 1994. LISCO is having four 3650 gt general cargo ships built to Lloyd’s Register class. The hulls are under construction at Klaipeda’s Baltija Shipyard, and, on completion, will be taken to Spain where the ships will be fitted out at Astilleros Espanoles de Huelva. LISCO has decided to finance new tonnage with old and to sell the oldest ships of the fleet. By the beginning of 1999 LISCO should have about 35 vessels. (LISCO is aware of the increasing pressures on responsible owners and operators to make financial commitments to safety).

A British-Belgian study from 1993 (Master Plan..., 1993) stated that the management of LISCO was fairly well versed in the shipping operations. However, due to the legal status of LISCO at that time, and the legal situation in Lithuanian in general, the management was not really in a position to develop autonomically a strategic company development plan. Consequently, LISCO’s was in a position where it could only react instead of act.

As far as world-class shipping business is concerned, the company is clearly in a disadvantage as regards the access to state-of-the-art communications and management skills.

The functional structure of the fleet is still the result of the former centralised socialist regime where every MORFLOT shipping company had to fulfill certain tasks. The different types of ships were assigned to each shipping company according to “planned” or “strategic” traffic flows. Today, this causes structural problems for an efficient fleet management.

Some 62 percent of the fleet by number and 34 per cent by deadweight capacity is more than 15 years old. The maintenance and repair cost of the ships have increased considerably. Some of them are also overmanned. In 1999 the new SOLAS convention will come into force. The LISCO fleet will need technological improvements to be able to meet the international standards. About 17 ships are operated via time charters (short, 3-6 months), other non-liner vessels are operated on the spot market. Although the experience on the spot market is limited, this is seen as the market in which best revenues could be obtained.
5.3 Feeders Services to and from Lithuania

As far as the short feeder services from the Baltic to deep sea routes are concerned, Hamburg and to a lesser extent Bremerhaven are the obvious choices of load centres. The ports are served by most major carriers and are linked to most major carriers and are linked to most deep sea destinations. Klaipeda appears to be reasonably well suited to serve short sea feeders to Hamburg. In the future, the container traffic is anticipated to be carried out by feeder services from the major ports bordering the North Sea like Hamburg, Bremerhaven, Rotterdam, Antwerp and Southhampton. These feeder services have been a common practice for years in all West European countries in the Baltic Sea and will be soon extended to the East European countries along the Baltic Sea. The feeder service will be effected by the following type of typical feeder vessels (Types A, B and C in Table IV):

<table>
<thead>
<tr>
<th>Type</th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross tonnage</td>
<td>999</td>
<td>1599</td>
<td>3999</td>
</tr>
<tr>
<td>Net tonnage</td>
<td>700</td>
<td>1150</td>
<td>2200</td>
</tr>
<tr>
<td>Length (m)</td>
<td>90</td>
<td>98</td>
<td>117</td>
</tr>
<tr>
<td>Breadth (m)</td>
<td>14</td>
<td>15.5</td>
<td>18</td>
</tr>
<tr>
<td>TEU</td>
<td>226</td>
<td>293</td>
<td>348</td>
</tr>
<tr>
<td>Speed (knots)</td>
<td>12</td>
<td>12.5</td>
<td>13.3</td>
</tr>
<tr>
<td>Draft max</td>
<td>6.0</td>
<td>6.6</td>
<td>8.2</td>
</tr>
<tr>
<td>Consumption/day</td>
<td>8.0</td>
<td>10.5</td>
<td>13.7</td>
</tr>
</tbody>
</table>

Table IV: Container ship data for typical feeder vessels in Lithuanian trades

These types of ships are in service all over the European coasts and will dominate the coastal service for the next 10 to 25 years. As experience shows, liner services with a high frequency are demanded by the customers so that big container vessels are not likely to call at the port of Klaipeda in the near future. This can only be fulfilled with comparatively small ships.

The Ro-Ro traffic will be performed mainly from ports within the Baltic Sea area. Ro-Ro traffic is typical for short sea connections and the dominating type of the sea transport in the Baltic Sea.

5.4 Areas of Concern for the Lithuanian Maritime Policy

Some of the main areas of concern for the Lithuanian maritime environment were summarized in a Dutch study (LOGION...1993). The consultants had arranged meetings with shipping lines, shipbrokers and port authorities in the Netherlands, Belgium, Germany, Denmark, Sweden, Finland and Russia to obtain information, opinions about LISCO.
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Container/general cargo feeder lines are under pressure due to falling volumes and overcapacity. Competition was seen as intense and the market was characterised as “bad”. Feeder connections from the Baltic are connecting with main line ports in Western Europe predominantly Hamburg, Bremen, Rotterdam and Antwerp. LISCO was advised to be very careful to enter this market at that moment. But the interviews produced several interesting partners for LISCO. European origin or destination cargo will also increasingly be shipped in containers/trailers via sea, in order to avoid congestions on roads/borders, for among other environmental reasons. More direct connections are expected to be developed between regions in Europe and East block countries. Also railway may be used more often in particular on East-West routes. This may result increased opportunities for ferry/Ro-Ro operations. The age of vessels under pressure of insurance companies or cargo owners is becoming more important. Most brokers/cargo interest foresee max ages of ships of 15 years, with possible extention up to 20 years in case of good maintenance (cf. Ojala et. al. 1994).

Another development is an increasing demand with regard to quality of the crews. All this is being watched closely by the I.T.F. which seems to consider Baltic State registration more and more as flags of convenience and monitors sharply developments as to wage levels, service on board ships, crew education etc.

In the general cargo/semi-bulk/forest product trades, LISCO was generally considered to give an adequate service. Some markets were considered to be difficult to break into, in particular those of forest products. The ships involved are mainly owned or chartered long-time by cargo owners themselves and sail on regular routes with fixed schedules. However, still a lot of cargo seems to remain available on the open market.

LISCO’s ships have typically been used for carrying coal/steel or ferroproducts and forest products from the Baltic area to other European or Mediterranean destinations, with grain carried to the Baltic. LISCO should be able to do much more in this area. Bottlenecks indicated were mainly the communication problems (language, bad connections), and apparent lack of commercial feeling and know-how. Much more traffic could be generated by regular contacts with brokers, cargo interests and their agents. LISCO should improve its agency network and appoint new ones in some areas.

Overall, LISCO is fairly experienced in operating tramp vessels, forest products carriers and railway /truck ferries, maintaining contacts with FSU markets and companies, and ship management. LISCO employs a balanced fleet between 2000 and 14000 dwt, which makes it flexible in the development of the fleet to customers needs. Another pro was the availability of ice-class vessels. LISCO is operating out of a low cost-basis, making the company able to be a low price operator. It also has a thorough knowledge of throughput and handling of cargo in the Klaipeda Port.

Areas where the interviewed persons in the LOGION study envisaged LISCO to be weak: an obvious point was the age of the ships, causing high maintenance and
insurance costs. But a more serious problems encountered by the companies interviewed was the commercial behaviour of LISCO. Mentioned were lack of communications, caused by poor language knowledge, furthermore LISCO was seen as not very commercial in their activities, slow in acting and handling their agents. It was generally felt that LISCO should pay a lot of attention to internal organisation and control, efficiency and administration. Indicated was that opportunities for LISCO might arise from: increasing intra-European and deep-sea feeding in smaller size vessels in the markets where age of ships is less important like Mediterranean, forest product market, time charter contract possibilities, ferry market developments increasing use of ferries on East-West routes, charter market low value bulk goods/less sophisticated ports. Indicated was that threats for LISCO might arise from: Container developments, vessel age restrictions, crew/I.T.F. developments, quality of competition, Government or related authority restrictions, development of new or updating of existing transport modes, eg. rail connections or use of barges, currency/money situation. (cf. Baciauskiene 1996)

Consequently, these are also the problems that the Lithuanian maritime policy is facing. The policymaking situation is accentuated by the fact that virtually all shipping activities are gathered in Klaipeda - some 300 km west of the capital Vilnius, which is a city in the inland. Lithuanian shipping activities are also mainly under the control of one dominating company, LISCO.

PART III: SYNTHESIS AND CONCLUSIONS

6 Conclusions

The Nordic-controlled shipping industry greatly increased its earnings from sea freight exports during the end-1980s. Only for Finland this did not occur. Despite of the NIS-, DIS- and Swedish subsidy arrangements, the development seems to have been attributable more to heavy investment in new revenue-generating vessels, and an improving freight market rather than individual register policies (cf. Ojala 1994).

The extremely high levels of the Nordic currencies during 1987-1991 made investment decisions more feasible, even though the national cost level was also high at the time. Both of these factors operated in the same direction: they either effectively kept new investment in FOCs or, as an alternative solution, implied a NIS and DIS type arrangement in order to (re)gain international cost competitiveness in shipping under the national flag.

It is also difficult to find a "genuine link" between the proportion of national flag in a country’s shipping operations and the well-being of the country’s shipping environment and business milieu in general. The Nordic experience supports the idea that the flag the vessels fly, however symbolic and laden with national pride, is not the guarantee to ensure a profitable shipping environment and long-term
engagement and keeping up of a multitude of business and technical expertise in this highly international field of business (cf. Sietmo and Holste 1993).

Especially in high-cost shipping countries, the desirable maritime policy of any one government should be to enhance the broad spectrum of shipping related activities, from shipping consulting and insurance to shipping companies and shipbuilding, with linkages to subcontractors in maritime and other equipment. For maritime nations, also the know-how in port, fairway, maritime safety, environmental control as well as naval and coast guarding activities require a living shipping milieu to survive.

Also in Lithuania, the nurturing of maritime and shipping skills in the country are given a high priority in maritime policymaking. As far as the national flag issue is concerned, the approach at the Ministry could be characterised as rather pragmatic. The issue of the vessels’ flag is that of the national shipping company LISCO to decide rather than dictated by the Ministry. On the other hand, the Lithuanian register offers very low operating costs already. The true issue in the choice of a ship’s registry is the finance arrangement e.g. with foreign partners rather than being a politically unconstrained choice by LISCO.

The case of Lithuania shows vividly the wide array of economic, organisational and political obstacles for an emerging shipping nation. There is a simultaneous lack of adequate funds for renewal of ageing tonnage, lack of experienced people and a lack of stability in policymaking. For a low cost shipping nation, however, there is no lack of existing competition in open trades in the Baltic or in the European waters, not to speak of worldwide bulk, tanker and liner shipping.

Lithuania may represent a kind of an extreme in the sense that it has a relatively small tonnage. Emerging CIS/CEE countries with substantially more shipping muscle are found in Russia, Belarus and Rumania, for example. The type of difficulties on their way to build a solid maritime milieu are, admittedly, on a different scale than is the case with Lithuania, but their nature is largely the same.

When the business-oriented shipping activities are concerned, the general trend in the world shipping is towards ever-higher standards, be they environmentally induced or demanded by customers/shippers or insurance companies. In the long run, the high standards can only be guaranteed by high-quality shipping nations, with shipping milieus capable of nourishing the required skills both ashore and on board. In other words, successful operations in the world shipping are going towards increased specialization. But world-class specialization cannot be achieved without mastering the tools of the trade, which can only be achieved through a world-class shipping milieu. In this respect, the true challenge of the 1990s for Nordic as for other western European shipping nations comes from the Dynamic Asian Economies even in the field of shipping. In the European (Union) waters, the most obvious competition seems to stem from the near abroad.
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THE STATE OF THE ART

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<tr>
<td>6.7.10</td>
<td>United Kingdom</td>
<td>441</td>
</tr>
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</table>
Research in Shortsea Shipping: The State of the Art

RESEARCH IN SHORTSEA SHIPPING:
THE STATE OF THE ART

Abstract

There has been an explosive growth in shortsea shipping related research during the last six years. In this period there have been about 80 papers presented at the three European Research Roundtable on Shortsea Shipping conferences to date (1992, 1994, and 1996). In addition, the three FAST international conferences on fast waterborne transport (1991, 1993, and 1995) presented close to 300 papers, of which about 70 directly focus on shortsea shipping. Various projects, national and international, have been also initiated in this area. In the context of the 4th Framework Programme, the European Commission/ Directorate General for Transport (DGVII) has launched in early 1996 several shared cost projects, as well as a concerted action explicitly targeted to shortsea shipping. Other directorates such as DGXII and DGXIII have also launched related projects in early 1996.

In view of such a boom of research activity, it becomes imperative to critically survey such work, and also make a taxonomy of it, so that all this work is sorted out, and the baseline for further research becomes clear. Failure to do this will inevitably result in duplication of effort, gaps in research, lack of vision on what is needed, and other negative ramifications. The purpose of this paper is to carry out a critical survey and taxonomy of such work. The survey has involved a European-wide solicitation of input on related work, and also a collection of input from other sources. The paper also presents a software tool developed to assist in information entry, update, and retrieval, and also attempts to identify common trends on research topics. Without claiming that the contents of the paper are encyclopaedic, or that each and every piece of material collected has been reviewed in depth, we can at least claim that the 442 entries catalogued represent an unprecedented compilation of material in this area. Perhaps the most important trend identified within this vast collection the material is a significant degree of "fragmentation" of R&D effort in the SSS field, in the sense that problems that are methodologically similar in many contexts have been typically addressed in isolation. The most obvious consequence of this fragmentation is that the impact of R&D efforts to serve the real needs of European SSS has been so far limited. Commission-sponsored activities such as the SSS Roundtable Conferences, the Concerted Action on SSS, the collaborative R&D projects under way, and other related activities are expected to alleviate this situation in the future.
1 Introduction

Shortsea shipping is one of the least subsidized modes of transport in Europe, at least compared to its land-based competitors, such as road and rail transport. The true costs of the latter (including environmental costs) are not fully internalized, and as a result of this distortion there is severe congestion in the European road and rail freight networks, and severe environmental and social impacts. The Commission’s White Paper on the future development of a Common Transport Policy-CTP (COM(92) 494 final) clearly states that the CTP should minimize such distortions by focusing on environment-friendly modes such as shortsea shipping.

Shortsea shipping is thus emerging as an important focal point of the transport policy of the European Union. As intra-European borders are rapidly being dismantled, and Eastern Europe is gradually becoming more open, shortsea shipping’s significance gains a prominent role, and its potential in enhancing the EU’s competitiveness, economic and social cohesion, and sustained mobility is very real. Developments in information technologies and telecommunications have significantly increased the potential for efficient intermodal transport, which opens new horizons for shortsea shipping.

Addressing the entire spectrum of problems in shortsea shipping is a monumental task. It calls for (among other things) significant R&D to determine policy priorities in this area. Fora such as the Maritime Industries Forum and various conferences deal with many of the relevant issues. Much of the necessary R&D is being sponsored by the Commission. Individual countries are also sponsoring related programs.

It is fair to say that the growth in shortsea shipping related research during the last six years has been explosive. Conferences such as the European Research Roundtable in Shortsea Shipping (1992, 1994, and 1996) and the FAST international conference on fast waterborne transport (1991, 1993, and 1995) have collectively presented about 150 papers directly focusing on shortsea shipping and close to 250 others peripherally related to the subject. In addition, various projects, national and international, have been initiated in this area. In the context of the 4th Framework Programme, the European Commission/ Directorate General for Transport (DGVII) has launched in early 1996 several shared cost projects in areas related to shortsea shipping, as well as a concerted action explicitly targeted to shortsea shipping. Other directorates such as DGXII and DGXIII have also launched related projects.

In view of such a boom of research activity, and in view of ambitious plans for further research in this area (5th Framework Programme, to state one example) it was felt that the time was ripe to take stock and critically survey such work, and the baseline for further research becomes clear. Failure to do this would inevitably result in lack of knowledge on where one stands, duplication of effort, gaps in research, lack of vision on what is needed, and other negative ramifications.
In that context, the purpose of this paper has been to carry out a survey and taxonomy of such work.

The goal of compiling a comprehensive "inventory" of shortsea shipping related research presents a number of significant difficulties. These following two are the most important:

1) **Lack of an unambiguous delineation of the field:** Does a paper or a project on the hydrodynamic or structural analysis of fast catamarans belong to shortsea shipping? Is a project on risk analysis in coastal waters a shortsea shipping project? What about projects on integrated ship control, marine propulsion performance, or the analysis of maritime law? Even though shortsea shipping is a multi-disciplinary field, there are no unique answers to these questions, much of which are matters of subjective judgment. This paper is no exception. As in all surveys, the composition of material in this paper is in many ways (although by no means exclusively) a product of our judgment call on what should be included in it and what not.

2) **Lack of information on every conceivable project, paper, or related work:** Much of the material in this paper has been provided to the authors by individuals who undertook the task of collecting such information either for a specific country (eg, Finland or Italy), or for a specific discipline related to shortsea shipping (eg, telematics or ship design). In either case, there is absolutely no way to guarantee that information collected is absolutely complete and up to date. In this paper, this has been manifested by a lack of complete homogeneity of the collected material, some of which is very detailed, and some is very general.

In spite of the above two main difficulties (which will be further elaborated upon in the sections that follow) we feel that the results of this paper are interesting and significant, for at least the following reasons:

a) They represent, to our knowledge, the most extensive array of information on shortsea related work that has been compiled to date. This information can form the baseline for further research in this area.

b) A concrete methodology for indexing, classifying, and further updating this information has been developed, including a user-friendly software package that can be used for entry, retrieval, update, and searches of related material.

c) The material collected shows, in our opinion, a significant degree of "fragmentation" of R&D effort in the SSS field, in the sense that problems that are methodologically similar in many contexts have been typically addressed in isolation. This situation can only be remedied by aggressive dissemination of research results (including those of this paper) and by common fora of discussion of issues among all involved players.
The rest of this paper is organized as follows: Section 2 presents the approach that was followed. Section 3 gives an overview of collected material, broken down by source. Section 4 describes the software. Section 5 draws conclusions. Finally section 6 is a bibliographical list of all collected material.

2 Approach

Work that has been surveyed has focused primarily (but not exclusively) on Europe, and has fallen into at least the following categories:

1. National research programmes or studies, either privately or publicly funded;
2. EU research programmes or studies;
3. Demonstration projects;
4. Technology development projects in related areas (vessel traffic management, telematics, shipbuilding, ship design, cargo handling, etc);
5. Policy studies;
6. Regulatory studies;
7. Any related publication;
8. Other.

2.1 Sources of information

Sources of information for this survey have been the following:

1) Proceedings of European Research Roundtable Conferences on Shortsea Shipping
   Since 1992, these biennial conferences have been the main scientific forum for dissemination of SSS-related research results. All papers presented at these conferences (1992, 1994, and 1996) have been catalogued.

2) Proceedings of International Conferences on Fast Sea Transportation (FAST)
   Since 1991, these biennial conferences have been the main forum on all aspects of fast waterborne transport. By contrast to the SSS conferences (which are European in focus and have a roundtable format), the FAST conference have a worldwide scope and have the traditional parallel session format. This is perhaps the reason that the three FAST conferences to date number close to 300 papers. However, not all of these papers have been catalogued here, since many (in fact most) approach the subject from specific engineering disciplines such as computational fluid dynamics, structural analysis, etc. Although all of these papers have merit, we felt it would serve no meaningful purpose to include them in our survey (in fact, doing so could very well shift the focus away from important issues in SSS). By exercising some judgment, we have identified a number of papers that can be considered to fall into the SSS mainstream, and we have included these papers into our database.
We note here that even though the above two conferences (European SSS and FAST) were the only two conferences that were specifically targeted as sources for this survey, material in other related conferences has also been included, so long as it was brought to our attention. The main vehicle for doing so has been through the concerted action on shortsea shipping, as described below.

3) Concerted action on shortsea shipping

The "Concerted Action on Shortsea Shipping" (task 6.1.2/4) is expected to play an important role in the Commission's Waterborne Transport Research Programme (4th FP). It will do so by setting out the following goals:

- Compiling the state of the art in this (broadly defined) area;
- Synthesizing all relevant research and other related work;
- Monitoring related projects;
- Defining relevant pilot projects and demonstrators;
- Defining criteria for interoperability and SSS logistical efficiency;
- Identifying the key focal points for shortsea shipping future development;
- Providing the widest possible exposure and dissemination of the results of the action.

Representation is open to all EU countries and other countries associated with the research programme (according to the association protocol). As many as 13 meetings are envisaged for the action in the period 1995-1998. The Technical Secretariat of the action is managed by a 4-partner consortium, with the National Technical University of Athens as Coordinator, and with the Alliance of Maritime Regional Interests in Europe (AMRIE), the Institute of Shipping Economics and Logistics (ISL Bremen) and the WEGEMT Association as partners.

Participants of this concerted action (which has held four meetings since June 1995 and plans to hold a workshop in Bergen immediately after the SSS conference) have provided significant input regarding SSS-related research in their countries.

4) Additional sources

The Commission services (DGVII) have provided additional information on related projects. Also, ISL Bremen and WEGEMT have collected additional information related to telematics and ship design aspects. All of this information has been catalogued.
2.2 A two-level taxonomy

In classifying all this material, a two-level taxonomy was used, with the first level providing the "indexing format" by which each entry was catalogued, and the second level providing some additional information on each entry.

First level: The indexing format for each entry is [ABCYRXn], where:

ABC are the first three letters of the first author, in case of a published entry, or the first three letters of the organization responsible for the entry if the latter is a project or study (see also index X below);

YR are the last two digits of the year in which the work represented by the entry was finished (for ongoing projects or for entries for which no year is supplied YR is set to 96);

X is an index defining the type of work, and taking on the following values:

- A for a magazine article;
- B for a book or proceedings volume;
- H for a research or pilot project;
- P for a published paper (in a journal or in a conference);
- S for a study;
- T for a technical report, working paper, or thesis.

Finally n is an index that is present only in case there are two or more entries for which all other indices [ABCYRX] are the same (in which case these entries are distinguished by n = 1, n = 2, etc).

Examples:


It should be realized of course that there might be more than one entry catalogued for a specific piece of work: for instance, one for the project under which the work was done (research project or study), and one or more for publications related to this project. At the same time, not all entries referring to each and every piece of work have been received (or catalogued). Also, the way a specific entry could be classified is not necessarily unique (for instance a research project could
be classified as a study, or as a report). We followed the designations submitted
to us by the contributors of the material, or in their absence, our own judgment.

The indexing scheme described above is the basis of the bibliographical section (6)
of this paper. It is also used in the database management software developed (see
section 4).

Second level: This level provides additional information on the entries submitted
by the concerted action participants, although it can be extended to all other
entries eventually. It is also one of the main features of the database software.
The scheme provides a matrix representation of each entry, with rows indicating
methodological disciplines, and columns indicating SSS objects under study. One
or more boxes that apply can be checked, and the designation of "other" is
clarified as appropriate:

<table>
<thead>
<tr>
<th></th>
<th>Ships</th>
<th>Other technology</th>
<th>Ports</th>
<th>Networks</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineering</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economics/logistics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Business/management</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regulatory/policy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Due to space limitations, it was impossible to reproduce in this paper the matrices
of the material received. However, this information is included in the database
software, and we attempt to give an overview of some parts of it in the section
that follows.

3 Overview of collected material

As of may 10, 1996, the general tally from the collected material is as follows.

<table>
<thead>
<tr>
<th>Source</th>
<th>Number of entries</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSS and FAST conferences</td>
<td>147</td>
</tr>
<tr>
<td>Concerted action participants (by country)</td>
<td>176</td>
</tr>
<tr>
<td>Commission projects</td>
<td>29</td>
</tr>
<tr>
<td>Additional input from WEGEMT (by country)</td>
<td>90</td>
</tr>
<tr>
<td>Total entries</td>
<td>442</td>
</tr>
</tbody>
</table>

All collected material is listed in Section 6. Here we attempt to highlight some
important features of this material, realizing that presenting a detailed analysis of
such a large number of entries is an impossible task (suffice it to realize that
presenting the matrix representation of the entries collected would entail increasing the size of this paper to more than 200 pages!). Equally difficult is any attempt to sort out the forest from the trees, identify trends, methodological gaps, or possible research overlaps within this vast collection. Therefore we stress that the material of this section is, by necessity, imperfect.

3.1 SSS and FAST conferences

We have little to add to the results of the two previous European Roundtable SSS conferences (references [WIJ93B] and [WIJ95B]), and, a fortiori, to the results of the current one. Collectively, about 80 papers have been presented, spanning the entire spectrum of SSS related topics. Reference [PEE94P] does a good job of reviewing the previous two conferences from the perspective of a European SSS policy. The active participation of the European Commission (DGVII) and the mix of maritime researchers and maritime policy makers in these events contributed to a sharp focus on relevance of research as regards actual implementation of technologies, practices and policies.

The material of the three FAST conferences is far more extensive. In spite of (or maybe because of) a rather specific focus on the object of study (the fast ship), the perspective of these conferences has not been very helpful in sorting out the strategic ramifications of these technologies, both in general terms, and as regards shortsea shipping in particular. The (about 70) references we selected for inclusion in this survey are representative of papers that are (in our judgment) mostly SSS-related. Many of them are from outside Europe. In fact, it is interesting to note that the Yokohama conference (FAST’93) contributed about 30 of these papers, which is more than its expected share. Whether this difference is "statistically significant" or whether it is due to a different attitude of non-Europeans on the subject of fast ships is subject to speculation.

3.2 Input from concerted action participating countries

The contributions of the fourteen (14) countries participating in the concerted action merit some more extensive discussion. These are all EU member states except Luxembourg and Austria, plus Norway. A first feature of the collected material has been its volume. At the time of the writing of this paper, 176 entries had been received, not counting some entries that had to be suppressed (for reasons see below).

A second feature of the material was lack of complete homogeneity. In spite of a standardized solicitation for input, the following have been observed:

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1The UK joined the concerted action in the spring of 1996 and no "official" contribution from it has been received. However, the UK section is not empty, representing input submitted by WEGEMT (see section 6.7.10).
Some countries submitted many more entries than others;
Some countries provided detailed information on their entries, whereas others provided much fewer details;
Some countries submitted entries in their own language (other than English). Such entries have been temporarily suppressed from our database (and will remain so until an English translation can be obtained);
Some countries submitted as entries mostly studies or projects, others submitted mostly publications, and others submitted a mix;
Finally, some countries submitted some entries that fall on the periphery of SSS, addressing detailed technical problems, such as ship resistance, seakeeping, etc. These entries are similar to some of the entries of the FAST conferences that we decided to suppress. However, and by contrast to conference material, we decided not to suppress on the basis of subject any of the entries submitted by individual countries. All of these entries are part of our database.

Other than feedback to the contributors for clarifications (eg "please translate" or "please provide this again in the appropriate format"), it has been outside the scope of our own work to fill out possible gaps of information that exist in the submissions, extensively reformat them, translate them, or generally undertake a deeper search of information about the material. A reasonable assumption has been that ensuring an appropriate representation of a country within the European state of the art in SSS research falls within the responsibility of the nominated representatives of that country.

With these clarifications, the following can be said very briefly about the country-by-country submissions:

**Belgium**
Most Belgian submissions are in the economics, logistics and policy areas, and mainly study ships, cargoes, and ports. Among them, we highlight a study of the connection between Zeebrugge and Leixões (Portugal) by [AHL95S], a research project on cargo tracing [WES95H], and some policy studies on ports [POL96S] and logistics [POL95S].

**Denmark**
A list of published reports on shipping was submitted by Denmark, mainly covering topics such as deregulation [DER95T] and transport policy [TRA93T, DTP93T, EUT93T]. A report on the future of the coaster [FUT91T] is also included.

**Finland**
Some papers on ship resistance [LAH91P, HAN95P] and seakeeping [KAR95P] are identified. There are also many entries on economics and logistics [VAI90H, VAI94T, VAI92T], and several entries on innovative ship designs [NII91P, NII94P]. Some papers that are included in FAST conference entries [LEV92P, LEV93P] are not included in this list.
France
France submitted a general discussion paper on a new approach to SSS [FRA95T], and two proposed studies/projects, one on the concept of Sea/River Road [SRR95S] (an extension of the all-Road and Sea/Road transport), and another on the impact of time delays due to road congestion and restrictions [ITD95T]. The main view in these documents seems to be that inland waterway shipping should be promoted as a means to alleviate congestion and aid SSS. Some entries on the "Arc Atlantique" project have also been submitted.

Germany
Entries refer to the SUMO study (scenario investigation of maritime transport systems in the Baltic) [ATL94P], and to some economics/logistics studies related to SSS [ZAC91S, HAD95S, KRA95S]. A large number of entries submitted in German (computerized list from Ministry of Transport) were suppressed as it was impossible to obtain a translation in spite of several solicitations to that effect.

Greece
As expected, studies or projects on Greece's coastal system [IMP95S, PRA95S, DRO93S, NTU94S, PSA94A] are predominant. Some of this work, including a modal split analysis for 2004, the year of cabotage deregulation, has been presented at the SSS conferences (and is not repeated in this list). Also studied heavily is the connection with Italy [COM94H, TRA93S, SCH95T].

Ireland
Ireland's submissions are diverse, spanning areas that include unitized cargoes [TRA94S], ship design [TRA95H, KEN92T], vessel traffic services [RVT95S], casualty database [TRA95H2], passenger transport [COL91S], and ports [COL91H].

Italy
Two large-scale "umbrella" projects stand out in Italy's list. The first is a multi-year national project on transport, all modes included [BIA92H]. The second is BRITE-EURAM's "Targeted Research Action" on new ship concepts in shortsea shipping, also known as TRA-NESS, which is coordinated by Italy [TAR95H]. It consists of several multinational projects spanning a spectrum of advanced engineering problems related to fast surface-effect ships/SES.

The Netherlands
The spectrum of projects considered is very broad, covering subjects such as intermodal transport [SSS93S1], feeders [DGS93S, ROT91H], shift of cargo from road to sea [H0091H, DGS90H], ports [BUC94T1], policy issues [BAG94T], and telematics [DGS95T1, T2, T3].

Norway
These include a multiyear national programme on SSS [MAR98H], programmes on fast marine vehicles and ships of the future [MAR97H, KVA96H], a programme on "green" ships [DNV94H], and an umbrella programme on maritime information technology (the so-called MiTS system) [MAR93H]. Some entries in the
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Economics and logistics area were also submitted ([NOR95P, STR94P, WER95T], among others).

Portugal
Transport between Leixões and Zeebrugge [POR93H], and between mainland Portugal and the Azores [MAU91S, CAR92S1, S2] are included in the Portuguese list. Some port navigation systems are also listed [GAM95S, IHN95H].

Spain
Of particular emphasis are studies on maritime cabotage [PEE93S, CAR92S, MER94S, CON93S1], and ports [CON93S3, GOM95P]. Some "engineering" entries have been also submitted, on topics such as ship design [SIE95P, SIE93P, MOR93P] and (interestingly enough) propeller performance [PIR94P1, ZAT92A].

Sweden
Innovative loading and intermodal systems [WIJ94S, LUM93S, SJO90S2], feasibility studies [SJO93S], and general SSS studies [ALE94H, SJO95H] are highlighted.

3.3 European Commission projects

The projects catalogued fall into 4 categories: DG VII 4th FP projects, DG VII studies (sponsored by Directorate D and generally dealing with policy issues), DGXIII (telematics) 4th FP projects, and DGXII (BRITE-EURAM) projects. The 29 entries included here span a diverse spectrum, from "hard-core" engineering research all the way to "policy/regulatory" studies.

It is interesting to note that projects examining problems that appear, at least at first glance, very similar, have been launched in parallel in different DG's (some port projects in DG VII and DGXIII are examples). The official position of the Commission is that such projects are complementary, with each Directorate General looking at a problem from its own perspective (for instance, the DGXIII mostly focusing on the telematics infrastructure of a port, whereas the DG VII is mostly focusing on policy implications).

However, it is still not clear to what extent this will be followed strictly, or what overlaps may exist within such projects. Most of these projects are just under way in the context of the 4th FP, so it is still early to make an assessment of them. The concerted action on SSS will monitor these projects and try to identify overlaps, gaps, or other synergies among these projects.

3.4 Input from WEGEMT

WEGEMT, one of the 4 partners of the consortium managing the concerted action on SSS, submitted an impressive collection of material, broken down by country, on projects and publications focusing on the engineering side of SSS. All of this
material has been catalogued, and in a sense should be viewed as complementary to the material of section 3. 2. However, a word of caution is necessary. It is our opinion that some of these entries are outside the mainstream of SSS, addressing detailed technical problems, such as ship resistance, seakeeping, hydrodynamics, ship structural analysis, etc. This is particularly true for entries submitted by Italy and the UK. Still, as some of the other entries (eg, those of Germany) fall clearly within the realm of SSS, following our policy to avoid suppressing material directly supplied, we included all entries in this paper for the sake of competeness. Finally, it is interesting to note that all of Norway's WEGEMT entries are covered in the list submitted by Norway's representatives in the concerted action.

4 Software model

As soon as this extensive material started coming in, we quickly realized that there was a need to find an easy way to handle all this available information. The creation of an integrated dBase program became indispensable, in order to enter, update, and retrieve easily the collected data and extract statistics and reports fast and securely.

It was not an easy task to choose the most suitable package among all the available in the software market. We decided that the package should fulfill the following criteria:

- Compatibility with as many as possible other software packages, and capability of data interchange among several software environments;
- Friendly and smart interface between the user and the machine;
- Capability of upgrade from time to time, so all this information can be useful in the future.

Based on the above, we decided to use Microsoft's FoxPro v2.61 because of previous experience with this package and FoxPro's ability to provide communication with all major operating environments: Windows, DOS, UNIX and Macintosh. The database is formatted and constructed in a way that allows the user to import data of another format and retrieve it via its own interfaces. It is a usual practice to input data with a "drag and drop" way.

A typical screen is shown in Figure 1. It contains buttons which allow the user to enter, preview, and edit data, and print ready-to-use reports. There is an effort underway to create popup menus so there will be less buttons in the screen and also an effort to create new queries and report types.
5 Concluding remarks

This paper described an effort to compile and classify material related to shortsea shipping research. A two level taxonomy and a software model were developed, with the purpose to facilitate information entry, update, retrieval, and search. We believe that this scheme can form the infrastructure for a permanent update of knowledge on the status of research activity in this area. It can also form the baseline for further research, by helping identify what has been done, what gaps exist, and what possible overlaps can be avoided. Last but not least, it can facilitate the critical activity of dissemination of research results, a process that is recognized to be far less perfect than desirable.

Toward that end, we believe that the taxonomy developed in this paper, as well as the observations made in it, can be useful to a number of players in the field, such as:
- The SSS and waterborne transport research community;
- The waterborne transport industry;
- Maritime policy makers;
- National R&D agencies;
- The European Commission.

Venturing a first observation from the material collected, it is fair to say that research in this area has been growing at a very strong rate, at least within the
last 6 years or so. It is interesting to note that most of the research being done is still at the national level. However, an important trend seems to be taking place: this is the inclusion of SSS-related research into European Commission R&D programmes (mainly that of the DG VII, but also those of the DG XII and DG XIII). This trend is only recent, and mainly concerns the 4th Framework Programme. It is undoubtedly a reflection of the priority the Commission attaches to SSS, as a tool for the development of the Common Transport Policy. It is clear that events such as the Roundtable Conferences have played a key role in identifying the need for more research in this area.

Some related European Commission initiatives, such as the "Task Forces" on topics such as "Transport Intermodality" and "Maritime Systems of the Future" are expected to further add to the momentum in this area.

Since most of these activities are just starting, it is too early to make an assessment of their potential impact on real world SSS technology, practice, and policy. However, one of their potential contributions is worthy of discussion.

Looking at the material collected, one can observe that, with few exceptions, a significant degree of fragmentation exists, and this is essentially across country lines. As one example (and there can be many others), topics such as cabotage that have been studied mostly in Spain and Greece have been studied essentially in isolation, even though it is clear that much in common exists. The same can be said about other topics, such as ports. Lack of aggressive dissemination of research results, or of common fora in which such results are presented are the main causes for such a state of affairs. Although such fora do exist, clearly more can and should be done, particularly at the end-user level, which where the greatest degree of fragmentation exists.

The most obvious consequence of this fragmentation is that the impact of R&D efforts to serve the real needs of European SSS has been so far limited. There is certainly significant room for improvement in that regard, but as long as this fragmentation continues, the potential impact will likely continue to be low and diluted.

It is precisely one of the roles of collaborative R&D efforts such as those sponsored by the European Commission to help alleviate this situation. These collaborative projects are expected to reduce the risk of further fragmentation, by bringing together partners from several countries and by cross-fertilizing ideas both from the research end and from the maritime industry end.

An implicit assumption is of course that fragmentation does not spread to the EU projects too. In our opinion, a risk that is clearly present is that each Directorate General of the Commission that deals with Transport Research proceeds independently of what the others are doing. As at this point in time there are several DG’s dealing with Transport Research, either directly, or indirectly (DG VII, DG XII, DG XIII, DG III, among others), there is a clear need for internal Commission coordination of such R&D activities.
Although from an SSS researcher’s viewpoint the funds allocated to SSS (as a percentage of the Commission’s total transport R&D budget) can still be considered low, the fact that such funds practically did not exist a few years ago is certainly encouraging. Activities such as the Roundtable Conferences, the Concerted Action on SSS, and others, are expected to further maintain the focus on this important topic, so that SSS obtains a share equivalent to its overall importance in European transport.¹

6 Bibliography

The bibliographical section is organized in the following way:

6.1 Conferences;
6.2 Input from concerted action participating countries;
6.3 DGVII 4th FP projects;
6.4 DGVII/D studies;
6.5 Telematics projects;
6.6 BRITE-EURAM projects;
6.7 Other input from WEGEMT (listed by country).

6.1 Conferences

Catalogued below are all papers from the European Research Roundtable Conferences on Shortsea Shipping (1992, 1994, and 1996²) and SSS-related papers from the FAST conferences (1991, 1993, and 1995).

Further to the indexing scheme [ABCYRXn] defined earlier, the following acronyms are used:

ESSS’96: Third European Research Roundtable Conference on Shortsea Shipping (Shortsea’96), Bergen, Norway, 1996.

¹Acknowledgment: The work of this paper was supported in part by the Commission of the European Communities, Directorate General for Transport (DGVII), within the context of the “SSS-CA” concerted action (Waterborne Transport Research, 4th FP). The assistance of several individuals in providing input is gratefully acknowledged. In addition to the contributors listed within the paper, special gratitude is due to Prof. A. Papanikolaou and Mr. J. Grant of WEGEMT for providing input on ship design/engineering research, to Prof. V. Speidel of ISL Bremen for providing input on telematics research, and, last but not least, to Dr. J. L. Anselmo and Ms. A. Schlewing of the DG VII for their input and administrative assistance.

²Included are all papers as listed in the preliminary programme of the conference. Revisions of the programme after May 10, 1996 are not included.

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Section IV - Forecasting, Logistics and Safety


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<table>
<thead>
<tr>
<th>Reference</th>
<th>Description</th>
</tr>
</thead>
</table>
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6.2 Concerted action participating countries

The list of entries, broken down by source, follows (contributors are in parentheses).

6.2.1 Belgium (C. Peeters, H. Smitz)

the Commission of European Community, Directorate General for Transport.


6.2.2 Denmark (E. Styhr Petersen)


Research in Shortsea Shipping: The State of the Art


6.2.3 Finland (J. Vainio, J. Sukselainen)


[VAI90H] Vainio J., (1990), Knowledge Based Methodology for Simulation of Intermodal Transport Terminals, Research, University of Turku, Center for Maritime Studies.

[VAI93H] Vainio J., (1993), MULTIMOD: the system for Simulation Modelling of Seaports and terminals as logistics centers in Intermodal freight transportsimulation in logistic planning, Research, University of Turku, Center for Maritime Studies.
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6.2.4 France (M. Abeille, G. Tourret, E-L. Melenec)

[ITD95S] Impact of idle time and delays due to road congestions and restrictions, (1995), proposed study in the context of SSS promotion.
[LEC95S] Lecoq S., Chevance A., (1995), Prospective Study into the development of dry bulk traffics to, from and within the Atlantic Arc of Europe, Study.
[SRR95S] SeaRiver Road as an alternative and an extension to all Road or SeaRoad Transport, (1995), proposed study in the context of SSS promotion.

6.2.5 Germany (I. Harre, V. Speidel)

[KRA96S] Kramer, H., (1996), A feasibility study for a market-supply-concept in SSS on identified relations within Northern Europe/Germany/Western Europe with the consideration of shift potentials. Study for the German Transport Ministry.
Research in Shortsea Shipping: The State of the Art


[ZAC96S] Zachcial, M., (1996), Simulation-project with a transport modelling on shifting effects in SSS. Study for for the German Transport Ministry.

6.2.6 Greece (S. Papadimitriou, H. Psaraftis)

[COM94H] Combimare, ADK Consulting Engineers, and Triton Consulting Engineers (1994), Greece - Italy - Germany Multimodal Freight Transportation Corridor. Pilot Project, sponsored by CEC.


[FRE95S] Frederic Harris, (1995), Short -Sea Shipping / Greek Case Study. Sponsor: CEC DGVII.


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[TRA93S] Trademco Consultants, (1993), Pilot Action for a Pilot Operation of RoRo ships between NAVIPE (Gr) and Italy. Study sponsored by the Hellenic Industrial Development Bank (ETBA).

6.2.7 Ireland (V. Kenny)


Research in Shortsea Shipping: The State of the Art


6.2.8 Italy (C. Camisetti)


[TAR94H] Targeted Research Action TRA-NESS: New Ship Concept on the framework of Short Sea Shipping, Coordinator CETENA Spa, sponsored by EU DGXII.


6.2.9 Netherlands (R. Bagchus, S. Winkel)


[BUC94T1] Shortsea transport, a product of the port of Rotterdam and four Northwest-european competitors , (1994),Report by AVV; Buck.


[DEJ93P] deJong, M. (1993); From home-trade to ocean-going trade (in Dutch), Maritime Journal 1993, pp. 73-82.

[DGS90H] DGSM, NEA, and MERC, (1990), Potential shift of cargo from road to sea (in Dutch), National Research.


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[GRO93H] "Groene Golf": final survey, trial shipping line, project Trade-routes (1993), Research by DGSM, MST, MERC, HARRIS.


[ROT91H] Short Sea shipping lines and feeder services: between Rotterdam and European Ports, (1991), Port of Rotterdam, Research.

[SSS93S1] Shortsea shipping in intermodal transport: start of a campaign by DST Educatieve Communicatie, DGSM (1993), Study.


6.2.10 Norway (A. Minsaas, J. Mohr)


6.2.11 Portugal (H. Cid, M. Ventura)

[CAR92S1] Carichas E., (1992), Evaluation of Costs for Sea Container Cargo System Between Azores Islands and Mainland, Study conducted by RINAVE and sponsored by the Azores Regional Secretary of Transports and Communications.

[CAR92S2] Carichas E., (1992), Study on Sea Transport for General Cargo in Azores Islands, Study conducted by RINAVE and sponsored by the Azores Regional Secretary of Transports and Communications.


[MAU91S] Mauricio E., (1991), Study of Sea Transport for Petroleum Liquid Products in Azores Island, Study conducted by RINAVE and sponsored by the Azores Regional Secretary of Transports and Communications.

[POR93H] PORTLINE Transportes Marítimos Internacionais (1993), PORTRAILER - Ship Transportation of Trailers Between the Ports of Leixões/Portugal and Zeebrugge/Belgium. Research, self-sponsored.

[QSD95H] Quick Ship Dispatch Centers, Project developed in the port of Sines.


6.2.12 Spain (G. de Melo, M. Carlier)


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[ZAT92A] Zatarain, G. (1992), Experience with retrofitting CLT propellers. Published in "the Motor Ship".
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6.2.13 Sweden (A. Sjöbris)


LUM93S] Lumsuden, K. (1993), System development of standardised unit load carrier for sea, road and rail transport. Study sponsored by the Transport Foundation (Transportstiftelsen VTS), Western Sweden Chamber of Commerce.

ROB90S] Robertson, H., (1990), Mechanised mooring. Pre study, MARITERM AB. Sponsored by the Swedish Transport Research Board (TFB).

SJO90S1] Sjöbris, A., (1990), Coastal and SSS. Pre study, MARITERM AB. Sponsored by the Swedish Transport Research Board (TFB).

SJO90S2] Sjöbris, A. (1990), Integration of cargo units between railway and shipping. Pre study, MARITERM AB. Sponsored by the Swedish Transport Research Board (TFB) and the Swedish State Railway (SJ).


6.3 DGVII 4th FP projects

ASD96H] Project "ASDSS": Analysis of supply and demand of shipping services.

BOP96H] Project "BOPCOM": Baltic open port communication system.

EB096H] Project "EUROBORDER": Identifies bottlenecks, develops functional specifications and proposes demonstrators to improve the ports' function as intermodal hubs.


EMM96H] Project "European Marine Motorways": The potential for transferring freight from road to high speed sea transport.

IPS96H] Project "IPSI": Improved port-ship interface.
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[SPH96H] Project "SPHERE": Small/medium sized ports with harmonised, effective re-engineered processes.

[SSS96H] Project "SSS-CA", concerted action on shortsea shipping.

6.4 DGVII/D studies


[INT96S] Intermodal European Logistic Center, Short sea shipping pilot project German North Sea - Nordic countries / Western and Southern Europe.


6.5 Telematics projects (input provided by V. Speidel on behalf of ISL Bremen)


[LOC96H] LOCALE (1996), Low Cost Applications for Linking EDI, Project of the Commission of European Community, MARIS Programme, DG VII.

[MUL96H] MULTITRACK (1996), Tracking, tracing and monitoring of goods in an intermodal and open environment, DGXIII project, 4th FP.

[POS96H] POSEIDON (1996), DGXIII project, 4th FP.

[TIL96H] TILEMATT (1996), DGXIII project, 4th FP.

[VAD96H] VADE MECUM(1996), DGXIII project, 4th FP.

[WEL96H] WELCOM (1996), DGXIII project, 4th FP.

[WIS96H] WISDOM (1996). Waterborne Information System Distributed to Other Modes, DGXIII project, 4th FP.
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6.6 BRITE-EURAM (DGXII) projects (input provided by A. Papanikolaou and J. Grant on behalf of WEGEMT and by C. Camisetti on behalf of the TRA-NESS targeted research action)


6.7 Other input from WEGEMT (ship design/shipbuilding/ engineering projects or publications; input provided by A. Papanikolaou and J. Grant and arranged by contributing country)

6.7.1 Belgium

[TRU96H] Truijens P., Preliminary design of a low profile coaster, Research (privately founded), U.Gent.

6.7.2 Denmark


[DES96H] Design of a Harbour ferry, Research, Technical University of Denmark (DTU).

[WAV96H] Wave-induced hydroelastic response of fast mono-hull ships, Research, Technical University of Denmark (DTU) and Danish Technical Research Council (STVF).

6.7.3 France


[H0094H] Hoof van R.W., (1994), Project Trimaran High Speed Ferry, Research.

[LAN95H] Lancelot E., (1994), Feasibility study for the route Marseilles to Barcelona by a fast marine transportation system (in French), Research.

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6.7.4 Germany

[BMB94H] BMBF, STN, ISSUS, (1994), BV scenarios: Maritime Transport systems for the Baltic Sea (in German), Research, BMBF.
[ENG95H] Engelkamp, (1996), Inland water transport between North Spain and Duisburg (in German), Research, German Ministry for Research and Technology.
[LIN90S] Linde, H. (1990), Analysis of the German and European shortsea shipping system, Study, German Ministry for Research and Technology.
[MUE96H] Mueller, E. (1996), Development of a large sea-river ships with limited draft (in German) 4 projects, Research, German Ministry for Research and Technology.
[PUS94S] Pusch, (1994), Protection of the local conditions for the maritime industry in Germany (in German), Study.
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6.7.5 Greece


[PAP96H] Papanikolaou, A., N. Daphnias, (1996), Development of the 80m LOA catamaran passenger car ferry SUPERCAT HAROULA, Project, ALPHA MARINE Ltd.


6.7.6 Italy


All entries provided are already covered in section 6.2.10.
Section IV - Forecasting, Logistics and Safety

6.7.9 Spain

[ROU95H] Optimizing routing system for the advanced design cruiser ship (1995), Research, Spanish Administration (CICYT), managed by the CDTI.

[VTS95H] Implementation of the VTS in the Spanish coast (1995), Project sponsored by the Spanish Transport Department, Maritime Administration.

6.7.10 United Kingdom

[BUR96H] Burns, R. S., G. N. Roberts, M. M. Pourzanjani. Modelling and control of small vessels, Research, EPSRC (MTD), Marinex, Polytechnic South West.


[PRI96H] Price, W. G., R. A. Shenoi, P. Temarel, Design of aluminium structures subjected to high frequency, high cycle loadings, Research, EPSRC (MTD), Vosper Thornycroft, FBM Ltd, Southampton University.


[DOV96H] Dove, M.J., C.T. Stockell, R.S. Burns, A navigation and collision avoidance system for marine vehicles, Research, EPSRC (MTD), Kelvin Hughes, WS Atkins, University of Plymouth.


[MOL96H1] Molland, A. F., The development of improved techniques for the prediction of ship rudder performance characteristics, Research, ESPRC (MTD), MoD, Southampton University.

[BET96H] Bettess, P., P. Sen, J. B. Caldwell, Development of intelligent knowledge-based design systems for marine technology, Research, EPSRC, Newcastle University.

[HOR96H1] Horsley, M.E., Modelling of fires in steel ships and offshore structures, Research, EPSRC (MTD), Portsmouth.
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[THO96H] Thompson, J. M. T., Safe transient basins: a new tool for designing against capsize, Research, EPSRC (MTD), University College London.

[CAL96H] Caldwell, J. B., M. Pawlowski, Development of knowledge-based design systems for marine technology - ship safety, Research, EPSRC (MTD), Newcastle University.

[FAI96H] Fairlie-Clarke, A. C., I. E. Winkie, Construction of hydrodynamic lifting surfaces, Research, EPSRC (MTD), Brown Brothers, Glasgow University.

[SEN96H] Sen, P., M. J. Downie, Voyage management using parallel processing, Research, EPSRC, Newcastle University.

[HOR96H] Horsley, E., Modelling of fires in steel ships and offshore structures, Research, EPSRC (MTD), Portsmouth University.


[FAN96H] Fan, M., Fluid impact loading on wedge-shaped bodies, Research, Strathclyde University.


[ATK96H] Atkins, A. G., The tearing of ships' plating upon grounding, Research, EPSRC (MTD), MoD, University of Reading.


[SHE96H] Shenoi, R. A., Assessment of damage tolerance levels in FRP ships' structure, Research, EPSRC (MTD), MoD, Southampton University.


[VAR96H] Varyani, K. S., A. Incecik, A theoretical and experimental investigation of the hydrodynamics of a manoeuvring ship in deep and shallow water, Research, EPSRC (MTD), Glasgow University.
[HEA96H] Hearn, G. E., A theoretical and experimental investigation of the hydrodynamics of a manoeuvring ship of deep and shallow water, Research, EPSRC (MTD), Newcastle University.

[VAS96H] Vassalos, D., Ship capsizing in severe following/quartering seas by broaching-to (Visiting Fellowship), Research, EPSRC (MTD), Strathclyde University.


[ROB96H] Roberts, G. N., J. Davis, Advance control strategies for motion control of vessels, Research, EPSRC (MTD), MoD, RNEC Manadon.

[VAS96H] Vassalos, D., Ship capsize in severe following/quartering seas by broaching-to: a dynamical systems approach, Research, University of Strathclyde.
AN ANALYSIS OF SERVICE ELEMENTS FOR FERRY NETWORKS

By H. Heijveld and R. Gray

The objective of the paper is establish the importance of the different service elements and who should provide them in a passenger car ferry service network.

The study is based on international and domestic ferry services provided in Ireland, United Kingdom, France, Spain, and Portugal in the European region known as the Atlantic Arc.

The ferry service offer, as perceived by customers, is the provision of different service elements by port authorities, port operators, ferry operators, local and regional governments, and independent third party operators. This service offer is not just the ferry crossing, but effectively consists of a ferry network, which includes service elements such as reservations, road and rail access to the ferry port, the ferry port facilities and terminal, the ferry and on-board facilities and services, and exit infrastructure for onward travel by car, public transport, or train.

The study, based on data collected from ports, ferry operators, and regional government, shows the preferences of significant decision makers in providing a total network for ferry passengers and the various providers' perceived importance of specific parts of this network.

The ferry service offer network.

The user of the ferry service is offered a number of facilities and services by different providers, normally ports, regional governments and ferry companies. The main components of this 'total ferry experience' are pre-booking, booking, access to the ferry terminal at the port of departure, the ferry terminal facilities and services, the ferry crossing, and the continuation of the voyage at the port of arrival (exit). The ferry service offer network and its main components are shown in Figure 1.

Using these components, a questionnaire was designed to obtain the views of companies or organisations providing the various elements of the ferry service offer: the importance and preferred providers of on-board facilities and services, and of ferry terminal facilities and services. A survey was conducted to establish which of the components are important to the different providers, and who should provide specific facilities and services. This study extends previous research into the ferry service offer (see: Heijveld and Gray, 1993).

Data collection.
The target population consists of ferry service providers located and operating between the United Kingdom and Ireland, France, Spain and Portugal. This provided a sampling frame of 31 ferry operators, 98 ports and 23 regional governments. Data collection was carried out as part of an 8-page postal questionnaire sent to the target response group. The overall response rate was about 25%, which is typical for business surveys and is acceptable given the length of the questionnaire.

Data Analysis.

Data analysis derived an importance score for each component of the ferry service offer, based on the aggregate importance ratings of the service elements of the component. For example, the prebooking component consisted of two service elements (advertising the service and providing route information). Thus, in table 1, 73.1% of responses from ports rated prebooking elements as very important, and 76.9% of port responses considered that prebooking elements should be undertaken by ferry operators. Booking was measured by three service elements: reservations, issuing tickets, and the keeping of passenger and cargo lists. Access to the ferry terminal at the port of departure and exit of the terminal in the port of arrival were measured by four service elements; sign posting, road-, rail-, and bus-links. As these elements
An analysis of service elements for ferry networks

enable both access and exit this ferry service offer component was renamed infrastructure. The ferry terminal was measured by twelve different service elements. Upon initial analysis these were split in two groups of seven and five service elements respectively. The first group was renamed basic terminal facilities comprising terminal buildings, terminal waiting area, security, baggage, restaurants, cafeteria, and linkspans. The second group, renamed special terminal facilities, was measured by the service elements of special facilities for children, disabled, business travellers, lorry drivers, and motorists. The ferry component was also upon initial analysis divided in basic and special on-board ferry facilities and services. Basic on-board facilities were measured by the service elements of shops, restaurants, and bar. The special on-board facilities were measured by the swimming pool, cinema, casino, and health club/spa.

Results and Findings.

Analysis of the service component of prebooking (see Table I) shows that advertising the ferry service and providing route information is considered very important and that the ferry operators should provide these elements.

Only a limited number of responses from port operators indicated that they should provide prebooking services. An important point for further investigation is whether the ferry user, when making initial contact with the industry, identifies with a ferry company (which is the perception of the industry) or with a port/route, or whether there may be two significant market segments, one segment identifying with ferries and one with routes or ports.

Booking

The responses to the booking component of the ferry service offer are shown in Table II. Most groups agree that the booking service elements should be provided by ferry operators as well as perceiving them to be important. Port respondents were, unlike the ferry operators and the regional governments, also of the opinion that passenger and cargo lists should be kept by the port authority or port operator, suggesting that they felt responsible to collect this information for both safety and commercial reasons.

Infrastructure

Questions about the infrastructure component provided mixed responses from the different groups. The majority of the ferry operators felt that the government should be the provider of these service elements, but some indicated that the infrastructure should be provided by the port authority or private third parties. The regional governments do not perceive port authorities, port operators, or ferry operators as providers of infrastructure, but the ports identified a wider range of possible providers of infrastructure.
### Prebooking

Preferred providers and perceived importance according to Ports, Regions and Ferry Operators by number of responses and rating score (out of 100)

<table>
<thead>
<tr>
<th>According to</th>
<th>To be provided by</th>
<th>++</th>
<th>+</th>
<th>O</th>
<th>-</th>
<th>--</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>26 Ports</td>
<td>Port Authority</td>
<td>4 (7.7)</td>
<td>1 (1.9)</td>
<td></td>
<td></td>
<td></td>
<td>5 (9.6)</td>
</tr>
<tr>
<td></td>
<td>Port Operator</td>
<td>29 (56)</td>
<td>8 (15.4)</td>
<td>3 (5.8)</td>
<td></td>
<td></td>
<td>40 (76.9)</td>
</tr>
<tr>
<td></td>
<td>Ferry Operator</td>
<td>5 (9.6)</td>
<td>2 (3.8)</td>
<td></td>
<td></td>
<td></td>
<td>7 (13.5)</td>
</tr>
<tr>
<td></td>
<td>Government</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Private Third Party</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Combination</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>38 (73)</td>
<td>11 (21)</td>
<td>3 (5.8)</td>
<td></td>
<td></td>
<td>52 (100)</td>
</tr>
<tr>
<td>4 Regions</td>
<td>Port Authority</td>
<td>2 (25.0)</td>
<td>3 (37.5)</td>
<td></td>
<td></td>
<td></td>
<td>5 (62.5)</td>
</tr>
<tr>
<td></td>
<td>Port Operator</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ferry Operator</td>
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</tr>
<tr>
<td></td>
<td>Government</td>
<td></td>
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<tr>
<td></td>
<td>Private Third Party</td>
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<td>Combination</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>4 (50.0)</td>
<td>4 (50.0)</td>
<td></td>
<td></td>
<td></td>
<td>8 (100)</td>
</tr>
<tr>
<td>7 Ferry</td>
<td>Port Authority</td>
<td>11 (78)</td>
<td>2 (14.3)</td>
<td>1 (7.1)</td>
<td></td>
<td></td>
<td>14 (100)</td>
</tr>
<tr>
<td>Operators</td>
<td>Port Operator</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ferry Operator</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Government</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Private Third Party</td>
<td></td>
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<td></td>
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<tr>
<td></td>
<td>Combination</td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>11 (78)</td>
<td>2 (14.3)</td>
<td>1 (7.1)</td>
<td></td>
<td></td>
<td>14 (100)</td>
</tr>
</tbody>
</table>

++ = very important  
+  = important  
O  = Neutral  
-  = unimportant  
-- = very unimportant

**Table I: Prebooking**
An analysis of service elements for ferry networks

<table>
<thead>
<tr>
<th>According to</th>
<th>To be provided by</th>
<th>++</th>
<th>+</th>
<th>O</th>
<th>-</th>
<th>--</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>26 Ports</td>
<td>Port Authority</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td></td>
<td></td>
<td>2 (2.9)</td>
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<tr>
<td></td>
<td>Port Operator</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td></td>
<td></td>
<td>3 (4.3)</td>
</tr>
<tr>
<td></td>
<td>Ferry Operator</td>
<td>47</td>
<td>7</td>
<td>2</td>
<td></td>
<td></td>
<td>56 (81.2)</td>
</tr>
<tr>
<td></td>
<td>Government</td>
<td></td>
<td>7</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Private Third Party</td>
<td></td>
<td>3</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Combination</td>
<td>5</td>
<td>3</td>
<td>2</td>
<td></td>
<td></td>
<td>8 (11.6)</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>56</td>
<td>11</td>
<td>2</td>
<td></td>
<td></td>
<td>69 (100)</td>
</tr>
</tbody>
</table>

|               | Port Authority    | 5  | 4 | 1 |   |    | 9 (81.8) |
|               | Port Operator     |    | 4 | 1 |   |    |       |
|               | Ferry Operator    | 15 | 4 | 1 |   |    | 19 (90.5) |
|               | Government        |    |   |   |   |    |       |
|               | Private Third Party|   | 2 | 1 |   |    |       |
|               | Combination       |    | 2 | 1 |   |    | 2 (18.2) |
|               | Total             | 17 | 4 | 1 |   |    | 21 (100) |

++ = very important  
+ = important  
O = Neutral  
- = unimportant  
-- = very unimportant

Table II: Booking
Section V - Papers not discussed at the Conference

### Table III: Infrastructure - Access/Exit

**Preferred providers and perceived importance according to Ports, Regions and Ferry Operators by number of responses and rating score (out of 100)**

<table>
<thead>
<tr>
<th>According to</th>
<th>To be provided by</th>
<th>++</th>
<th>+</th>
<th>O</th>
<th>-</th>
<th>--</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>26 Ports</strong></td>
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++ = very important  
+ = important  
0 = Neutral  
- = unimportant  
-- = very unimportant
Ferry Port Terminal

The facilities and services provided at the ferry port terminal have been divided into basic facilities (see Table IV) and special facilities (see Table V).

The basic facilities and services are the terminal buildings, the terminal waiting area, terminal security, baggage handling, restaurants, cafeteria, and linkspans. Basic terminal facilities and services should, in the main, be provided by the port authorities (according to ports and ferries), or the port operators (according to regions). The preference for private third parties (for providing restaurants and cafeteria) was indicated by some port and ferry respondents.

There was complete agreement on the importance of linkspans by both the regions and the ferry operators, but no such agreement was found to exist when identifying the preferred provider. One port and one ferry operator indicated that the ferry operator should provide the linkspan.

All other port and ferry respondents gave the port authority as the preferred provider followed by the port operator. Three port respondents preferred a combination of providers, as did two regional governments. The ferry port terminal special facilities to be provided for children, disabled people, business travellers, motorists, and lorry drivers are generally seen as important, although a smaller number of respondents rates them as neutral, and a few as not important. Interestingly, a significant number of respondents prefer the ferry operators to provide these terminal facilities and services, in contrast to basic facilities. The majority, however, favour the port authorities or the port operators as providers.

The ferry crossing.

Facilities and services to be provided during the ferry crossing have also been divided into basic (see Table VI) and special (see Table VII) on-board facilities and services.

There was a high level of agreement among the respondents about basic on-board facilities (bar, shop, restaurant) both in importance and who should provide these services. The regions and ferry operators are unanimous in their preference of the ferry operator in providing these facilities and services. All, but one port respondent indicate the same preference. The importance ranges from very important to neutral. One ferry operator classified the basic on-board facility of a shop as unimportant.

Special on-board facilities were measured by the importance and provision of a swimming pool, a casino, a cinema, and a health club/spa. The majority of the respondents gave an importance rating of neutral or unimportant. It also received the largest number of very unimportant ratings of all ferry service components. The majority was also of the opinion that these services should be provided by the ferry operators. There is little enthusiasm for the use of independent third parties in the provision of either basic or special on-board facilities.
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| | Port Operator | 4 (20.0) | 2 (10.0) | 8 (40.0) |
| | Ferry Operator | 1 (5.0) | 1 (5.0) |
| | Government | 1 (5.0) | 1 (5.0) |
| | Private Third Party | 1 (5.0) | 1 (5.0) |
| | Combination | 3 (15.0) | 1 (5.0) | 5 (25.0) |
| | Total | 8 (40.0) | 4 (20.0) | 10 (100) |

| 7 Ferry Operators 14 Responses | Port Authority | 11 (23) | 4 (8.2) | 3 (6.1) | 18 (36.7) |
| | Port Operator | 6 (12.2) | 3 (6.1) | 2 (4.1) | 11 (22.4) |
| | Ferry Operator | 2 (4.1) | 4 (8.2) | 1 (2.0) | 10 (20.4) |
| | Government | 1 (2.0) | 3 (6.1) | 1 (2.0) | 10 (20.4) |
| | Private Third Party | 5 (10.2) | 1 (2.0) | 3 (6.1) | 10 (20.4) |
| | Combination | 19 (39) | 16 (33) | 9 (18.4) | 4 (8.2) | 49 (100) |

++ = very important  
+ = important  
O = Neutral  
- = unimportant  
-- = very unimportant

**Table IV:** Ferry port terminal - basic facilities
An analysis of service elements for ferry networks

### Ferry Port Terminal - Special Facilities
Preferred providers and perceived importance according to Ports, Regions and Ferry Operators by number of responses and rating score (out of 100)

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<th>O</th>
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++ = very important
+ = important
O = Neutral
- = unimportant
-- = very unimportant

Table V: Ferry port terminal - special facilities
Section V - Papers not discussed at the Conference

Ferry Basic On-board Facilities
Preferred providers and perceived importance
according to Ports, Regions and Ferry Operators
by number of responses and rating score (out of 100)

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++ = very important
+ = important
O = Neutral
- = unimportant
-- = very unimportant

Table VI: Ferry basic on-board facilities

European Shortsea Shipping 453
An analysis of service elements for ferry networks

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<td>6 (23.1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Combination</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>3 (11.5)</td>
<td>3 (11.5)</td>
<td>12 (46)</td>
<td>8 (30.8)</td>
<td>26 (100)</td>
<td></td>
</tr>
</tbody>
</table>

++ = very important  
+ = important  
O = Neutral  
- = unimportant  
-- = very unimportant

Table VII: Ferry port terminal - special facilities

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Conclusion

The ferry service offer is provided by a number of different organisations. The various elements of the ferry service offer differ in perceived importance. This study has shown that agreement on both provider and importance is similar for some of the elements, but varies widely among other elements. For those elements where agreement is large, it can be concluded that this is the standard or core view of what a ferry service is to contain. This applies not only when setting new services, but equally when modifying existing ones.

Despite widespread agreement on the nature of provision of services, there are some areas where opinions differ, such as the provision of linkspans. In a multinational survey, there are likely to be not only differences in corporate culture, but also in national culture. The overall impression of the results is one of the 'middle way', where respondents overall are not strongly in favour of government involvement (for example, only 3 out of 244 responses indicate that government should provide basic terminal facilities such as terminal buildings at ports), nor are they in favour of a heavily devolved privatisation with focus on a limited core business (there is little support for the provision of services by independent third parties). Other areas of transport, sometimes as a result of privatisation, have had to reassess the nature of their core business and responsibilities.

References

MINIMISING THE RISK OF FAILURE FOR AN EFFECTIVE AND RELIABLE EUROPEAN SHIPPING NETWORK

By K. Giziakis, E. Giziaki, A. Pardali-Lainou, V. Michalopoulos and D. Kokotos

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MINIMISING THE RISK OF FAILURE FOR AN EFFECTIVE AND RELIABLE EUROPEAN SHIPPING NETWORK

Abstract

In order to create a shipping network able to be an attractive alternative to shippers and receivers of cargo, transport companies and forwarders, shipping lines and operators, we are of the opinion that we have to increase the reliability and effectiveness of the shipping network. One element of this procedure is to minimise the risk of failure towards a reliable and effective network.

It is widely known that a failure can be distinguished in two broad categories, i.e. human and structural failure. One way to reduce the risk of structural failures is the improvement of inspections by the port authorities. However, port surveyors have limited resources and time to inspect a ship and therefore it is not possible to carry out a thorough structural inspection to all ships.

This paper presents a methodology that identifies and quantifies the relative importance of factors associated with the risk of failure of ships. This methodology can (a) set in a hierarchical order the various factors affecting the ship safety (b) identify the ships at risk that should be included in an inspection program and (c) estimate the probability of failure for each ship. Variables included in the risk analysis are associated with the ship characteristics, voyage particulars as well as commercial factors.

Port authorities would inspect those ships that present a probability of failure above a certain prescribed level.

The methodology was applied in a pilot study using data from the port of Piraeus.

1 Introduction

Between October '89 and December '91 50 dry bulk ships failed throughout the world. Many of these ships sank and the evidence of the cause of failure was lost with them. A lot of committees have been formed to comment on regulations which could reduce the risk of failure and a lot of discussions have been raised, that are referred to safety and the probable causes of failures (accidents) in maritime transport.

One of the most recent development towards reducing the risk of accidents is the directive 95/2/EC coming into force by the state members of European Union on...
Minimising the Risk of Failure

July 1996. This directive is based on the Paris Memorandum of Understanding for Port State Controls, in short is called the Paris-MOU.

The purpose of this directive is to help reducing drastically substandard shipping in the waters under the jurisdiction of Member States as it is quoted in article 1 of directive 95/21:

- Increasing compliance with international and relevant community legislation on maritime safety, protection of the marine environment and living and working conditions on board ships of all flags;
- Establishing common criteria for control of ships by the port state and harmonising procedures on inspection and detention, taking proper account of the commitments made by the maritime authorities of the member state under the Paris Memorandum of Understanding on Port State Control (MOU).

There is an obligation of the port authorities of the member states to carry out an annual total number of inspections corresponding to at least 25% of the number of ships entering its ports during a representative calendar year.

Although there is an analytical description concerning which ships must be considered for priority inspection, these criteria are not exhaustive and present no hierarchical importance. According to Article 5: "the member state and the commission shall co-operate in seeking to develop priorities and practices which will enable ships likely to be defective to be targeted more effectively".

It is possible the number of ships that fulfil the criteria for inspection to be greater or smaller than 25%. The port authorities must have an indication about the importance of each criterion in order to be able to identify the ships for inspection effectively.

Certainly, we are of the opinion that in order to reduce the risk of failure, especially the risk of structural failures, the port state control inspections should be improved. There is evidence that this improvement will have an effect in the detection of unsound ships. However, port surveyors have only limited time to assess a ship and a thorough inspection is not normally possible. Therefore, an assessment that will identify and also will allow the ranking of the most important factors associated with the risk of failure, is considered to be of great value. Very little research has been done to this area in shipping industry, due to the very limited resources available for this kind of research as it is noted by Holder, 1995 (1), Goss, 1995 (2).

In this paper a methodology that allows the ordering, the relative importance, of the most important factors contributing to the risk of failure is described. This technique could also identify ships with high probability of failure and therefore help port authorities in the selection of ships for inspection.
Each port has its own pattern of ship movements and commercial characteristics. Therefore, the results of the application of the above methodology apply only to the specific port under study.

A pilot study was carried out for the Port of Piraeus. Its aim was to show how this methodology can be applied to a port of a member state, the data needed and how this technique can help the port authorities to identify the ships at risk.

2 Methodology

The methodology suggested by the authors is called logistic regression analysis. The procedure can be used in order to assess the potential risk in a risk analysis approach. Its task is to estimate the effects that might occur following an exposure to a risk factor. It answers questions of the form:

- "Is there evidence that exposure to factor X produces effect Y?"
- "What is the strength of this evidence?"

The effect Y could be successful voyage (no failure) or unsuccessful voyage (failure). The model used should reflect this binary response.

The procedure also seeks to assess the importance of the different factors that could influence the risk of failure by assigning a certain weight (loading) to them. This weight is called odds ratio coefficient or relative risk coefficient. The odds is the ratio of the proportion of a group experiencing an event to the proportion not experiencing the event. The ratio of two odds, the relative risk coefficient, compares the odds of those ships having a particular characteristic to the odds of ships on not having it.

The model can be tested by measuring how well could identify the ships that actually failed. Hence the model is a valuable tool that allows surveyors to predict which ships are more likely to fail or exceed a certain threshold probability of failure and therefore should be selected for inspection. More about this methodology can be found in appendix A and in Breslow N E, 1986(3), Breslow N. and Day NE, 1980 (4), Lemeshow S and Hosmer DW, 1982 (5) Checkoway H. et al, 1989(6).

3 A pilot application

To show how this methodology can be applied, a pilot study was carried out for the port of Piraeus. Its objective was firstly to find out the main difficulties that one could face when applying this method to a port and secondly to show to the authorities its usefulness as a guide in the selection of ships targeted for inspection through an automatic approach based on scientific statistical findings. Since, there was not any funding, we collected data for a period of three months.
3.1 The data

The data include all the commercial arrivals and departures to and from the port of Piraeus, that is passenger ships were excluded. There were 2213 approaches to the port for the period of three months. The sizes were of 500 grt class and above. The port authorities did not have recorded all the particulars needed for a complete description of the ship and the voyage undertaken. The ships' characteristics have been completed from Lloyd's register.

Ship particulars were found for 457 ships which correspond to 1701 ship movements.

The particulars of ships, which completed the remaining 512 ship movements were not found in the Lloyd's register and therefore these ship movements were excluded from further analysis.

The casualty data were collected from the Lloyd's casualty weekly. These are all the incidents that occurred to the above ships for this specific period of time.

The information gathered refer to (a) the ship characteristics, that is grt, age, flag state, ownership, type of ship, name of ship, classification society, number of changes of owners (b) voyage characteristics, that is route taken, commodity carried and (c) casualty characteristics, that is type of accident, place of occurrence, weather conditions.

Figure 1 pictures the ten most frequent flags, that fly the ships approaching the port. The mean age of all approaches was 16.8 years. Almost 51% of the sample data had changed more than two owners. Figure 2 presents the distribution of the type of ships. The number of accidents for each type of ship is shown in Figure 3 and the cause of accident is presented in Figure 4. The mean age of all accidents was 18 years old. The mean grt for ships involved in an accident was 12765. In Figure 5 the flags of ships which were involved in an incident are shown.
Section V - Papers not discussed at the Conference

Figure 1: Ships approaching the port of Piraeus by flag

Figure 2: Ships approaching the port of Piraeus by type
Minimising the Risk of Failure

Figure 3: Analysis of accidents by ship type

Figure 4: Analysis of accidents by cause
3.2 Modelling the risk

The variables used for modelling the risk are either categorical or indicator variables. The categories were chosen in a meaningful way subjectively.

The variable age, presented as AGEGR, is classified into two categories, that is ships having an age over 12 years and ships having an age less than or equal to 12 years. The variable AGEGR takes the values 1 for category over 12 years and 0 for category less than or equal to 12 years.

The variables LOSS2, LOSS3 represent the flag state. The casualty experience of all ships that comprise the fleet of a flag state was taken into consideration for the variable flag. Flags were classified into three categories. The categories were determined using loss ratios for each flag state. The loss ratio is calculated as the ratio of the total gross tonnage of the losses for a year divided by the total registered gross tonnage of the fleet. The loss ratio reflects the losses of all types of ships in the fleet of each flag state. The three groups were: (a) flags with a loss ratio up to 2 grt per 1000 grt (b) flags with a loss ratio from 2 grt to 6 grt per 1000 grt and (c) flags having a loss ratio above 6 grt per 1000 grt. In the tables the variable LOSS2 takes the value of 1 for a flag state having a loss ratio 2-6 grt per 1000 grt and 0 if the flag state does not belong to this category. Similarly the variable LOSS3 takes the value of 1 for a flag state that belongs to category (c) and the value of 0 for a flag state not belonging to this category.
The variables SIZEGR2 and SIZEGR3 represent the size of a ship. The variable size was classified into three categories. The first category includes ships up to 10000 grt, the second category between 10000 and 30000 grt and the third over 30000 grt. In the model the variable SIZEGR2 takes the value of 1 if the ship belongs to the second category and the value of 0 if the ship does not belong to the second category. The variable SIZEGR3 takes the value of 1 if the ship belongs to the third category and the value of 0 if the ship does not belong to the third category of size. The first size category is represented when both variables SIZEGR2 and SIZEGR3 take the value of 0.

The routes of a voyage are represented by variables ROUTE1, ROUTE4 and ROUTE5. The routes undertaken are classified into four groups: voyages to the Eastern Mediterranean (area 4), voyages to Western Mediterranean (area 5), voyages to North Western European Waters (area 1) and voyages to all other areas. The variable ROUTE4 takes the value of 1 if a voyage takes place in the area of the Eastern Mediterranean and the value of 0, for a voyage that does not take place in this area. Similarly ROUTE5 takes the value of 1 if a voyage is taken in the area of Western Mediterranean and the value of 0, for a voyage not taken in this area. The variable ROUTE1 takes the value of 1 for a voyage undertaken in the area 1, North Western European Waters, and the value 0 for a voyage not undertaken in this area. Voyages to areas other than 4, 5 and 1 are represented when variables ROUTE1, ROUTE4 and ROUTE5 take the value of 0.

The variable OWN represents the number of changes of ownership. It is classified into two groups, that is more than 2 owners, less than or equal to 2 owners. The variable takes the value of 1 for a ship having more than 2 changes in ownership and 0 for a ship having less than 2 changes of ownership.

Using the SPSS (Statistical Package for Social Scientists) software, we performed logistic regression analyses for dry bulk, tankers, general cargo and container type of vessels. The variables along with the corresponding odds ratios are presented in Tables I to IV.

The amount of data used is very limited and therefore the results presented are only indicating how to use and interpret the coefficients of the variables and they are not used for drawing any conclusions about the port of Piraeus.

The usefulness of the models refers to:
Section V - Papers not discussed at the Conference

<table>
<thead>
<tr>
<th>Variables</th>
<th>Relative risk coefficient (odds ratio)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIZEGR2</td>
<td>4.94</td>
</tr>
<tr>
<td>LOSS3</td>
<td>3.53</td>
</tr>
<tr>
<td>LOSS2</td>
<td>2.69</td>
</tr>
<tr>
<td>SIZEGR3</td>
<td>2.49</td>
</tr>
<tr>
<td>ROUTE4</td>
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</tr>
<tr>
<td>AGEGRA</td>
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</tr>
<tr>
<td>OWN</td>
<td>0.92</td>
</tr>
<tr>
<td>ROUTE5</td>
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</table>

Table I: A model for bulk carriers

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<tr>
<td>AGEGR</td>
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<td>LOSS3</td>
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<tr>
<td>LOSS2</td>
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<td>SIZEGR2</td>
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<tr>
<td>OWN</td>
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<tr>
<td>SIZEGR3</td>
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<tr>
<td>ROUTE5</td>
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</tr>
<tr>
<td>ROUTE4</td>
<td>0.14</td>
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</tbody>
</table>

Table II: A model for tankers

<table>
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</tr>
</thead>
<tbody>
<tr>
<td>OWN</td>
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</tr>
<tr>
<td>AGEGRA</td>
<td>0.68</td>
</tr>
<tr>
<td>LOSS2</td>
<td>0.31</td>
</tr>
<tr>
<td>ROUTE5</td>
<td>0.25</td>
</tr>
</tbody>
</table>

Table III: A model for general cargo

(a) The ranking of the various factors - variables - according to their contribution to the risk of failure.

The value of the odds ratio represents the relative importance of each variable. The variables in each table are set in a hierarchical way according to the value of the relative risk coefficient.
Minimising the Risk of Failure

<table>
<thead>
<tr>
<th>Variables</th>
<th>Relative risk coefficient (odds ratio)</th>
</tr>
</thead>
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<tr>
<td>LOSS2</td>
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<tr>
<td>AGEGR</td>
<td>0.602</td>
</tr>
<tr>
<td>ROUTE1</td>
<td>2.893</td>
</tr>
<tr>
<td>OWN</td>
<td>0.67</td>
</tr>
</tbody>
</table>

Table IV: A model for containers

In Table I the odds ratio value for SIZEGR2 is 4.94, which means that the odds of a ship experiencing a failure are increased by 4.94 if a ship belongs to the size category 10000-30000 grt as compared to a ship that does not belong to this size group.

The coefficient - the odds ratio - for LOSS3 equals to 3.53. This is interpreted as follows: The risk of a ship experiencing an accident is 3.53 times higher for a ship flying a flag with a loss ratio over 6 as compared to a ship that flies a flag that does not belong to this loss ratio category. The relative risk for LOSS2 is 2.69 and is interpreted as follows: the probability of an accident in a ship flying a flag with a loss ratio between 2-6 is 2.69 times greater than the probability of an accident in a ship that does not fly a flag belonging to this loss ratio category.

The variable SIZEGR3 carries a coefficient of 2.49. The odds of a ship experiencing a failure are increased by 2.49 if a ship belongs to the size group over 30000 grt as compared to a ship that does not belong to this size category.

The odds ratio value for the variable ROUTE4 is calculated to 1.86. Its interpretation is that the risk of a ship failing is increased to 1.86 for a ship that undertakes a voyage in Eastern Mediterranean as compared to a ship that does not undertake a voyage in this area.

The coefficient for AGEGR is 1.48 and denotes that the odds of having an accident are increased by 1.48, when the age of the ship is over 12 years as compared to a ship of age less than or equal to 12 years.

The odds ratio for OWN is equal to 0.92, which means that this factor does not affect the risk of failure, the odds are almost unchanged.

The corresponding value for the variable ROUTE5 is 0.77. Its interpretation is that the risk of failure is decreased for a ship that undertakes a voyage in western Mediterranean as compared to a ship that does not undertake a voyage in this area.

The coefficients of the variables presented in Tables II, III and IV can be interpreted in a similar way. To sum up if the value of the odds ratio is greater than one, the risk is increased; if it is less than one, the risk is decreased and if it is one the risk is unchanged.

(b) The selection of ships for inspection. A model developed using historical data can provide a tool that could be used to assist in the selection of ships for inspection. The model can be used to estimate the probability of failure for each ship in terms of its characteristics and route. A ship on a particular voyage that has a
probability of failure in excess of a a threshold level would be subject to inspec-
tion. This threshold is determined according to the proportion of ships included in
the inspection group. As the threshold for inspection is raised, the proportion of
ships included for inspection will be declined.

4 Conclusions

A similar technique to the one described in this paper has been used by the
Australian Bureau of Transport and Communications Economics (BTCE), 994 (7). The BTCE used Lloyd’s voyage data for bulk ships departing from Australia and
from the major exporting countries of Brazil, India, South Africa and the U.S.A. for
voyages over the period May ’90 to May ’92. Twenty nine thousand voyages,
that included 60% of the known failures, were examined. Expected failures were
calculated assuming that the risk of failure is proportional to the number of
voyages. The results were compared to actual failures considering each factor
separately. This is what is normally done by researchers in maritime transportation
to test the effect of a variable (an assumed risk factor) on failure. The BTCE has
also analysed the relative importance of the different factors contributing to the
risk of failure. The results have shown that factors that considered to be of impor-
tance in the previous mentioned type of analysis (univariate analysis) appear to be
less important when a model that includes more factors was studied. The ranking
of factors according to their relative importance to an accident was as follows:

- the route undertaken
- commodity carried
- flag state
- finally the age

The pilot application showed that the port authorities did not have any com-
puterised system of entering data for the ship approaches. There were kept
certain characteristics of ships such as flag, type of ship, grt, name, but other
ones had to be sought in Lloyd’s register for our pilot application. It must be clear
that the authorities have to keep complete data for ships approaches in order to
be able to test the risk significance from the exposure to certain factors and
construct a model that will picture the risk factors for the ships approaching the
specific port.

The above difficulties and the lack of funding were the reasons we get data for
only three months and the results of the pilot study can not be used for drawing
conclusions. It would have been preferred to use data for at least a year in order
to avoid seasonalities and to have statistically sound results.

The pilot study, despite the above mentioned difficulties, showed the usefulness
of the methodology twofolds:

a. Port authorities should be able to rank the variables employed according to
the risk associated with these variables objectively.

b. A model, as the one used in the pilot study for the various ship types, that
will be based on historical data and will be tested for its goodness, could be
computerised for each port. The port authorities will enter the characteris-
tics of any ship approaching and they could have immediately on line the information whether the ship should be targeted for inspection. By setting an acceptable threshold level in such a way as to define the more risky 25% of the approaching ships, the authorities can be scientifically sound that they have been collected the targeted for inspection ships among those with the highest risk of accident.

We hope that this pilot study has given some ideas to the European Commission and the Port Authorities as to how they could solve the problem of targeted for inspection 25% of ships approaching European ports.

5 Bibliography


Appendix 1

The appropriate multivariate technique, that estimates the probability that an event occurs is the logistic regression model. The model can be written as:

\[ \text{Prob (event)} = \frac{1}{1 + e^{-z}} \]  
(1)

Where:
\[ z = \beta_0 + \beta_1 X_1 + \ldots + \beta_k X_k \]

The relationship between dependent (probability) variable and explanatory variables \( x \), is nonlinear and its graph resembles an S-shaped curve. The parameters of the model are estimated using the maximum likelihood method. Since the logistic regression model is nonlinear, an iterative algorithm is used for parameter estimation.

To interpret the coefficients of the logistic regression, (1) can be rewritten in terms of the log of the odds of an event occurring, that is

\[ \log \left( \frac{\text{Prob (event)}}{\text{Prob (no event)}} \right) = \beta_0 + \beta_1 X_1 + \ldots + \beta_k X_k \]  
(2)

or:
\[ \frac{\text{Prob (event)}}{\text{Prob (no event)}} = e^{\beta_0 + \beta_1 X_1 + \ldots + \beta_k X_k} = e^{\beta_0} e^{\beta_1 X_1} \ldots e^{\beta_k X_k} \]  
(3)

In formula (3), \( e \) raised to the power \( \beta_i \), is the factor that expresses by how much the odds change when the i-th independent variable is increased by one unit, for continuous independent variables, controlling for other variables. When the independent variable is categorical denoting presence or absence of a certain exposure factor, \( e^{\beta} \) expresses the amount of change of the odds in the presence of the exposure level.

For large samples, the statistical significance of coefficients is tested using the Wald statistic, which has a \( \chi^2 \) distribution. When the regression coefficient is large, its standard error is also large and this produces a very small value for the Wald statistic. This leads us to fail to reject the null hypothesis, when we should. Hence in the presence of a large coefficient, we should try a model with and without that variable and make decisions based on the difference between the two likelihood ratio chi-squares.

A confidence interval for the odds of failure subject to the presence of a particular exposure category is constructed from:
The goodness of fit of the model is assessed using the value of $-2\log$ likelihood, which under the null hypothesis that the model fits perfectly, has a chi-square distribution with $n-k$ degrees of freedom, where $n$ is the number of observations and $k$ the number of parameters to be estimated - this statistic is also called deviance - (Hosmer & Lemeshow, 1989).
POLICY OPTIONS FOR INCREASING THE COMPETITIVENESS OF INTRA-GREEK CARGO COASTAL SHIPPING

By M. Lekakou and E. Tzannatos

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POLICY OPTIONS FOR INCREASING THE COMPETITIVENESS OF INTRA-GREEK CARGO COASTAL SHIPPING

This paper examines the current status and trends of cargo coastal shipping (CCS) and ferry freight around Greece. It should be noted that Greece has a large island complex and consequently the transport of cargo between mainland Greece and the islands is performed without alternative modal choice to sea transport. However, the transport of cargo around mainland Greece is dominated by road transport.

Improvement in competitiveness of cargo shipping in this particular area will certainly lead to an overall improvement of the national transport network as it will attract a high share of the market currently controlled by other modes and especially trucks.

The paper analyses the existing situation with regards to the origin and destination points, the volume and type of goods transported by CCS and ferry fleet, the vessel doing this operation and the available infrastructure. These parameters are assessed and a number of policy options are proposed for increasing the modal share of goods transported by sea and in particular by the coasters.

1 Introduction

The recent research efforts into shortsea shipping operations constitute a breakthrough to the shipping research which has been traditionally dominated by the deepsea shipping theme. The research results are so far encouraging but continued effort is necessary in order to reveal the full potential of shortsea shipping and to guide governments, organisations and companies towards the production of policies which will support and strengthen this potential {1,2}.

In general, the ability of shortsea shipping networks to gain a bigger share of the transport load depends on their successful competition with land transport. As far as Greece is concerned, the transport between the mainland and the islands offers no alternative apart from air which is mainly restricted to passenger movement. The experience gained through the establishment of land transport networks in northern Europe reveals that despite the heavy investments in this sector significant transport inefficiencies are recorded {2,3}. The economic assessment of the effectiveness of land transport has consistently shown that the road and rail modes have increasing costs, diminishing safety, delays, congestion and environmental drawbacks. Therefore, in conjunction with the delayed development of extensive land transport networks within the Balkan peninsula (due to geomorphological restrictions or other limitations), the transport experience gained elsewhere indicates that shortsea shipping networks are a promising alternative for the much needed transport optimisation in this southeastern European region.
In the achievement of this objective Greece has to fulfil a leading but challenging role.

Also, Greece presents an interesting case for shortsea shipping research mainly because of its rich coastal and island geomorphology, its geographically critical position in Europe and hence its potential in regional transport, its particular institutional framework and infrastructure (with respect to this mode of transport), its general maritime tradition, etc.

For this region of Europe, the efforts towards the development of efficient intra-European shortsea networks must be accompanied by those which aim at the development of the intra-Greek equivalent. Therefore, the interest on Greek shortsea shipping research should not be restricted towards the establishment of efficient sea bridges between Greece and the rest of Europe, but also towards that of an efficient national shortsea network. Otherwise the process of regional transport development will be halted at the national gates and the transport inefficiencies will be propagated back into the European networks.

In Greece, the research on national shortsea networks has been mainly focussed on the transport of passengers and vehicles (4-6) by ferries, whereas the CCS has had little attention in this respect (7,8). This represents a significant deficit in the research effort towards the development of Greek shortsea networks, since it leaves the relevant transport picture incomplete. Also, unlike the Greek passenger coastal shipping, its cargo counterpart will very soon (1/1/97) have to experience the effects from the lifting of the cabotage on the domestic transport of strategic goods.

This paper provides a picture of the domestic cargo transport with particular emphasis on the waterborne component and indicates its competitiveness with the other modes of transport where such a comparison is feasible, i.e. in coastal operations. The features of this mode and type of transport are revealed and policies are proposed for overcoming the obstacles which hinder its development.

2 Modal Split of Domestic Transport of Cargo

The domestic transport of cargo is performed by land, sea and air. However, the contribution of the latter has been steadily negligible (<0.5%) and therefore the modal split on the transport of cargo involves the road truck, the train, the ferries (and Ro-Ro's) and the dry cargo and tanker coasters. According to this vehicular split, the cargo weight percentages are as shown in Figure 1. The figure for the CCS is the product of the authors survey on the domestic transport of dry and liquid cargoes, whereas those for the land and ferry freight data have being obtained by reference to other sources and by trend based estimations.

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1National Statistical Service of Greece, NSSG Centre of Economic and Planning Research, CEPE Ministry of Merchantile Marine, MMM
During the last decade, the domestic CCS is holding by far the second position in terms of the weight of the transported cargo, in comparison to the other modes of transport (Table I). In terms of the changes which are observed, it is significant to note that the increase in truck freight is taking place at the expense of the CCS and the "ever" low carrying train. Also, it appears that these changes have favoured the ferry transport. This is not an unexpected development since these passenger/cargo "combis" are the mainland-island and inter-island "bridges". Freightwise the ferries are not experiencing any threatening competition in the field of general cargo movement, apart from the limited influence of airplanes. After all, the rising trend in the road transport of cargo which is manifested through the average annual increase of 4.3% in the truck fleet during the last decade (Table II), is also reflected in the average annual increase of 7.1% in the movement of trucks on ferries (Table I). These ships constitute an extension of the road network due to the intermodality of the vehicles involved in the two systems. In the mid-80s, 5.8% of the road transport of cargo went through the ferry system, whereas in the mid-90s, this percentage rose to 8.1%. The ferry and road transport analysis developed above suggests that the road is carrying a continuously higher share of the freight, i.e. increasing its leadership in the modal split, although the highest increase per vehicle is recorded within the ferry sector.
### Section V - Papers not discussed at the Conference

#### Employed modal fleet

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#### Employed modal fleet

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<tr>
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1) Private and public use trucks
2) Freight and luggage rail cars
3) Dry cargo ships < 500 grt (excluding industrial and > 500 grt carriers)
4) White product carriers (petrol, industrial and heating diesel, MDO, MGO) and excluding oil barges

Sources:
- a) NSSG; (1995) is authors estimate based on previous trend
- b) Ministry of Merchantile Marine
- c) Authors survey (based on information for 1970, '80 and '95 provide by the Association of CCS < 500 grt)
- d) Authors survey (based on information provided by oil traders)
- - Not available or estimate doubtful

### 3 Domestic Waterborne Freight

The present day comparison between the ferry and coastal cargo ships shows that the former carry 21% of the waterborne freight, whereas in the mid-80s its participation was down to 13%. In 1970, the ferry was a newcomer into coastal shipping and the statistical records on the cargo transported catered only for the coastal cargo ships, whereas for ferries only the number of trucks was recorded. With reference to that time, a comparison based on the 500 grt split shows that the dry cargo "baby coasters" were carrying 34.45% of the total recorded waterborne transport, whereas their "big brothers" (>500grt and industrial carriers) had 37.58% of the total and the coastal tankers had the remainder (27.97%) irrespective of size. About 25 years later, the larger dry cargo carriers

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are reduced to a 25% participation in the coasters’ market\textsuperscript{1} and their transport work was distributed between the “babies” of the coaster fleet, the well established ferries and the industrial carriers (mainly of the cement industry).

The distribution of the relatively high-valued general cargo has been ferry biased, because of the fast door-to-door transportation capability offered to this cargo through its unbroken carriage on trucks in conjunction with ferries.

The entry of the industrial carriers is compatible with the growth of the cement industry in Greece during the last 25 years and the need for specialised ships (“floating factories” and self-unloaders) in this area. The presence of large coastal cement industries (AGET-Hercules, Chalkis, Titan) caused a demand for the transport of raw materials in large quantities, such as sand, plaster, “thiraiki soil”, etc. These materials come mainly from the islands of the Aegean and the origin-destination scheme makes these industrial carriers a true door-to-door vehicle of transport. Despite the significant growth of regional energy consumption over the same period of time, the transport demand for the carriage of the raw material of the petrochemical industry (crude oil) did not follow along the lines of the cement practice, since crude oil is imported. The transport of oil and cement products is related to local needs and therefore the small quantities in demand are transported by small-sized cargo ships and trucks.

4 The Coaster Market

The WW2 destruction of the road and rail systems and the post-war economic growth (increased transport demand), dictated that development of this small coastal fleet and its transition to the motorship type of coaster (Figure 2). This fleet peaked in the ’60s and by the beginning of the ’70s the extension of the national roads and especially the entry of the ferry fleet introduced the first serious problems of fierce competition. The split between dry and liquid coaster (inc. barge) transport currently stands at the 1 to 2.3 ratio for a total cargo movement of about 15 million tons. This represents a reversal to the share of the market 25 years ago, when the ratio was 2.6:1 in favour of the dry coaster for a total cargo of about 7 million tons. Apart from the economic growth which is reflected in the increase of the transport demand in both types of cargoes, the increase of the tanker loads are significantly higher due to the ability of these ships to retain their cargo because of the restrictions imposed on the carriage of dangerous goods on ferries. This has not been the case for the dry cargo carriers which have suffered higher losses mainly through the transfer of the general cargo to the ferry fleet.

\textsuperscript{1}Insignificant competition was declared by the Association of CCS <500 grt from the >500 grt fleet, although the industrial carriers were not considered in this statement.

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4.1 The fleet analysis (market supply)

The dry cargo coaster fleet currently employed in the domestic market consists of 61 ships and the corresponding oil product fleet stands at 31 ships (Table II).

As far as the dry cargo coaster fleet which is employed in the market is concerned, it presents the following characteristics:

- **Size of ships**: The mean ship size is about 1250 dwt, which gives a total availability of 76250 deadweight tons;
- **Age**: The range of entry is between 25 and 30 years and the mean age of the fleet currently stands at 35 years. It is interesting to comment that the oldest Greek ship in operation belongs to this fleet (1917 built);
- **Speed**: The mean speed of the fleet is at 11 knots, typical for the carriage of low valued cargoes, especially after the shrinkage of the transport of general cargo;
- **Country of built**: Western Europe has been the supplier of 90% of these mainly second-hand acquired ships. In particular, 40% were built in the Netherlands, 30% in Germany, 20% in the U.K. and the rest in Nordic countries, Italy and France. Over the last five years, a noticable supply comes from the eastern European shipyards;
- **Manning**: The size of crew is ranging from 7 to 9 (depends on a propulsion power split of 650 hp). The availability of manning is low and so is its level of competence;
- **Costs**: The distribution of the expenses in the operational cost is as follows:
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<td>-</td>
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<td>Rail (2,b)</td>
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<td>1264</td>
<td>948</td>
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<td></td>
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<tr>
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<td>(395)</td>
<td>(401)</td>
<td>(428)</td>
<td>-</td>
<td>-</td>
<td>(637)</td>
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<td>Load (d)</td>
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<td>3229</td>
<td>-</td>
<td>-</td>
<td>5037</td>
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<tr>
<td>DCC (&lt;500grt) (4,c,e)</td>
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<tr>
<td>DCC (&gt;500grt) (4,c,e)</td>
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<td>2827</td>
<td>1874</td>
<td>1910</td>
<td>2107</td>
<td>2058</td>
<td>1915</td>
<td>4963</td>
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<tr>
<td>Tanker coaster (5,c,e)</td>
<td>1950</td>
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<td></td>
<td></td>
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<td>10237</td>
</tr>
</tbody>
</table>

1) By road truck
2) By freight and luggage rail cars.
3) Number of trucks in thou.
4) DCC = Dry Cargo Coaster.
5) Oil Tankers, chemical carriers, LPG, and self-propelled and towed barges.

Sources:
- a) (1986) CEPE's 7050 mil ton-km and authors estimate on aver. payload dist. of 150 km; (1995) authors estimate based on the number of trucks of Table II.
- b) NSSG; (1995) authors estimate based on previous trend.
- c) Ministry of Merchantile Marine.
- d) (1995) authors estimate based on previous trend on number of trucks and 8 tons/truck.
- e) Authors survey (based on information provided by the Association of CCS of <500grt and oil traders); (1995) authors estimated for DCC (>500grt) is based on previous aggregate trend.
- Note: Estimates in italics

Table II: Modal split of domestic transport of cargo (in thousands of tonnes)

- manning: 45%
- technical: 20%
- fuel: 15%
- port and canal: 5%
- other expenses: 15%

The cost of manning and port/canal is high in comparison with the deepsea shipping market;

- Ownership: The market is fragmented into small ownerships in which the single-ship owner has a strong participation and he operates the ship on a family basis (i.e. captain-owned). All these small-sized coasters are joined into a companies' co-operation which manages almost the entire fleet;

- Exit from the fleet: The ships are mainly re-sold to shipowners of the middle-East (i.e. Syria, Saudi Arabia, etc.). Also, throughout the years a significant number of ships flagged out, and although they retained their Greek ownership they were excluded from the domestic market (cabotage restriction) and became active in the south and southeastern Mediterranean, middle-East and Africa. Laying-up is not a strong feature of this fleet, since it is very expensive to support such a state.
As far as the tanker coaster fleet which is employed in the market is concerned, it presents the following characteristics:

- **Size of ships**: The mean ship size is about 2150 dwt, which gives a total availability of almost 70000 deadweight tons;
- **Age**: The mean age of the fleet currently stands at 30 years, the oldest being 42. The age of entry is around 25 years;
- **Speed**: The mean speed of the fleet is at 13 knots;
- **Country of built**: Western Europe has been the main supplier these mainly second-hand acquired ships, although the far-East (Japan) has supplied a small number of ships too;
- **Manning**: The size of crew is ranging from 8 to 14, with the availability of manning and its level of competence low. The oil barges are manned with 5 to 7 persons;
- **Costs**: The distribution of the expenses in the operational cost is as follows:
  - manning: 61%
  - technical: 11.5%
  - fuel: 12%
  - port and canal: 9.5%
  - other expenses: 6%

The cost of manning and port/canal is very high in comparison with the deepsea shipping market.

- **Ownership**: The market is now concentrated into 4-5 shipowners, with the number of owners halved over the last five years (1991-95). In this time, the strong leadership of a owner has increased from 44% to 58% of the engaged fleet, in a trend of reducing numbers of ships from 41 to 31 (Table II). Also, the unique presence of a single trading company carrier has ceased in 1993. The oligopoly of this coastal tanker fleet is contrasting the ownership characteristics of the deepsea tanker market which is widely acknowledged as one of perfect competition.

This coastal tanker fleet is complemented by a number of around 60 oil barges ("slepia") which operate mainly in Piraeus and Patras for covering the needs of bunkering and general fueling in these areas, through straight ship feeding and supply to storage installations. Some of the larger self-propelled barges are also employed in the coastal transport of marine fuel from Piraeus to Patras and of industrial fuels to some of the national industrial "giants" AGET, LARKO, Electricity Co., etc. With respect to ownership, this particular fleet of very small tankers is scattered into a multi-owner scheme.

Finally a comment is due with respect to an interesting trend for the future of the dry cargo coaster fleet. In 1970, 300 dry cargo coasters were recorded and this fleet size reflects the status of this shipping market when the real competition from the ferry stepped in. Fleet size is shrinking and the records for 1995 suggest that during the last 25 years a 460% reduction has occurred! This suggests a withdrawal of 9-10 ships per year (Table II). On the other hand, a prediction based on a time series calculation (see Annex) using the 1970, 1980 and 1995 data, reveals that in the year 2000 only 7 ships will remain employed, whereas by 2005

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no ship will be operating in this market! This prediction assumes that no drastic extrinsic or intrinsic changes will take place in the market over the predicted period.

The coastal tanker fleet has a more sustainable position in the market in terms of fleet size, although its decline in cannot go without notice.

4.2 The cargo analysis (market demand)

The dry and tanker cargo flows are shown in Figures 3 and 4, and in both cases Piraeus is the dominant origin of the flows because of the industrial concentration in the area. About 40% of the dry cargoes transported by the coasters is connected with the islands, the remaining being related to the mainland Greece. The transport of oil cargoes is heavily concentrated around the Piraeus region, where the coaster tanker fleet is involved in many local (<20 miles) routes within the refinery industrial zone.

Figure 3: Main flows of domestic transport of dry cargo
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Figure 4: Main flows of domestic transport of dry cargo

The picture of the demand in dry cargo coaster transport is presented in Table III. The soils represent 68% of the total quantities, followed by grain, fertilisers and animal foodstaffs as a distant second with 13%. The very low participation of the general cargo (3.4%) reflects the strong competition coming from the ferry carriers. Incidentally, the number of the general cargo coasters has declined from 76 to 7, over the 1970 to 1995 period. The (weighted) mean of the utilisation of the fleet stands at around 96%, but this is mainly attributed to the full utilisation of the coasters in the soil and grain trade. For these cargoes, ship size and consignments exhibit a best fit of supply and demand. Grain and fertiliser cargoes have a strong seasonality (spring and autumn) and therefore, although the fleet in these cargoes peaks with an overall maximum of 23, a strong cross trading is experienced during the year. As anticipated, the lowest level of utilisation of the fleet is experienced in the time charter trades (general cargo and military).

The picture of the demand in liquid cargo transport is dominated by the transport of oil products (black, white and marine), with the chemical and LPG's cargoes accounting for less than 1% of the total (Table IV). The O-D scheme is based on
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<table>
<thead>
<tr>
<th>Cargo type</th>
<th>Quantities Carried (tons)</th>
<th>Average mileage (per payleg)</th>
<th>Transport Work (tons/miles)x 10^4</th>
<th>Number of Ships</th>
<th>Utilisation (%)</th>
<th>Freight Rate (USD/ton)</th>
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<td>220</td>
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<td>7</td>
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<td>11.2</td>
<td>2</td>
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<td>bidding</td>
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<td>Building, Industrial and Other materials</td>
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<td>75</td>
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<td>4.6</td>
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<tr>
<td>Total = Weighted Total = Mean = 226</td>
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<td>Total = 61*</td>
<td>Weighted Mean = 96</td>
<td>Weighted Mean = 7.34**</td>
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<td></td>
</tr>
</tbody>
</table>

1) Cross-trading of 2 to 4 ships
2) Excluding military cargo

Note: The freight rate is regulated by the state i.a.w.

\[ FR = \text{nautical miles} \times \text{coefficient} \times \text{tonnes} \]

where:

- coefficient = 8.32 for > 200 nm
- coefficient = 11.28 for < 200 nm

Table III: Demand of domestic coastal transport of dry cargo (1995)

the location of the refinery industries near Piraeus and Thessaloniki from which the oil products are transported to various storage installations in the islands of the Aegean (Crete, Kos, etc), to coastal storage installations in western Greece (Patras and Epirus), as well as to large industrial oil consumers. About 50% of the oil products are however coasted around the Piraeus region, with the small barges covering the bunkering of ships and other storage exchange activities.

4.3 Scenarios on modal choice

An example on oil transport: "transport of oil from Elefsis refinery to Patras with tanker coaster and tank truck for the bunker feeding of the Patras-Italy F/Bs".

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<table>
<thead>
<tr>
<th>Cargo type</th>
<th>Quantities carried (× 10^3)</th>
<th>Number of ships</th>
<th>Average freight rate (US$/ton)</th>
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<tbody>
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<td>White products {1}</td>
<td>6305</td>
<td>31</td>
<td>6.75</td>
</tr>
<tr>
<td>Black products {2} and bunkering {3}</td>
<td>2380</td>
<td>as in 1 + 60 barges</td>
<td>5.3</td>
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<td>LPG {4}</td>
<td>26</td>
<td>3</td>
<td>5</td>
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<tr>
<td>VGO/SPAR {5}</td>
<td>540</td>
<td>as in 1</td>
<td>4</td>
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<tr>
<td>Chemical {6}</td>
<td>12</td>
<td>2</td>
<td>6.25</td>
</tr>
</tbody>
</table>

*Varies greatly with distance, quantities and customer

1) Petrol, diesel, Jet-A1 (all in cubic metres)
2) Residual (Mazout), Asphalt (all in metric tonnes)
3) Marine FO, MDO, MGO (all in metric tonnes)
4) For the National Petroleum Company (in metric tonnes)
5) For the National Petroleum Company, Vacuum Gas Oil/Straight Run Atmospheric Residue (all in metric tonnes)
6) In cubic metres.

Table IV: Demand of Domestic Coastal Transport of Tanker cargo (1995)

a. Cost by tanker coaster:  
   
   b. Cost by tank truck: (Distance = 202 km)  
      - Journey cost¹ = 0.07 US$/km-ton  
      - Toll post dues  
      - Tank truck pump  
      - Transhipment cost²  
      
      Total = 17.1 US$/ton

   An example on dry cargo transport: "transport of grain from Alexandroupolis (Thrace) to Crete by coaster and by a combination of truck and ferry".

   a. Cost by coaster (Distance = 390 n.m.):  
      b. Cost by truck and ferry (Distance = 800 km + 180 n.m.):  

   Although the coaster option is favourable for both cases costwise, it is necessary to take into account that the modal choice has also to be assessed in terms of:

   - Time;
   - Reliability;
   - Level of service.

¹Includes Corinth canal dues
²The cargo is carried by an oil barge from Elefsis to Skaramanga depo and then by tanker truck to Patras
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Transport practice is showing that despite the cost advantage of the coaster services, the road is a preferred mode due to its superiority in time, reliability and level of service, when a socially insensitive assessment governs the choice.

5 Conclusions

This work is highlighting the need for expressing a number of concluding remarks which are relevant with the policies required for promoting the domestic coastal network of cargo in Greece. This is an objective which has to be fulfilled for the improvement of the national transport network and for its comprehensive interlinking with its neighbouring intra-European.

It is, however, necessary first of all to present the main points of this work which dictate the above mentioned need for proposing a number of improving policies. These points are as follows:

- Lack of reliable and consistent statistical data;
- Ageing coaster fleet;
- Poor industrial image - Lack of prestige;
- Low morale - Sense of a decaying industry;
- High port costs (poor management and infrastructure leading to long turnaround times);
- The Corinth canal in as much as being a short cut bridging eastern-western Greece it presents problems with respect to pricing discriminations with respect to time of passage, type of vessel and cargo, etc.;
- Poor planning and scheduling on demand-supply relationship (shipping companies, ports, shippers, brokers);
- Centripetal/centrifugal network;
- Lack of financial support;
- Poor Manning support.

The policy proposals with the aim of achieving the above mentioned objective of network promotion and in view of the stated points of observed inefficiencies are:

- The development and implementation of a database system by mode of transport and goods for commercial development and policy making;
- Research for the production of standardised coasters particularly suitable for the Greek market;
- Improvement of industrial image through the acquisition of specialised training (e.g. UNCTAD’s European Trainmar), with the involvement of all related partners;
- Low morale is a product of abandonment from supervisory institutions and inadequate participation in the market, fora, chambers, etc.;
- Apart from the design of a productive ship while at berth, port costs can be reduced through better communications (avoidance of delays), soft investment upgrading of facilities and time shift optimisation;
- A new rational pricing system for sailing through the Corinth canal;
Establishment of a cargo stock exchange for bringing together all the parts of the demand-supply relationship (shippers and forwarders, ports, brokers, industrialists, traders, etc.);

A change of the network configuration is necessary through re-allocation incentives which will lead to better network diffusion;

Financial support to small sized coaster companies for renewal of the fleet, marketing and organisation, through co-operative credit organisations;

The establishment of roundtable and discussion fora for analysing and solving the problems of coastal cargo shipping.

Acknowledgements

The authors wish to express their sincere thanks to Prof. S. G. Sturmey for his valuable support and encouragement in this work. Also, the authors feel equally grateful for the kind assistance of Mr. N. Papadopoulos and Mr. A. Arvalis towards the provision of information which was very useful in this work.

References


Polish short sea shipping at the break of the 80ties and 90ties

During the last twenty years, Polish shipping underwent a process of intense technological, operational and economical transformation, connected both with global progress and change in sea transport and shipping markets, and with the internal Polish social and economical crisis and then with the process of economical and political transformation of Poland towards market economy. These changes formed new chances for Polish maritime economy but at the same time caused significant difficulties in its development. For shipping companies came even a period of fighting for survival. These difficulties increased at the beginning of the 90ties, when confrontation of Polish shipping, which suddenly found that it is left without protection of the State, with liberal market economy proved very painful. Exceptionally inadequately prepared for the new conditions was the Polish liner operator (Polish Ocean Lines), the shipping activities of which became gravely endangered. All these phenomena found also strong reflection in the economical condition and in operational difficulties of Polish short sea shipping.

Since nearly twenty years, the direction of development of Polish short sea shipping did not correspond with global trends. This resulted mainly from internal conditions, and in that from the underdevelopment of the Polish container system, from the political limitations on trade with West Europe, insufficient financial means for buying modern ships, etc. In effect, on short range relations the Polish Ocean Lines used mainly conventional general cargo carriers. This shipowner wasn’t even prepared for opening feeder services for own container ocean lines, when at the beginning of the 80ties they changed their base ports from Gdynia to Bremerhaven and Rotterdam.

Low activity of Polish road carriers on European roads caused that even in the 80ties Polish conventional tonnage found demand for short sea services. It lost only in competition with Polish ferries on Scandinavian lines, mainly on connections with Sweden. As late as 1983, conventional general cargo ships of the PLO carried on short sea lines (in that only two ro/ro lines) about 710 thous. tonnes. In the same time rail ferries carried about 180 thous. tonnes to Sweden.

The new geopolitical system in Eastern Europe, which changed the area of the economical hinterland and forefield of Polish seaports, because at present their boundaries - instead of the previous political - are determined by economical criterions, the decrease of Polish foreign trade, and very strong competition of road transport on the West European transport market, had the result that in 1992 transports of the Polish short range shipping lines decreased by more than 50%, and the conventional Scandinavian lines were not able to defy the competition of
Section V - Papers not discussed at the Conference

<table>
<thead>
<tr>
<th>Line</th>
<th>1983</th>
<th>1993</th>
<th>1994</th>
</tr>
</thead>
<tbody>
<tr>
<td>West European</td>
<td>213</td>
<td>76</td>
<td>-</td>
</tr>
<tr>
<td>United Kingdom (ro/ro)</td>
<td>157</td>
<td>110</td>
<td>161</td>
</tr>
<tr>
<td>Finnish (ro/ro)</td>
<td>182</td>
<td>110</td>
<td>300</td>
</tr>
<tr>
<td>Scandinavian</td>
<td>70</td>
<td>38</td>
<td>-</td>
</tr>
<tr>
<td>Stockholm</td>
<td>10</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Norwegian</td>
<td>60</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Danish</td>
<td>20</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>712</td>
<td>334</td>
<td>461</td>
</tr>
<tr>
<td>Swedish (ferry)</td>
<td>190</td>
<td>550</td>
<td>762</td>
</tr>
</tbody>
</table>

Table I: Carriage by PLO on shortsea lines in 1983 and 1993 (1000 tonnes)

ferry lines, and were closed. Year later, when the private operator Euroafrica was formed, which rented coasters and ro/ro vessels from PLO, on the West and North European shipping scene no Polish conventional line was present. On the other hand, container carriage on these lines reached 22 thous. TEU.

Polish ferry shipping started to take up a visible position on the Baltic ferry transportation market only at the end of the 70ties. It was based on two lines: Świnoujście-Ystad, and Gdansk-Helsinki. On these lines sailed old second-hand passenger/car ferries, and newer but rather small car/rail ferries. As late as 1979-80, the Polish ferry shipowner Polish Baltic Shipping Co. at Kolobrzeg introduced two new, built in Polish shipyards, ferries of 7400 BRT each. Due to the political and economical limitations imposed upon Polish international tourism and on trade with Scandinavian countries, Polish ferry shipping played an insignificant role in the overall Baltic ferry traffic. This situation changed at the beginning of the 90ties, in step with the political, social and economical change in Poland, when limitations on foreign trade and touristic traffic were removed.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Passengers</td>
<td>271</td>
<td>560</td>
<td>677</td>
<td>613</td>
</tr>
<tr>
<td>Cars</td>
<td>-</td>
<td>134</td>
<td>140</td>
<td>130</td>
</tr>
<tr>
<td>Lorries &amp; busses</td>
<td>-</td>
<td>62</td>
<td>78</td>
<td>72</td>
</tr>
<tr>
<td>Rail cars</td>
<td>-</td>
<td>32</td>
<td>28</td>
<td>30</td>
</tr>
</tbody>
</table>

Table II: Dynamics of ferry traffic through seaports (in 1000 tonnes)
Short-range Trade in Transport of Central European Cargo from Polish Ports

Taking into account the values of geographical position of Poland as a transit country on the map of Europe, the production potential of our country and the size of cargo exchange and passenger traffic - it must be stated that these volumes do not reflect the position of Poland in Europe.

The market for Polish short sea shipping

It might seem that since dynamics of Polish economy are improving, since foreign trade grows both in export and import relations, and 63% of this is with European Union, and the main trade partners of Poland are Germany, the Netherlands, United Kingdom and France, there should be a strong demand for short range transportation from Polish ports.

<table>
<thead>
<tr>
<th>Participation in total traffic</th>
<th>Export 1991</th>
<th>Export 1993</th>
<th>Import 1991</th>
<th>Import 1993</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
<tr>
<td>EU countries</td>
<td>55.6</td>
<td>63.2</td>
<td>49.9</td>
<td>57.2</td>
</tr>
<tr>
<td>Germany</td>
<td>29.4</td>
<td>36.3</td>
<td>28.5</td>
<td>28.0</td>
</tr>
<tr>
<td>Netherlands</td>
<td>x</td>
<td>5.9</td>
<td>x</td>
<td>4.7</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>x</td>
<td>4.3</td>
<td>x</td>
<td>4.2</td>
</tr>
<tr>
<td>France</td>
<td>x</td>
<td>4.2</td>
<td>x</td>
<td>4.2</td>
</tr>
<tr>
<td>Central/East Europe</td>
<td>16.8</td>
<td>13.3</td>
<td>19.0</td>
<td>13.5</td>
</tr>
<tr>
<td>Post-USSR</td>
<td>11.0</td>
<td>7.6</td>
<td>14.1</td>
<td>9.1</td>
</tr>
<tr>
<td>Other countries</td>
<td>27.6</td>
<td>23.5</td>
<td>31.1</td>
<td>29.3</td>
</tr>
</tbody>
</table>

Table III: Geographical structure of Polish trade (in %)

The demand for short sea shipping should be strengthened by the needs of countries transiting their cargo through Polish ports (Czech Republic, Slovakia, Hungary, Austria). Besides, in the case of the ports of Gdańsk and Gdynia the eastern hinterland of the post-USSR countries, and for the Szczecin and Świnoujście ports - the hinterland of Berlin agglomeration and of the eastern Lands of Germany become opened. However, in the present throughput of Polish ports these trends find very week reflection. This is connected with such conditions as:

1. Weak economical position of the Eastern Central European hinterland of Polish ports, measured either by means of GNP, or foreign trade, or of the development of modern branches of economy;
2. Foreign trade of Eastern Central European countries which are the economi­
   cal hinterland of Polish ports (Czech Republic, Slovakia, Hungary) is directed
   at West Europe, mainly Germany, and uses land transport;
3. Low participation of Eastern Central European countries in foreign trade
   with Scandinavia;
4. The short sea shipping market operates in conditions of extremely strong
   competition with road and rail transport, which take over a significant part
   of potential ship cargo;
5. Insufficiently developed multimodal transport in Eastern Central Europe;
6. Low frequency of departures of ships operating on short sea lines from
   Polish ports;
7. Lack of developed motor- and expressway network, connecting Polish ports
   with their Central European hinterland;
8. Insufficient knowledge of sea transport among Polish forwarders and shippers,
   and in effect giving up by them transport gestion;
9. Lack of modern Polish ro/ro, container and ferry tonnage.

Due to these factors, in spite of the above mentioned trend facilitating the
development of short sea shipping activities serving Central European cargo, there
are still significant barriers imposed on the demand for this shipping service.
Political and economical change in this part of Europe did not yet result in a sig­
nificant strengthening of the European segment of Polish port market.

The adoption by Scandinavian countries of the strategic objective of doubling the
participation of Eastern Central European countries in their foreign trade, the
-growing presence of Scandinavian investment in this part of Europe, growing
North-South touristic traffic, and also the programs for building motorways and
expressways in Poland, and at the same time the high rates of development of
Polish, Czech, Slovak and Hungarian economies, give grounds for more optimistic
forecasts of the development of the Polish segment of short sea shipping market.

Polish seaports are specially interested in the dynamic development of this shipp­
ing, since after losing the ocean lines they see short sea shipping as their basic
activity at the break of 80ties and 90ties.

The need for development within the Baltic basin is also stressed by the EU Com­
in Kopenhagen, dr Wim A.G. Blonk - Director for Maritime Transport and Ports in
the European Commission stated that one of the main objectives of adjusting
Baltic shipping to the requirements and needs of the EU is the developmet of short
sea shipping. The priority of this type of shipping results from two reasons:

- Congestion on the road and rail network in West Europe results in a
dramatic rise of cost and environmental noxiousness of transport, especially
road transport, therefore it is necessary to move a part of the cargo from
land to sea routes;

- Short sea shipping has several advantages, such as:
  - It is the cheapest transport route;
  - It is safe and environmentally friendly;
  - Has easily available reserves of transport capacity;
Short-range Trade in Transport of Central European Cargo from Polish Ports

Investment in it is effective.

There are also difficulties and obstacles on the road to effective development of Baltic short sea shipping, which lower its competitiveness in comparison with land transport. They are connected with too long times of cargo transportation, especially too long times of ships in port, which increase the cost of sea/land transport. Also the quality of service and of transport connections of the ports with their hinterland must be improved. But these inconveniences can be removed at rather low cost, for this shipping to become an alternative to land transport.

Organisational and quality aspects of land - short sea transport chain development

The level of effectiveness and competitiveness of Polish ports and short sea shipping, serving Central European cargo, depends not only on the political and economical factors, and on the development of transport infrastructure in this region, but also on the efficiency of management and organisation and on technological modernity of land-sea transport chains, of which short sea shipping is a part.

Prospects of wider engagement of short sea shipping into service of Central European foreign trade cargo depends also on such factors as:

- Level of integration of components of the land-sea transport chains;
- Introduction of modern informatics and telecommunication techniques into the organisation and management of transport chains;
- Level of modernness of used techniques and organisational structures;
- Advances in quality management in all components of the land-sea transport chains.

Short sea transport can compete with land transport only on the condition that it ensures better integration of shipping, ports and land transport into intermodal transport chains. Difficulties in the development of sea-land intermodal transport in Central Europe lie not only in the underinvestment of transport infrastructure, but also in the lack of experience in organising intermodal systems and in their effective management, especially when these systems consist of independent private companies. The lack of ability to organise cooperation of the dozens of private, often quite small, transport, agency, trade and production enterprises is apparent. Cargo gestors have very little knowledge about organisation, requirements and advantages of cargo transportation by sea. Their level of knowledge about land transport is much higher. In effect shippers often decide not to use the sea route.

Integration of sea-land transport chains means first of all that modern techniques and organisation of cargo transportation and handling are simultaneously introduced into all branches of transport functioning in a given transport corridor. In the Central European North-South corridor, modernity of the various branches of transport is very diverse. Outdated rail, road and shipping stock predominates. The average age of ferries and ro/ro vessels operated by Polish short sea lines is over 15 years. In Central European countries there is a lack of intermodal terminals, and there is nearly no modern fast railway stock. This forms a technological gap.
between EU countries and Central European countries. Today, it also is an impor-
tant factor, limiting possibilities of development in this region of short sea shipping
integrated with North European intermodal transport systems.
An important characteristic of contemporary transport is the wide use of logistic
philosophy and logistic solutions, and implementation of informatics and telecommu-
nication techniques. Flexibility and adaptiveness of new information techniques
allows a quick and effective adaptation of the functioning of a sea-land transport
chain to the requirements posed by competition on the turbulent, quickly changing
transport market. They allow to shorten technological processes, to reduce opera-
tional cost and risk, to increase reliability and efficiency of transport operations,
and also ensure continuous control of these operations along the whole transpor-
tation route.
In the Central European sea-land transport corridors, implementation and develop-
ment of logistic systems, and of logistic approach, meet with numerous difficul-
ties, which among others result from:

- Low level of integration and coordination of infrastructure and of transport
  and port services;
- Lack of efficient communications system;
- The preliminary only stage of designing of transport computer centres and
  of common information networks;
- Lack of integration and standardization of technical equipment and of
  transport means;
- Numerous administrative barriers, especially in international transport.

The system of quality management and quality assurance must cover the whole
sea-land transport chain. This means that better service of the customer is the
objective of all efforts to improve quality. E.g.: introduction of the ISO 9000
system in the Port of Helsinki was defined as introduction of a System for Cus-
tomer Satisfaction. The level of quality of services within the transport process
has the following sense for the customers in the process:

- Minimum money spent on transport;
- Minimum time used by the transport service;
- Minimum risk to be carried;
- Maximum added value;

and is an important criterion in the selection of a transport chain alternative, which
in case of Central European shippers is a selection between land and sea-land
routes.
It should be stressed that the low competitiveness of short sea shipping in terms
of time has to be recompensed by the other quality features of sea-land
transport chains.
Too low quality of services offered by the sea-land Central European transport
chain may also become a barrier to the development of Baltic short sea shipping.
Practical cognizance, by the Central European transport community, of the condi-
tions and principles of functioning in market economy of sea-land transport chains,
gaining experience in modern management of transport processes, transfer of
Short-range Trade in Transport of Central European Cargo from Polish Ports

modern techniques, and participation in EU integration programmes will allow gradual passing over organisational and qualitative barriers, and will accelerate development of land - short sea transport chains in Central Europe.

Port forecasts

Also Polish and international consultants point to the increasing importance of short sea shipping. This is shown by the forecasts of general cargo throughput in Polish seaports. It is predicted that in the years 1993-2010 they will increase by 52-90%, in that container traffic will reach 3-4 mln. tonnes, and ro/ro 6.3-8.0 mln. tonnes. In that Baltic cargo will constitute 29%, and West European (including feeder services) ca. 49%.

An increasingly important place in short range transportation will be taken by ferry shipping, which is in the centre of interest of not only Baltic ferry operators, but also of ports - especially Swedish. According to forecasts, in the years 1993-2010 passenger ferry traffic will increase from present 700 to 1,900 thous., lorries from 70 to 250 thous., cars from 130 to 450 thous.

<table>
<thead>
<tr>
<th>Year</th>
<th>Total</th>
<th>in that:</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>transit</td>
<td>Polish foreign</td>
<td>Containers &amp;</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1994</td>
<td>10.9</td>
<td>0.7</td>
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<td>3.5</td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td>12.0-14.0</td>
<td>1.8-2.0</td>
<td>10.2-12.0</td>
<td>6.0-7.0</td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>15.8-19.0</td>
<td>2.2-4.0</td>
<td>13.6-15.0</td>
<td>9.0-12.0</td>
<td></td>
</tr>
</tbody>
</table>


Table IV: Forecast of general cargo traffic in Polish seaports in mln. tonnes

<table>
<thead>
<tr>
<th></th>
<th>Gdańsk</th>
<th>Gdańsk/Gdynia</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1993</td>
<td>2010</td>
</tr>
<tr>
<td>Passengers</td>
<td>430</td>
<td>1000</td>
</tr>
<tr>
<td>Cars</td>
<td>89</td>
<td>250</td>
</tr>
<tr>
<td>Trailers</td>
<td>59</td>
<td>180</td>
</tr>
<tr>
<td>Rail cars</td>
<td>30</td>
<td>45</td>
</tr>
</tbody>
</table>


Table V: Forecast of ferry passenger traffic in Polish ferry ports ($\times 10^3$)

It should be stressed that Polish ferry shipping will find itself under strong pressure of competition from German shipowners, maintaining ferry connections from East
Section V - Papers not discussed at the Conference

Germany (Rostock, Warnemünde, Sassnitz), and also of Swedish ferry operators which already are beginning to come into the Polish shipping market (e.g. Stena Line). Besides, competitiveness of lorry transport from Sweden and Norway will be increased by the presently under construction bridge/tunnel land connection between Sweden and Denmark. A competitive alternative to ferries on the Poland-Finland relation will be the planned Via Baltica motorway.

The expected increase of ferry, ro/ro and container traffic in Polish ports requires further development of ferry terminals at Świnoujście, in Gdynia and in Gdańsk. Already 60% of ferry traffic passing through Polish ports concentrates at Świnoujście. Predictions indicate that in 15 years passenger and cargo traffic in this port may multiply by 2.5, reaching over 1 mln. of passengers, 250 thous. cars and 180 thous lorrys. A step towards these predictions is the building of the PBS Co. international ferry terminal, which already in the year 2000 will be prepared for servicing 800 thous. passengers, 150 thous. cars 100 thous. lorries and 60 thous. rail cars.

In 1993, through the PBS Co. ferry terminal in Gdańsk passed 100 thous passengers, 20 thous. cars and 5 thous. lorrys. These are the maximum capacities of that terminal, and that at low quality of services. In the Master Plan for the port in Gdańsk a new site for a much larger ferry terminal is planned. It would be a part of a passenger and touristic centre.

The ferry terminal in Gdynia served in 1993 about 130 thous. passengers and 20 thous. lorrys on the Karlskron-Gdynia line. According to forecasts, a traffic of 500 thous. passengers, 40 thous. lorrys and 15-20 thous. rail cars may be expected on this line. A design for building a new ferry harbour in Gdynia has been made. This harbour will have 4 berths (passenger/car and passenger/car/rail).

Besides, in plans for the development and modernization of Polish seaports it is designed to build about a dozen ro/ro berths, to develop the Baltic Container Terminal in Gdynia for feeder services, and of container berths in the Szczecin and Gdańsk ports.

At present, an important obstacle in the development of Polish ferry transportation, is the bad state of roads connecting Polish ferry terminals with their direct and far cargo and touristic hinterland. It is an outdated and inefficient road system from the first half of this century. However, port towns have already developed plans for adapting their roads to the needs of ferry transportation. Most advanced is the realization of the new urban road system for the container and ferry terminal in Gdynia, where after a break of several years, construction work on the new route connecting the port in Gdynia with the Gdańsk agglomeration ring-road has been restarted.

In december 1995, the Polish government approved a plan for building a motorway and expressway network of total length 6770 km., in that 2600 km of motorways. It is planned that 3 motorways and 6 expressways will connect the Polish ports with their hinterland.

Forecasts of general cargo throughput of Polish seaports, of their geographical and type structure, indicate that these ports should prepare to serve the following short range lines:

1. Intereuropean container and ro/ro lines:

European Shortsea Shipping 493
### Table VI: Planned network of ways connecting Polish ports with their hinterland

<table>
<thead>
<tr>
<th>Designation</th>
<th>Route</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>motorways</strong></td>
<td></td>
</tr>
<tr>
<td>A1</td>
<td>(Helsinki) Gdańsk-Toruń-Lódź-Piotrków Trybunalski-Częstochowa</td>
</tr>
<tr>
<td>A2</td>
<td>Szczecin-Zielona Góra-Legnica-state border (Praha)</td>
</tr>
<tr>
<td>A6</td>
<td>(Berlin) Kolbaskowo-Szczecin</td>
</tr>
<tr>
<td><strong>expressways</strong></td>
<td></td>
</tr>
<tr>
<td>S3</td>
<td>(Malmö) Świnoujście-Szczecin</td>
</tr>
<tr>
<td>S5</td>
<td>Gdańsk-Grudziądz-Bydgoszcz-Poznań-Wrocław</td>
</tr>
<tr>
<td>S6</td>
<td>(Szczecin) -Goleniów-Koszalin-Gdańsk</td>
</tr>
<tr>
<td>S7</td>
<td>Gdańsk-Elbląg-Warszawa-Kielce-Kraków-state border</td>
</tr>
<tr>
<td>S10</td>
<td>(Warszawa) Zakroczym-Toruń-Bydgoszcz-Pila-Szczecin</td>
</tr>
<tr>
<td>S50</td>
<td>(A1 Tczew) Elbląg-state border (Kaliningrad)</td>
</tr>
</tbody>
</table>

- Feeder lines to German and Dutch ports;
- Ro/ro lines to North Sea ports;
- Ro/ro lines to United Kingdom and Irish ports;
- Ro/ro lines to Baltic States’ ports;
- Ro/ro lines to Scandinavian ports.

2. **Passenger/car and rail ferry lines:**
   - To ports of central and southern Sweden;
   - To ports of Finland and of the Baltic States.

The growth of volume of cargo mass tending towards these lines allows to expect a significant increase of the frequency of departures of vessels. This is one of the basic conditions of reality of the transportation forecasts. Without a larger number of shipping lines and larger frequency of departures, there are no real chances for a development of short sea shipping in Polish ports.
After the successful First Conference in Delft (26-27 November 1992) and the equally successful Second Conference in Athens/Vouliagmeni (2-3 June 1994), the Organising Committee is now pleased to present the Conference Papers of the Third European Research Roundtable Conference on Shortsea Shipping, which will be held on 20-21 June 1996 in the Radisson SAS Royal Hotel, Bergen, Norway. The Conference is being organised in close cooperation with the Centre for International Economics and Shipping (SIØS), Bergen and Marintek A.S., Trondheim.

There is general agreement that only by focusing research on shortsea shipping in Europe, it will be able to profile itself as an attractive alternative to shippers and receivers of cargo, transport companies and forwarders, shipping lines and operators, governmental and European institutions, and politicians. Without their collective support, shortsea shipping risks to remain merely a promising, but unreachable alternative.

We invite maritime researchers and decision-makers to participate in this stimulating event and contribute to the discussion. The papers will present different perspectives to cover all aspects of shortsea shipping.