SECOND EUROPEAN RESEARCH ROUNDTABLE
CONFERENCE ON SHORTSEA SHIPPING

strategies for achieving cohesion in Europe through shortsea shipping

2-3 JUNE 1994 ATHENS/VOULIAGMENI

CONFERENCE PAPERS

DELTFT UNIVERSITY PRESS
1994
Ook aanwezig: European Shortsea Shipping,
ISBN 90-407-1050-3 (proceedings, incl. commentaries)
This volume was compiled by Prof. N. Wijnolst and ir. F.A.J. Waals.

Delft, April 26, 1994
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FOUNDATION EUROPEAN RESEARCH ROUNDTABLE CONFERENCE
DELFT THE NETHERLANDS

DELFt UNIVERSITY PRESS
1994
PART 1 - CONFERENCE PAPERS INTRODUCTION

PREFACE

Shortsea shipping plays a vital role in the international movement of goods and passengers within Europe; a role that is increasingly recognized by European policymakers, witnessing the European Commission’s White Paper on a future European Transport Policy and the reports from the Maritime Industries Forum. In spite of its importance, shortsea shipping has attracted relatively little attention from maritime and transportation researchers. For this reason the First European Research Roundtable Conference on Shortsea Shipping was organized on 26-27 November 1992, at the Delft University of Technology in The Netherlands.

The success of this Conference demonstrated the value of uniting maritime researchers and maritime policymakers (from business and government), and led to the organisation of the Second Conference on 2-3 June 1994 in Athens/Vouliagmeni. This Conference is hosted by two universities: the National Technical University of Athens and the University of Piraeus.

The 25 papers which will be discussed at the Conference, approach the general theme from the following three perspectives:

* General and business economics: demand, supply, industry structure, freightmarkets;
* Operational and technical innovation in the logistical chains: ships, ports, handling, hinterland transport, control;
* Maritime transport policy and regulatory analysis at the national and European level.

The ultimate purpose of the research is to define strategies for achieving cohesion in Europe through shortsea shipping.

Six more papers are included in this volume, but will not be discussed due to time constraints which are imposed by the Roundtable set-up of the Conference.

Not all participants sit at this Roundtable; only the authors of the papers and a selected number of policymakers, and a number of participants who will comment the papers.

Each paper is presented in approx. 10 minutes by the author; thereafter the commentary is presented by a fellow participant in 5 to 10 minutes; the general discussion may take 10 to 15 minutes.
Conference Papers Introduction

This volume does not represent the Proceedings of the Conference; it only contains most of the papers \((22 + 6 = 28)\), but not the commentaries, discussions, policy recommendations, nor a list of participants. The Proceedings will be available by November 1994. The papers in this book are not yet edited, and changes may occur in the final text.

The Conference is supported by the International Committee, and financially by Sponsors, and organised by the Organising Committee. The members are shown on the following pages.

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The funds for the Second Conference are provided by the generous donations of various sponsors, for which we are very grateful. These are presently:

* European Commission, DG-7 Transport, Brussels
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* Hellenic Chamber of Shipping, Greece
* International Bulk Journal, United Kingdom
* Lloyd's of London Press, United Kingdom

ORGANISING COMMITTEE

The role of this Committee is to select the research papers and to recommend policymakers. The Committee also forms the core of the maritime research network which the Conference has established.

The Organising Committee is composed of the following members:

* Assoc. Prof.dr. A. Goulielmos - University of Piraeus
* Drs. P. Liebman - Van Ommeren Tankers, Paris
* Dr. P.B. Marlow - University of Wales, Cardiff
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The day-to-day organisation of this Conference is in the hands of: Assoc. Prof. A. Goulielmos, drs. P. Liebman, Prof. C. Peeters, Prof. H.N. Psaraftis, Prof. N. Wijnolst
CONference Papers Introduction

CONFERENCE SECRETARIAT

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PART 2 - CONFERENCE PROGRAMME

WEDNESDAY JUNE 1, 1994

20.00 Pre-registration and welcome drinks

THURSDAY JUNE 2, 1994

08.30 Registration

09.15 Welcome by Assoc. Prof. A. Goulielmos, General Secretary, Ministry of Mercantile Marine

09.25 Opening by the Minister of Greek Mercantile Marine, G. Katsifaras

09.40 Keynote address by Prof. H.N. Psaraftis, National Technical University of Athens

10.00 Chair of the day: Prof. N. Wijnolst

Session I - Shortsea Shipping Regional Analysis

1. T de Raymond, France
The setting-up of feeding/coastal services, a solution for the medium sized ports of the Atlantic arc?

2. W. Förster/B. Zigic/W. Simon, Germany
Prerequisites for improvement of the shipping in South-East European region

3. J. Truau, France
Metro-coastal shipping

4. L. Ojala/S. Lall/M. Svendsen, Finland/Norway/Sweden
Baltic bulk shipping in the 1990's: How to match an ageing shortsea fleet with increasing demand?
Conference Programme

12.00 **Session II - Multimodal and modal split**

5. J.L.J. Marchal, Belgium  
Shortsea shipping from hinterland ports by sea-river going vessels: study of the influence of a free cabotage policy

6. J. Igielska, Sweden  
An alternative system for shortsea shipment of road vehicles

12.45 Luncheon buffet

14.00 **Session II - continued**

Modal split analysis in Greek shortsea passenger/car transport

8. R.J. Martens, The Netherlands  
Shortsea shipping: Via optima?

Water-based multimodal terminals: An eclectic site evaluation model

15.30 **Session III - Ships, ports and safety issues**

10. J.P. Dobler, France  
Growth prospects of high-speed car-ferries utilization on European shortsea routes

11. G. Trincass/C. Closca/R. Nabergoj/J.S. Popovici, Italy  
Futura - a fast ro-ro ship for mediterranean coastal trade

12. E. Heirung, Norway  
Are roro ferries subsidizing lolos?

13. J.A. Stoop, The Netherlands  
Safety in a modern perspective

14. F.M.Everard/C.P. Boyle, United Kingdom  
The single market and the removal of obstacles to the greater use of shortsea shipping

18.00 End of session
19.00 Departure for the Yacht Club of Greece, Piraeus for the Conference dinner.

Dinner speech by Dr. P. Sarlis, member of the European Parliament

FRIDAY JUNE 3, 1994

09.00 Chair of the day: Prof. C. Peeters

Session IV - Shortsea shipping case-studies

15. P. Sutcliffe/M. Garratt, United Kingdom
Container traffic in Europe - changing patterns and policy options

16. A.A.C.M. Wierikx/J. van Riet, The Netherlands
Strategic profiles for transport companies: The case for Dutch forest product carriers

17. E.G. Frankel, United States
Integrated tug-barge systems for shortsea shipping in Europe

18. A.M. Goulielmos/M. Milliaraki, Greece
The economic and social impact on Greek passenger coastal shipping of the free movement of marine labour in European Union

19. A. Sjöbris/N. Wijnolst/C. Peeters, Sweden, The Netherlands, Belgium
Fast self-loading and unloading unitload shipsystems for coastal and shortsea shipping: potential in North-West Europe

20. L. Maertens, Belgium
Competiveness of shortsea shipping ports: The case of Zeebrugge

12.00 Session V - Policy making

21. T. Kelchtermans, Belgium
Introduction to the corridor-study

22. C. Peeters/A. Verbeke/E. Declercq, Belgium
The future of European policies for shortsea shipping

12.45 Luncheon buffet
14.00  *Session V - policy making continued*

23. S.G. Sturmey/G. Panagakos/H.N. Psaraftis, Greece
   Institutional and socio-economic issues in Greek ferry services

24. J.J.L. Packer, United Kingdom
   **UK roads to water initiative: a focusing study**

25. Th.H. de Meester, Belgium
   **Maritime Research Priorities for Europe**

15.30  Dr. W. Blonk, European Commission, DG-7
   **Shortsea shipping in the EU: a status report**

16.00  Closing remarks on behalf of the Organising Committee by prof. N. Wijnolst

16.15  Farewell drinks

18.00  Closing of the Conference
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THE SETTING-UP OF FEEDERING/COASTAL SERVICES, A SOLUTION FOR THE MEDIUM SIZED PORTS OF THE ATLANTIC ARC?

By T. de Raymond

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European Shortsea Shipping
THE SETTING-UP OF FEEDERING/COASTAL SERVICES, A SOLUTION FOR THE MEDIUM SIZED PORTS OF THE ATLANTIC ARC?

ABSTRACT

The origin of the project: ESTURIALES -1992

Following a discussion about the foreseeable evolutions of maritime transport and their consequences for the ports on the Atlantic seabord of Europe, the ESTURIALES, a club of european estuaries, decided in 1993 to commission the research consultancy CATRAM to identify the potential market of feeder­ing/coastal services for the transport of containerized goods along the Atlantic Arc.

Promising results ...

This identification survey carried out in 1993 under ESTURIALES and ACEL’s supervision and co-financed by the EEC (Exchange of Experience Programme), has led to promising conclusions.

Actually, the feedering/coastal potential traffic along the Atlantic Arc seems high enough to bring into service small container ships linking up the main medium sized ports of the Atlantic Arc.

Three types of services have been considered:

* A self centred service linking up the ports of the European west Atlantic, excluding any linkage to ports not located on the Atlantic coast. The potential traffic is about 240,000 Tons/year;

* A disenclavement service connecting up these ports and linking them to a main hub of Northern Europe. The potential traffic is about 1,150,000 Tons/year. This service seems to be the most viable one;

* A network (mixed) service combining two disenclavement services and a self centred service. The potential traffic is about 1,400,000 Tons/year, but the implementation of that service would be more delicate.

The traffics which might be potentially handled by the ports of the Atlantic Arc are impressive, especially when compared to the current containers traffics of these ports
... which need confirmation by the operators in 1994 within the ATLANTIS Programme:

In 1994, following the 1993 survey, a feasibility study will be carried out by CATRAM under ACEL's supervision, within the ATLANTIS Programme. The European union and ten Regions in France, Great Britain, Spain and Portugal, are involved in this project.
The purpose of the project is to test with the operators (shipping companies, large shippers...) the hypothesis of the 1993 survey, and to achieve comprehensive technical and financial files in sight of a later negotiation for the setting up of maritime services.

1 ORIGIN AND OBJECT OF THE STUDY

In 1992, the foreseeable evolutions of maritime transport and their consequences for the ports on the Atlantic seabord of Europe were discussed within the ESTURIALES Club. One of the main conclusions was that the bringing into operation of bigger and more sophisticated ships, which are more costly, and the concentration of shipowners, would enhance the tendency to concentrate the traffics on a limited number of main ports (hubs) generally located within the north range, to the detriment of the medium sized ports of the Atlantic Arc.
This seemed particularly true for the containers traffic which the ports bitterly fight over.
Besides, such a concentration of traffic in a few main ports leads to an increasing saturation of the main overland transport routes to/from these ports.

On this basis, the ESTURIALES decided in 1993 to commission the research consultancy CATRAM to identify the potential market of feedering/coastal services for the transport of containerized goods along the Atlantic Arc, in order to:

* Bring the companies in these regions a more adequate service at better rates, likely to facilitate their import and export activity with the world;
* Give new life to the ports of the Atlantic coast of western Europe by enhancing their complementarity and consolidating the regular ocean-going shipping lines at these ports;
* Increase the integration of the economies of the regions along the Atlantic coast of western Europe amongst each other and with Europe;
* Open up subsequent possibilities for creating new regular ocean-going shipping lines.

---

1 ESTURIALIS is a club of elected Representatives and civil servants of European estuaries in Great Britain, France and Portugal
The Setting-up of Feedering/Coastal Services

Figure 1: Self centred feedering service

European Shortsea Shipping
Section I - Shortsea Shipping Regional Analysis

Figure 2: Disenclavement feedering

European Shortsea Shipping
Figure 3: Network (mixed) feedering service
Moreover, this reinforcement of the community capacity in the field of maritime transport, would contribute to limiting the saturation of the main overland transport routes and thus to conservation of the environment.

This survey is a direct follow-up to the recommendation concerning transport following the prospective study on the Atlantic regions, carried out for DGXVI in 1991.

It was financed by the members of ESTURIALES, ACEL and the European Community through an Exchange of Experience Programme (EEP).

More precisely, the method chosen consisted in testing ways of developing systems of maritime feederering traffic to service the main regions of the seaboard and to link them up with the closest international shipping lines. It also consisted in examining the additional traffic likely to be brought in by inter-regional coasting traffic to the feederding services for the intercontinental lines studied.

2 THE METHOD

Two pathways have been used:

* The first was checking whether the development of a shipping route linking up the ports of the seaboard was likely to reinforce the different existing international routes in this, that or another port (by bringing in traffic from other ports on the seaboard not directly connected to these routes). This approach, (known as "self-centred" development) was based on the fact that the existing direct international routes from the ports on the Atlantic seaboard were in each case specific and generally more complementary than competitive;

* The second (known as "disenclavement") consisted in measuring what the feeder routes connecting the main ports of the seaboard to the large hubs of the North Sea could collect between Lisbon and Montoir (Nantes/St Nazaire) on one hand and between Glasgow and the Severn ports on the other hand;

* Lastly, a survey of a mixed service combining the possibilities offered by both of the approaches described above was carried out.

To carry out these analyses it was necessary to:

---

2 ACEL is the "Association Communautaire de l'Estuaire de la Loire" (in Nantes). Its members are local Authorities within the Loire estuary

3 Lisbon with South America and the Eastern Mediterranean, Liverpool with North America, Montoir (Nantes/St. Nazaire) with the Indian Ocean and the Caribbean, etc.
The Setting-up of Feeder/Coastal Services

Figure 4: Flowchart of the approach used

* Process regional data concerning overseas trade in all the regions of the five countries concerned (United Kingdom, France, Spain, Portugal and Ireland). As this data was available for detailed categories of products, it was possible to assess the containerizable proportion of products ex-

4But such detailed data was not obtained for Portugal and Ireland which were treated as entities.
changed through overseas trade with foreign countries for each Atlantic region.

* Build a computerised model to compare the different transport chains required to allow the products from each region to have access to the shipping routes linking them to the different regions of the world. This model, which allows the traffic to be allocated between the different competing transport chains takes into account both cost factors and quality of service factors for each type of transport (enhancing the forwarding time between the various sea "routes" or land routes giving access to the international shipping routes). This work required in particular an analysis of the existing transport offer and cross-checking numerous parameters involved in transport costs (overland or by sea) and handling costs in the ports as well as taxes and port fees in each of the ports concerned.

2.1 STATISTICAL SOURCES:

* To assess the potential feeder traffic, the survey mobilised national and european sources (EUROSTAT);
* The additional volumes of coasting traffic likely to partly supply the "feeder" ships are those studied by MDS Transmodal in a 1993 survey specifically pertaining to this subject.

2.2 DETERMINATION OF CONTAINERISABLE INTERCONTINENTAL TRAFFIC ACCORDING TO THE TYPE OF PRODUCT AND THE GEOGRAPHICAL AREAS SERVICED

According to the logic of maritime services, the world has been broken down into 31 geographical areas (subsequently grouped together in only 10 regions). At this stage, the containerisable tonnage is calculated from the overall tonnage, by applying a coefficient, the rate of containerisation varies according to:

* The type of product;
* The geographical region of origin or destination.

Corrections have been introduced:

* For the small volumes of goods which originate from or are sent to regions that are far away and highly containerised: this correction leads to a mean increase of about 5% of the containerised volumes to be taken into account, depending on the country;
The Setting-up of Feeder/Coastal Services

* For the weight of the different packaging (inner or primary packaging, cardboard, container ...). This is assessed at 20% of the net weight;

* For "hi-jacking" intercontinental traffic, particularly a sizeable proportion of French foreign trade in added value goods which goes through the Belgian ports, or for inter-regional traffic (coasting) between the different regions of the Benelux coastal area.

2.3 TYPES AND SIZE OF VESSEL

For feeder, containers are transported and the ship will be of the Lo/Lo\(^5\) type because of the favourable capital investments for this simple type of specialised vessel.

If the goal involved capturing larger parts of potential coasting, it would be necessary to consider a more multi-purpose ship, capable of embarking several categories of unitised freight: containers, road trailers or complete (trailers). If this were to be the case the "CONRO" option (containers and RO/RO) would better meet the requirements, in spite of significantly higher capital investment than for LO/LO, which would be partly compensated by possible gains in handling costs.

But the fundamental choice of the study is mainly aimed at the potential for feeder, and only takes coasting into account as a possible complement\(^6\). Thus, the study will be based on the use of LO/LO container ships (nothing but containers).

The size of the ships is submitted to constraints by the traffic potential considered and by technical criteria such as the "time at sea compared to time in port" ratio, by the frequency of services and by cost. The most suitable size of ship with respect to these criteria for "short sea" traffic on the Atlantic seaboard is included between 200 and 400 TEU\(^7\).

However, less productive ships, of a size included between 100 and 180 TEU have been studied for services with a lower potential. Apart from the problems

\(^5\)Lo/Lo: Lift On/Lift Off: container ship requiring vertical handling

\(^6\)This restriction is justified by the fact that the main part of inter-regional traffic is currently, and maybe for some time to come, transported in road trailers and not in shipping containers for which constraints are applied with respects to standards. This being so, a Lo/LO ship, which can practically only load containers, is heavily penalised.

\(^7\)TEU (Twenty feet Equivalent Units)
of cost, these smaller ships also have the disadvantage of being much more sensitive to navigation conditions.

The faster ships the market offers for capacities of 250 to 400 TEU have a commercial speed of 16 knots and all the calculations concerning such services are based on this speed. However, some rotations have been studied for smaller ships, ranging from only 100 to 180 TEU. For these ships, an operational speed of only 13 Knots was used because of the scarcity or lack of availability of high performance ships in this size range and the difficulty of navigation for smaller sized ships in the Bay of Biscay.

2.4 PORTS SERVICED AND ROTATION

For reasons of cost and length, the number of ports serviced by a feeder shipping line along the Atlantic seaboard is necessarily limited. The main competition such a shipping line will have to face is of course road haulage. To have any chance of conquering a significant market share for this type of clientele, a high level of service must be offered, as close as possible to that offered by road transport.

This quality expected by the shippers means a high degree of frequency (if possible at least twice a week), in addition to short transit time.

The study has only included the estuaries or ports already adequately equipped and accessible at all times with a sufficient potential in unitisable goods available from their hinterland. The ports and estuaries that meet these criteria could be the following: the Clyde, Dublin, Liverpool, the mouth of the Severn, the Loire and Gironde estuaries, Bilbao, Vigo and the Tagus estuary. In spite of this restriction one should also keep in mind that this service will be of the "milkround" type.

2.5 CHOICE OF TRANSHIPMENT PORTS AND SELECTION OF TRAFFIC TO BE ALLOCATED

On the basis of the international flow classified by origin/destination for each of the regions of the Atlantic Arc, we chose to study only those likely to lead to transport connected to the feeder service on the Atlantic Arc. These are flows for which pre or post shipping to another location of the Atlantic Arc is possible, as they include at least one direct call at one of the main ports on the Atlantic Arc (self-centred option) or to/from one of the North Sea hub ports, if there is no such link ("disenclavement" option with link to the North sea hub ports). This selection was made on the basis of traffic to or from the ten main maritime regions of the world considered.
The Setting-up of Feeder/Coastal Services

The ports of the Atlantic seaboard at which transhipment between mother ship and feeder is possible, that is to say at which there is at least one existing regular, sufficiently frequent shipping route (at least one a week) with the regions of the world defined, will be referred to as "transhipment ports" for this destination.

Using these criteria, two main transhipment ports can be distinguished amongst the ports on the Atlantic Arc: these are Lisbon for Africa, the eastern Mediterranean, the south of America and Liverpool for North America. Some other ports (Montoir and Bilbao) are secondary transhipment ports for certain destinations for some regions of the Atlantic Arc only.

2.6 DEFINITIONS, UNIT COSTS AND VALUES USED FOR PARAMETERS IN THE MODEL

The flows were allocated to the various alternative transport chains according to generalised costs. The criteria of choice used by the transport companies is "total quality", not only price. The "generalised costs" criteria, which determines how the model calculates allocation, is a step forward with respect to the latter, as it not only includes the direct financial cost (price) but also indirect costs due to transport and waiting times.

Thus, the model must be fed all the parameters required to calculate generalised costs, some of which are independent from the definition of the chains themselves: unit costs, distances, ships.

* The cost of maritime transport is calculated for defined rotations: it includes time at sea and time in the ports of call (on average 8 hours for a port of call for the services using vessels of 250 TEU or of 180 TEU, and 6 hours only for services operating small ships of 100 TEU).

* Unit costs for maritime transport (cost of TEU / mile)
The cost evaluation of maritime transport between ports of the Atlantic seaboard by various types of Lo/Lo feeder ships carried out by the consultant shows the mean cost of a TEU per mile at 0.11 ecu for 250 TEU ships for a mean filling rate of 66%.
This assessment is based on a breakdown of maritime costs into chartering costs, including capital costs and crew costs, and hold costs which are broken down into propulsion costs for the vessel itself and auxiliary costs.

* Cost of overland transport
This cost is equal to the product of an overland distance multiplied by the unit cost of TEU/km covered.
Numerous polls and surveys carried out amongst the road transport companies showed that the current cost of a km. covered for a truck (a transport capacity of 2 TEU) is generally between 0.68 ecu and 1 ecu. The mean cost used for calculation is 0.8 ECU/ truck/Km. covered, that is to say, 0.4 ecu/TEU/km. covered.

* The cost of ferry crossing for road links between the United Kingdom and the continent, based on information supplied by the road hauliers, is taken into account as a "fictitious distance in kilometres" added to the real distance and adjusted on the cost of maritime transport.

* Pre and post-shipping distances
These are calculated according to the radius of the hinterland for each of the ten ports. Two distances were used: the near hinterland defined for each estuary as its privileged area of supply where the ports captive market is the strongest, and a farther hinterland, the second belt, where the port can nevertheless capture a part of the goods exchanged.

For the near hinterland, the average estimated pre-shipping distance is about one third of the radius of this hinterland. For the second belt it is the average distance for access to the heart of this region from the port.

* Handling costs and harbour dues on goods
To recapitulate harbour dues, multiple sources were therefore required: estimates from the main handlers in the European ports (Great Britain, Ireland, France, Spain and Portugal), and also commercial documentation giving the tariffs of the main ports in Europe (ports of the Atlantic regions, but also Felixstowe, Marseille, Barcelona, Le Havre, Antwerp and Rotterdam ...), the magazine "Containerisation International" and "Le Marin" (particularly the comparative study on harbour fees, March 1992).

Harbour fees used for the model are those concerning containers or containerisable goods. With respect to handling, the consultant has tried to obtain full details of costs in all their complexity whenever possible: receiving/delivering, loading/discharging, overtime ..., for containers of 20 and 40, full and empty, and for trailers.

* Commercial expenses
The consultant took into account the shipping companies’ commercial expenses by applying a coefficient of + 15% to maritime transport and a coefficient of + 10% to the handling costs. The latter rate reflects the fact that the overall cost of handling cannot be dissociated from the shipowner’s share (handling on board). The handlers’ commercial expenses are taken into account at their source (they are included in the tariffs supplied by the handlers).
The Setting-up of Feeding/Coastal Services

* **Enhancement of time**

The comparison between the chains of transport for the purposes of allocating traffic means taking into account transit time since the shippers are very sensitive to the quality of service which is judged mainly on the time required for transport. To achieve this result, the consultant calculated the enhancement of the time parameter by overland or maritime route. The unit cost of time is one of the most important adjustment parameters in the model.

After several sensitivity analyses, the final value selected was a unit cost of time at a rate of 30.5 ECU per day for the feeding chains and 45.5 ECU for the coasting chains.

The values selected, which were substantially higher than the strict financial costs of immobilisation of the goods, had a non-negligible impact on the allocations, insofar as the time cost may represent a high fraction of the total cost of the maritime chains, whereas by its very definition it bears very little weight on alternative road chains.

For the types of feeder/coaster ships considered, the speed used was fixed at 16 knots for the most productive vessels (250 TEU) and 13 knots only for ships of smaller size.

For road haulage, the mean speed selected, based on the information supplied by the road hauliers is 45 km/hour (taking into account the compulsory resting time).

The model for transit time also takes into account inevitable waiting time for the good at the port (waiting for the feeder, or waiting for the mother ship). The values selected as parameters for the model are an average of two days waiting time for the "self-centred" type of circuit and one day only for the "disenclavement" type of service as the frequency of feeders and mother ships is generally higher in this case.

* **"Hub effect"**

Another adjustment parameter used in the model is a "bonus" or "malus" system for certain transport chains, to take into account factors concerning the competitive aspects of these chains which is known, but which the basic structure of the model cannot account for.

This is true for the "Hub" effect which is characteristic for the feeding chains which transit through the ports in Northern Europe.

---

8Coasting chains are relatively short from door to door; any variation in one of the segments has a relatively high impact on the whole chain. Conversely, the international chains taken as a whole (including the transoceanic link) are long and thus less sensitive to a variation in the time factor in one of the feeding links.
Section I - Shortsea Shipping Regional Analysis

On one hand, the high frequency of transoceanic services which can be found in such ports (Le Havre, Antwerp and Rotterdam), and more particularly Rotterdam, minimises waiting time for goods in these ports. On the other hand, fierce competition between shipping companies which is the general rule between shipping companies on ocean-going routes, allows the shippers to obtain conditions which are exceptionally favourable for ocean-going transport.

This is why the chains using the hubs in the north have been favoured by the allocation of a bonus of 175 ECU, so that the model restores the attractiveness which these hubs represent in reality.

On the contrary, the port of Algésiras, to the south of the Arc is only a hub for two shipping companies, practically speaking, who operate private terminals there Maersk and Sea Land. This port is not as open as the others and accessible to all traffic. The chains of traffic which involve calling at this port have therefore been penalised by applying a malus of 100 ECU.

* Storage
In most ports there is a storage period free of charge. The feeder/coaster service proposed is frequent and we have based it on the hypothesis that the storage time for the goods will not exceed the period that is free of charge.

2.7 COST OF COMPLETE CHAINS OF FULL CONTAINERS

The total cost of the complete chains can be broken down as follows:

Coasting chain:
- Pre-shipping overland;
- Handling from overland to maritime mode in the port of boarding;
- Harbour dues on the goods in the port of boarding;
- Maritime transport (freight);
- Handling from maritime to overland mode in the port of discharge;
- Harbour dues on the goods in the port of discharge;
- Enhancement of transit time (including stops).

Feeder chain:
- Pre-shipping overland;
- Handling from overland to maritime mode in the port serviced by the feeder (connected port);
- Harbour dues on the goods in the connected port;
- Maritime transport (freight);
The Setting-up of Feeder/Coastal Services

- Handling from one ship to another in the transhipment port (master port);
- Harbour dues for the goods in the transhipment-shipment port;
- Enhancement of transit time (including stops).

Road haulage chain:

- Overland transport;
- Handling from overland to maritime mode in the boarding port;
- Enhancement of transit time (including stops).

2.8 ALLOCATION OF THE FLOW BETWEEN THE CHAINS WITH RESPECT TO GENERALISED COSTS OF THE LATTER

At this stage of the modelling, the flows must be broken down amongst the different transport chains according to the generalised costs they incur. The flows, the transport chains amongst which these flows can be shared and their generalised costs are known.

The rule of allocation used will allocate the flows with respect to an inverse function of generalised costs of the different chains. More precisely speaking, they will be allocated as an inverse function of generalised costs raised to a factor of a power between 4 and 8. This exponential factor will show up greater or lesser sensitivity to the decision-makers' costs: the higher the factor, the more that allocation will favour lower costs.

It is generally accepted that the most suitable factor of exponentiality for a model for the purposes of goods transport is 6. But sensitivity tests have been carried out to check that the results are dependent on this factor. The final parameters selected for the model did use this value.

Thus, the flows are always shared out amongst all of the alternative chains. But the distribution is very sensitive to generalised costs, and mostly (when there are significant differences in cost, above around 10%, between the alternative chains), the allocations concentrate the main flows on the transport chain which offers the best performance.

2.9 REDUCTION OF THE VOLUMES ALLOCATED TO THE MARITIME FEEDER/COASTING ROUTE CONSIDERED FOR THIS SERVICE

The structure of the model also defines the alternative chains amongst which the flows of transport can be distributed. For example, in the case of a "self-centred" circuit, for a feederering flux from the hinterland of Lisbon to be sent to the United States, the chains could be:

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* Lisbon - Algésiras by road;
* Lisbon - Algésiras by sea;
* Lisbon - Liverpool by sea (the proposed feeder);
* Lisbon - Rotterdam by road;
* Lisbon - Rotterdam by sea.

There would be no problem if there were currently no existing sea link between Lisbon and Liverpool. But if the contrary were true, the volumes allocated to the chain represent the potential which could be allocated to this line, a part of which is already dealt with by the maritime feeder.

The volumes which can be allocated to the new feeder are therefore reduced in the model according to the current maritime offer existing on that link at the rate of their frequency.

This requirement to reduce volumes allocated according to the frequency of competitors obviously appears much more clearly in the "connected" service diagram, because of the large number of feeder and/or coasting services already linking some of the Atlantic ports to the North Sea hubs.

2.10 CALCULATION OF THE NUMBER OF EMPTY CONTAINERS LIKELY TO BE OFFERED TO THE SERVICE FOR REPOSITIONING.

It is generally recognised that maritime transport can be particularly advantageous costwise (especially marginal costs) for repositioning empty containers.

The shipping companies are often faced with a market imbalance which can lead to complex problems to reposition containers. As low cost is a prime factor, the containers are re-located according to needs, but also according to the least expensive occasions to re-position them when these occur.

Empty containers do not necessarily come back to their departure point, but are often repositioned wherever a return freight is found ("triangular" trips). They can also be lent to overland, road or rail operators who have free use of the container for their own transport in exchange for shipping the container to a given place within a given time.

But, when all these resources run out, standard repositioning by road is very expensive as the marginal costs are indistinguishable from the mean cost. However, on the other hand, ships often have an unused capacity which can be negotiated at an advantageous price for both parties.

As the containers are empty, the handling costs are also lower since less sophisticated tools than container gantries are used for handling. These transports do not include harbour dues by definition.
The Setting-up of Feeder/Coastal Services

This is a complex item, to which we did not wish to apply the previous model of allocation according to the cost of alternative maritime and overland chains which seemed ill-suited for the purpose.

We preferred to use a rough assessment which had the advantage of being simple and allowing a rough idea to be assessed. We considered that the potential for the service considered was equal to half the volume of the imbalance of direction.

Thus, for example if 10,000 TEU are transported from Lisbon to Liverpool, and only 5,000 come back, the imbalance in direction amounts to 5,000 TEU, and half of this, about 2,500 TEU, will be allocated to the maritime service between Liverpool and Lisbon for repositioning.

3 THE RESULTS

3.1 "SELF-CENTRED" SERVICE

Lisbon--- > Bilbao--- > Bordeaux --- > NSN--- > Severn--- > Liverpool--- > Glasgow--- > Lisbon, and the other way round.

Flows allocated

For a price at a rate of 0.12 ECU/TEU/mile, the feeder flows total 14,735 TEU. The estimated coasting flow capturable would add around 9,100 TEU, which in this particular case is far from being negligible.

As regards feeder, the strongest links are:

* Bordeaux - Liverpool;
* Lisbon - Liverpool;
* Nantes/St Nazaire - Liverpool.

Bilbao offers a lesser potential, and the two other ports, the Severn and Glasgow, bring in very little traffic.

It should be noted that the situation is quite different in the field of coasting, for which Bilbao, the Severn and Glasgow offer high flows of traffic, which justifies maintaining these ports on the rotation.

There is a fairly limited potential for repositioning empty containers, mainly in the direction North - South between Lisbon, Nantes/St Nazaire and Liverpool.
Lastly, it should be noted that although four ports (Lisbon, Bilbao, Nantes/St Nazaire and Liverpool) on the service are transhipment ports for some regions of the coastal belt, the port which draws the most benefit from the service is undoubtedly Liverpool. Practically all the feeder traffic involving Liverpool is transhipment traffic for the ocean-going shipping lines operating from this port. This is partly explained by the high flow concerning North America, a coastal belt which in this system is only accessible through Liverpool.

Costs, receipts, financial balance of the service

The whole problem is the relative weakness of the flows allocated, which do not allow the costs of a frequent service to be covered (2 calls per week), which appears to be essential to provide a quality service. The possibility of using smaller ships has its limits as the cost of maritime transport increases in this case.

There is little room to manoeuvre as far as price is concerned, because if the threshold price of 0.13 ECU/TEU/mile is exceeded, the flows allocated to the shipping line will drop sharply, leading to a decrease in receipts.

This is the diagram which seems the most difficult to justify and implement under the current market conditions. The problem is linked to the relatively low flows allocated to the various chains of maritime transport which make up this service; this weakness can be explained by the handicap the ports on the Atlantic seaboard, increasingly deserted by deep-sea shipping companies, have to face, and impose higher cost on the transport chains. This weakness is also linked to the great attractiveness of the Northern ports.

<table>
<thead>
<tr>
<th>Price (ECU/TEU/mile)</th>
<th>Feeder (international traffic) TEU</th>
<th>Part of European regional traffic TEU</th>
<th>Total TEU</th>
<th>Income ECU</th>
<th>Filling Ratio %</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.10</td>
<td>16,977</td>
<td>9,776</td>
<td>26,753</td>
<td>1,859</td>
<td>84.72%</td>
</tr>
<tr>
<td>0.11</td>
<td>15,799</td>
<td>9,423</td>
<td>25,222</td>
<td>2,036</td>
<td>80.04%</td>
</tr>
<tr>
<td>0.12</td>
<td>14,735</td>
<td>9,081</td>
<td>23,816</td>
<td>2,100</td>
<td>75.70%</td>
</tr>
<tr>
<td>0.13</td>
<td>13,729</td>
<td>8,789</td>
<td>22,518</td>
<td>2,151</td>
<td>71.57%</td>
</tr>
</tbody>
</table>

Table I: Self-centred service; Sensitivity of the results to freight rate
3.2 "DISENCLAVEMENT" SERVICE.

Lisbon ---> Bilbao ---> Bdx ---> NSN ---> NH ---> Severn ---> Liverpool --->
Glasgow ---> Lis and the other way round. (NH = North Hub, tipically Rotterdam)

Our belief that a system which offered a link between the ports of the Atlantic
seaboard and Europe at one of the North Sea "hubs", with a feedering service, would have no great difficulty in finding a market as a complement to
existing services, was founded.

There are many reasons linked to the strong attractiveness of the ports in the
North, based on an unbeatable maritime service and also on the needs of the
shipping companies implanted there for serving the more remote European
regions from their home ports.

These needs have indeed led to the creation of coasting and feedering routes,
some of which are integrated into the ocean-going shipping routes and they are
always founded on such a logic.

Flows allocated

The competitive nature of the Northern hubs, the all-purpose type of coastal
area they offer, allow the projected maritime chains to conquer a large volume
of traffic from the competing chains, mainly road haulage, but also some
alternative shipping routes.

For a rate fixed at 0.11 ECU/TEU/mile, the feedering flows allocated would
amount to 80,000 TEU approximately. The coasting flows would also bring in
about 33,700 TEU and would thus represent 29% of the TEU.

Feeder flows:
Apart from the hubs in the North, which of course mobilised the most enormous
flows because of their major role in transhipment, the port of Nantes/St Nazaire
is clearly a leader, although it plays a minor role compared to Liverpool in the
field of transhipment. Although the Severn estuary has a non-negligible level of
activity (almost exclusively with the hubs in the North), Glasgow, however,
contributes very little to the service (because of competing lines towards Rot-
tterdam and departing from the east of Great Britain, which are much more
favourable in terms of distance, time and cost).

Coasting flows:
Apart from the hubs in the North, the Severn estuary, Bilbao, Glasgow and
Liverpool play an important role in the coasting lows (although three of these
ports contribute very little in terms of feedering). The French ports play a very
limited role here.
Costs, receipts, financial balance of the service

For an operational speed of 16 knots, the rotation can be carried out in 14 days. To maintain the frequency judged to desirable of two calls a week in each port, 4 ships will be required. This means that it will not be possible to use 400 TEU ships because the capacity of these would greatly exceed the potential traffic. The most suitable size is about 250 - 300 TEU.

The cost calculations were made on the basis of 250 TEU ships. These costs would easily be covered by the income from traffic for a tariff at 0.11 ECU/TEU/mile. The average filling rate would be very high, around 84%. A higher tariff (0.12 ECU/TEU/mile) would produce slightly higher income, but for less traffic, at a mean rate of use of 77%, which remains critical. Thus it would seem that ships of 300 TEU are required, these cost 1 million ECU extra to charter. The total cost would still be covered by the amounts receivable.

<table>
<thead>
<tr>
<th>Price (ECU/TEU/mile)</th>
<th>Feeder (international traffics)</th>
<th>Part of European regional traffics</th>
<th>Total</th>
<th>Income</th>
<th>Filling Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ECU/TEU</td>
<td>1000' TEU/miles</td>
<td>TEU</td>
<td>1000' TEU/miles</td>
<td>TEU</td>
</tr>
<tr>
<td>0.10</td>
<td>88,704</td>
<td>63,845</td>
<td>35,039</td>
<td>25,333</td>
<td>123,743</td>
</tr>
<tr>
<td>0.11</td>
<td>80,783</td>
<td>58,040</td>
<td>33,727</td>
<td>24,379</td>
<td>114,510</td>
</tr>
<tr>
<td>0.12</td>
<td>73,478</td>
<td>52,710</td>
<td>32,450</td>
<td>23,449</td>
<td>105,928</td>
</tr>
<tr>
<td>0.13</td>
<td>66,927</td>
<td>47,927</td>
<td>31,205</td>
<td>22,543</td>
<td>98,132</td>
</tr>
</tbody>
</table>

Table II: Disenclavement service; Sensitivity of the results to freight rate

3.3 "NETWORK" TYPE SERVICE

Interesting perspectives are opened up by the "disenclavement" system as described above. The feeder could have access to a high volume of traffic with good financial conditions. However, this system of service does not seem the best because some links are not favoured. In most case these are the links between the French ports (even Bilbao) and the British ports, as the route would be far too long because of transiting through the hubs in the North. Generally speaking, this type of trip includes very few shortsea routes.
The Setting-up of Feeder/Coastal Services

The design of the "network" type of service is founded on this point. It is an attempt to optimise the "disenclavement" system, aiming at increasing the volume of traffic capturable to the detriment of making the system more complex and increasing the means required to set it up.

The three services for the "network" system

Whereas the various services examined above were made up of a single "line" both ways, the "network" systems has three distinct "lines".

These lines are as follows:

* **Service 1**: Lisbon - NH (North Hub, tipically Rotterdam):
  Lisbon ---> Bilbao ---> Bordeaux ---> NSN ---> NH ---> Lisbon

* **Service 2**: NH - Glasgow:
  NH ---> Severn ---> Liverpool ---> Glasgow ---> NH

* **Service 3**: Bilbao - Liverpool:
  Bilbao ---> Bordeaux ---> NSN ---> Severn ---> Liverpool ---> Bilbao.

This system multiplies the short links. To optimise the system, we were led to shorten service 3 and separate the link to the hub in the North into two North and South circuits which, unfortunately, does not allow some direct links, such as Lisbon - Liverpool, or Glasgow - Nantes/St Nazaire. The model takes into account these links through a system of transhipment either at Nantes/St Nazaire or in the Northern hub served.

This operation is obviously costly, and will reduce the potential attracted by the service (which is in no way strategic, at least in the field of feeder/ing).

**Flows allocated**

The overall results immediately appear to be substantially higher than those for the systems previously examined. For a tariff at 0.11 ECU/TEU/mile, it would amount to 99,500 TEU in feeder/ing, plus 39,800 TEU in coasting.

We should thus be able to count on a total of 139,000 TEU.

With respect to feeder/ing, the Northern hub served clearly shows 168,000 movements linked to transhipment. But Liverpool (24,500 TEU entirely linked to transhipment), Nantes/St Nazaire (31,000 TEU with very little connection with transhipment), Lisbon (22,000 TEU), gain large volumes of traffic.

With respect to coasting, apart from the Northern hub served, the Severn estuary comes first with a total potential of 127,000 TEU. The other important ports are Lisbon, Bilbao and Glasgow.
However, as the system includes three independent routes, operated by different ships, one cannot make general statements. The potential for each one of these routes should be examined in order to dimension the service (ship, frequency).

From this point of view, the three are totally different:

* **Service 1**: Lisbon - NH: this service clearly presents the post potential, with around 56.5 million TEU/miles (55% of the total potential), of which 48.5 M TEU/miles in feeding (86%) and 8 M TEU/miles in coasting (14%);

* **Service 2**: NH - Glasgow: the potential is a good half of that for the above route, with 34.9 M TEU/miles which are equally divided between coasting and feeding;

* **Service 3**: Bilbao - Liverpool: as expected, this route shows the least potential with only 11.4 M TEU/miles, 8.4 M TEU/miles of which are feeding and 2.9 M TEU/miles are coasting.

**Cost, receipts, financial balance of the service**

Using these parameters, the three services show more or less favourable results, depending on the unequal amount of capturable traffic, and also on the productivity of the type of ship used, which incurs high costs for service 3.

It was necessary to check that the means implemented for each service were cohesive with the flow to be transported. This is shown by the rates of use of the capacity of transport, an overall figure of 65%, which varies according to the services between 76.4 and 62.7%, which is acceptable.

Financially speaking, all three services showed contrasting results: services 1 and 2 are profitable, while service 3 shows a deficit. However the overall result is positive.
### The Setting-up of Feeder/Coastal Services

<table>
<thead>
<tr>
<th>Price</th>
<th>Feeder (international traffics)</th>
<th>Part of European regional traffics</th>
<th>Total</th>
<th>Income</th>
<th>Filling Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECU/TEU/mile</td>
<td>TEU</td>
<td>1000' TEU/miles</td>
<td>TEU</td>
<td>1000' TEU/miles</td>
<td>TEU</td>
</tr>
<tr>
<td>0.10</td>
<td>107,006</td>
<td>80,076</td>
<td>40,837</td>
<td>28,892</td>
<td>147,843</td>
</tr>
<tr>
<td>0.11</td>
<td>99,496</td>
<td>74,686</td>
<td>39,809</td>
<td>28,116</td>
<td>139,305</td>
</tr>
<tr>
<td>0.12</td>
<td>92,325</td>
<td>69,473</td>
<td>38,887</td>
<td>27,416</td>
<td>131,212</td>
</tr>
<tr>
<td>0.13</td>
<td>85,902</td>
<td>64,810</td>
<td>37,985</td>
<td>26,730</td>
<td>123,887</td>
</tr>
</tbody>
</table>

### Table III: Network system (mixed service); Sensitivity of the results to freight rate

<table>
<thead>
<tr>
<th>Vessel size (TEU)</th>
<th>Service 1. Lisbon-Rotterdam</th>
<th>Service 2. Rotterdam-Glasgow</th>
<th>Service 3 Bilbao-Liverpool</th>
<th>All Services</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>250</td>
<td>250</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Total distance (miles)</td>
<td>2,739</td>
<td>1,901</td>
<td>1,741</td>
<td></td>
</tr>
<tr>
<td>Number of round trips per year</td>
<td>108</td>
<td>104</td>
<td>104</td>
<td></td>
</tr>
<tr>
<td>Theoretical Capacity (1000' EVP/miles)</td>
<td>73,953</td>
<td>48,426</td>
<td>18,106</td>
<td>141,485</td>
</tr>
</tbody>
</table>

| Feeder, International traffics (1000' EVP/miles) | 48,491 | 17,742 | 8,433 | 74,666 |
| European regional traffics (1000' EVP/miles) | 8,032 | 17,145 | 2,927 | 28,104 |
| Total traffics (1000' EVP/miles) | 56,523 | 34,887 | 11,360 | 102,770 |
| Filling ratio | 76.43% | 70.58% | 62.74% | 72.64% |

### Table IV: Network system (mixed service), results by line

European Shortsea Shipping
4 CONCLUSION

The results of the survey are encouraging. Indeed, the potential feeder­
ing/coastal traffic along the Atlantic Arc seems to be sufficient to support the
bringing into service of small containerships linking up the main ports of the
Atlantic Arc.
The type of service which appears to be most viable is the "disenclavement"
one which would link up these Atlantic ports to a hub in the north range, such
as Rotterdam.
The potential traffics which might be handled by the main ports of the Atlantic
Arc are important, especially when compared to the current containers traffics
of these ports.

5 PROSPECT FOR 1994: A FEASIBILITY STUDY

One should keep in mind that this was a "home study", mainly based on the
treatment of statistics.
Therefore, it will be necessary to test the hypothesis with the operators (ship­
ing companies, large shippers ...) and to introduce new variant versions.

This is the aim of a feasibility study which has been launched in January 1994,
following the 1993 survey.
That feasibility study will be carried out by CATRAM under ACEL’s supervision.
It is financed by 10 Regions of the Atlantic Arc (in Great Britain, France, Spain,
Portugal) and by the European union through the ATLANTIS Programme.

The purpose is to test with the operators (shipping companies, large shippers...) the
hypothesis of the 1993 survey, and to achieve comprehensive technical and
financial files in sight of a later negociaition for the setting up of maritime
services.
**PREREQUISITES FOR IMPROVEMENTS OF THE SHIPPING IN SOUTH-EAST EUROPEAN REGIONS**

By W. Förster, B. Zigic and W. Simon

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PREREQUISITES FOR IMPROVEMENTS OF THE SHIPPING IN SOUTH-EAST EUROPEAN REGIONS

South-east European region that geographically comprises Balkan peninsula together with surrounding seas (Adriatic, Ionian, Aegean, Sea of Marmara, Black Sea) [10], as well as the countries which come out these seas (at the first place Ukraine, Russia and Turkey), represents one of the traditional travelling directions and an important cross-roads between West and East and North and South of the continent.

Just the fact that this part of Europe is practically surrounded from three sides with the seas, imposes the traffic solutions where the participation of shortsea shipping is almost unavoidable.

The intention here is not to repeat once more the list of unambiguous advantages of shipping in comparison with the other transport modes, but to introduce some more light on the trends of traffic in general and to find the realistic place of shipping, at the first place shortsea and inland navigation, in future traffic’s development of the respective region.

The general development tendencies of the particular traffic branches imposed by the trade and technology demands, state of infrastructure, and of course the influence of the ecological requirements, the recent political changes in the majority of countries in the region, as well as the state of war in some parts of former Yugoslavia, make the problem of finding long-term quality solution for traffic integration between the region and the mid- and west Europe both complex and actual.

From one side, the expansion of road traffic in the last two or three decades according to the all estimates will not change trend nor in the near future, because, besides all the weaknesses such as relatively high costs per ton-kilometre, high energy consumption (Wh/tkm), accident risks and environmental pollution through exhaust gases emission and noise [15, 17], road traffic mode is the only one that completely matches "door-to-door" transport concept.

The technics and international share of production, on the other side, develops herself in such a way to bring the entire process from raw material to the product suitable for further transport as near as possible to the location of finding place. The logical consequence is that the trend of requirements for huge transport capacities, traditionally linked with the railroad and shipping, decreases.

The aforementioned is of course not applicable on certain strategic raw materials or agricultural products whose finding places and production centres
Prerequisites for Improvements of the Shipping in South-East European Regions

<table>
<thead>
<tr>
<th>Spec. energy consumption [Wh/tkm]</th>
<th>Inland navigation vessel</th>
<th>railway</th>
<th>road truck</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total external costs [DM/tkm]</td>
<td>18-130</td>
<td>85-195</td>
<td>260-350</td>
</tr>
<tr>
<td>Air pollution [DM/tkm]</td>
<td>0.0036</td>
<td>0.0115</td>
<td>0.0501</td>
</tr>
<tr>
<td>Traffic accidents [DM/tkm]</td>
<td>0.0034</td>
<td>0.0033</td>
<td>0.0236</td>
</tr>
<tr>
<td>Noise [DM/tkm]</td>
<td>0.0001</td>
<td>0.0012</td>
<td>0.0178</td>
</tr>
</tbody>
</table>

*) the similar values can be expected for coaster

Table I: Specific energy consumption and external costs for inland navigation vessels, railway trains and road trucks

respectively are concentrated only in the particular world regions (crude oil, natural gas, various sorts of cereals). But in case of mines, either metal or non-metal, due to the economical reasons, process on spot at least to the semi-product level, is highly recommended. Then, the further processing up to the finalising is possible anywhere because the increased price per mass unit makes now such product or semi-product more convenient for containerisation, but at the same time for the transportation by road truck, too.

To what general conclusions the fore statements could lead when applied on considered European region? It is not irrelevant to remain that the region with its geographical characteristics and state of infrastructure represents the ideal field for research of the competition chances of all transport modes, as well as any of their combination. Such investigation should require the knowledge of current situation in traffic, current and future transport needs (definition of traffic knots, vectors of traffic flows), kind of goods to be transported, state of infrastructure (railroad, inland waterways and road capacities), as well as harbours disposition, capacities and equipment and a plenty of other details that may have an influence on traffic efficiency. Two practical examples that could be useful to describe the state of the facts and their influences on future chances of shortsea shipping in South-east European region will be herewith roughly considered:

* Middle Europe - Ukraine link over the Black Sea;
* Middle Europe - Greece link over the Ionic and Adriatic.

1 MIDDLE EUROPE - UKRAINE LINK OVER THE BLACK SEA

Two of the biggest European rivers, Danube and Dnjepr, represent the natural waterway connection between these two regions. Mutual distance between
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Danube mouth by Sulina and Dnjepr mouth by Kherson, over the north-western part of the Black Sea, is about 300 km. Both on Danube and Dnjepr exists relatively vivid river traffic. According to the political and economical changes in Ukraine and countries on Balkan along the lower Danube, both parties have a lot of concern to use this natural waterway. The section over the Black Sea is too short to be considered separately as the route of importance for shortsea shipping, but in conjunction with Danube and Dnjepr and their role in transportation shares of mentioned regions, the problems of shipping on this section become very attractive. Therefore, this route will be treated together with its fluvial prolongations.

1.1 TRANSPORT NEEDS

The cargo that is usually transported in both directions is up today mostly the iron ore and scrap. Among other goods that appear in significant amounts there are metal semi-products (steel plates, profiles, wire, castings). Coal, timber and non-metal row materials are mostly transported in direction East-West, while cereals and different final products are being transported to the East. About 13 mil. tons of all kind of goods have been exported and some 6.4 million tons imported in former USSR (now Ukraine) harbours on Danube alone in the year 1990 [4].

In the near future there is to be expected that after the certain period of recession, the trade shall get the increasing trend, specially in European export to Ukraine. Due to the lack of highways and different railway standards (in former USSR the track span is 1524 mm while European standard span is 1435
Prerequisites for Improvements of the Shipping in South-East European Regions

mm), the river and trans-seashipping will probably keep the huge part of transport shares. But due to the great discrepancy in kinds of goods (in general, raw materials from east to west and high-tech products suitable for containerisation from west to east) the problem of exaggerated number of empty containers on the east could involve difficulties. Supposing that this problem will be solved through the future investments in Eastern regions economy (to bring their export goods in form suitable for container transport) the conclusion is that always more and more shares of container shall be introduced on this traffic route.

1.2 RESTRICTIONS THAT IMPOSE SPECIFIC TRAFFIC SOLUTIONS

1.2.1 Draught restrictions

Danube is navigable for sea/river ships theoretically up to Kelheim, Danube km 2414, i.e. along the whole length [17]. But practically, due to the shallow water on the upper section, economical navigation of coasters (about 2.5 meters draught during at least 90% of the year) can be achieved eventually up to Budapest (Danube km 1647) [2, 7]. For reliable reaching of harbours further upstream, the draught must be limited even to 1.5 meters [4, 6, 7] in certain periods of the year when extreme low water level occurs. It can be said that for moderate size coaster, Danube is with 100% probability navigable only up to Braila (170 km from the mouth by Sulina through the main arm), or up to Cernavoda (300 km far from the mouth by Sulina but through the 65 km long Danube-The Black Sea Canal). Upstreams these two points, the traffic is usually performed using various types of river barges assembled in pushed trains whose size depend on section of the river [2, 5, 7]. The most frequent barge type is so-called "Danube-Europe II" that differs from standard "Europe II" barge at most in beam - 11.0 m versus 11.4 m. River motor ships are also present but their total carrying capacity is neglectful comparing with that of barge trains.

On the other side, on Dnjepr from the mouth up to Kiev, capital of Ukraine, along about 870 km, guaranteed draught of 3.65 m is always provided [8, 9].

1.2.2 Breadth restrictions

River lock chambers [1, 2, 3] on Danube have the variety of usable widths. Starting from the mouth, on Danube-The Black Sea Canal there are two river lock groups with chamber width of 25 metres. In Iron Gate area there are another two groups with 34 metres width (one auxiliary chamber has 14 m width). Further upstream in Slovakia the river locks have also 34 m width, and in Austria and Germany there are chambers with 24 m width. The narrowest are located upstream Regensburg (Danube km 2379) and have the width of 12 m,
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as well as all the other lock chambers along the Main-Danube canal. For standard "Europe" ship of 11.4 metres beam (that also navigate on Danube, especially after the opening of the Rhine-Main-Danube canal), river lock chambers of $12 + n \times 11.4$ metres width seem to be ideal (to allow the transpassing of more ships packed abreast). River locks located on Iron Gate and in Slovakia allow the transpassing of only one 11.4 m packed together with two 11.0 m ships abreast. The chamber lengths do not represent restriction for corresponding ship lengths.

All Dniepr river locks have the standard dimensions of 270 x 18 metres [9]. The breadth of standard Dniepr vessels varies between 12 and 16 metres. It is obvious that different standards for ship breadth do not allow the optimal utilisation of lock chambers on both rivers simultaneously.

1.2.3 Air draught restrictions

The bridge heights over high water on Dniepr are approximately 10 metres and more. On middle and upper Danube in periods of high water level, certain bridges have the height of only 6 metres and represent unavoidable obstacles not only for sea going ships but for some types of river motorships and pushboats too. It is not the curiosity that a great number of vessels are gathered on the both sides of e.g. bridge by Novi Sad (Danube km 1255) forced to wait the decrease of water level.

1.2.4 Climatic restrictions

In the last decade the Danube has been navigable practically during the whole year. Only in couple of years the ice appearance that caused certain short lasting restrictions has been reported. But on Dniepr the situation differs because the ice period and total stoppage of navigation lasts at least four months per year.

1.2.5 Restrictions for river-going vessels over the Black Sea

The Black Sea [6, 10] is relatively calm, but nevertheless the navigational conditions do not allow the using of standard river-going vessels, especially those designed for Danube. Insufficient freeboard and longitudinal strength, non-suitable deck equipment and the body lines form not convenient for the waves, make Danube motorships not applicable at all. Dniepr motorships are in general nearer to meet the requirements for navigation over the Black Sea, but their commercial effects specially on the middle and upper Danube appear to be poor. The widely used pushing technology on Danube (just about 9% of total cargo capacity of Danube fleet belongs to the self-propelled vessels) [4] can not be.
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applied over the sea. Towing technology is possible, comprising that the barges are designed and equipped for such area of navigation, but that is up today not the case.

1.3 POSSIBLE SOLUTIONS

There are three conceptually different solutions for Danube-Dnjepr transportation over the Black Sea.

1.3.1 Using the existing fleet of sea-going ships in traffic between the Port of Kherson on Dnjepr mouth and harbours on Danube delta

In harbours on Danube delta (Galatz, Braila, Constantza/Cernavoda, Izmail, Reni) and Port of Kherson on Dnjepr mouth, the cargo should be reloaded on river going barges and proceeded to final destinations upstream Dnjepr and Danube respectively. Such solution requires two additional loading/unloading procedures and thus the overall transport costs significantly increase. As example it can be mentioned here that reloading of each 20 feet container from one transport carrier onto another, costs about 60 DM in Rhine terminals [17]. Assuming here the reloading price twice cheaper regarding those on Rhine, it is still about 30 DM. The transport price per TEU-kilometre with the river-going ship is on Danube between 0.15-0.37 DM (stand: 1985, dependable on cargo class and transport direction - down- or upstream) [16]. The similar transport price can be expected on Dnjepr too. That means that on the overall distance of e.g. 1000 kilometres, total transport price per TEU is about 300 DM. This rough estimate shows that additional reloading costs is about 10% of total price, and when applied on the total amount of transferred TEUs during the year, it brings to enormous sum of unnecessary expenses. Besides, the existing infrastructure in above mentioned harbours requires further huge investments to improve its efficiency.

1.3.2 Building the ships of new design with particulars that will match the navigation conditions along the whole route

Due to the numerous restrictions regarding ships principal particulars in three different navigational areas, the compromise should be achieved to design and construct a ship that could be convenient and effective along the whole route. The idea to build a self-propelled vessel designed respecting at the same time the draught and height restrictions on upper Danube and freeboard and strength requirements for the Black Sea, would result in economically non-effective unit with poor load to own weight ratio and overall load capacity. Such vessel would be too small for economical service on the huge section of lower Danube, the Black Sea and Dnjepr up to Kiev. Therefore, an idea has been born to design
special barges that shall be pushed along the river sections and towed over the sea. On each section, another suitable tug (Danube and Dnjepr pushboats and the Black Sea towing tugs respectively) shall be used, and the take-over manoeuvre shall be quick and easy. The barges shall be equipped for both pushing and towing. Their principal dimensions shall be determined to match as good as possible the lock chamber lengths and widths on both rivers. Such considerations have brought the length overall of 95 m and the beam of 16.5 metres. Two longitudinally aligned barges, together with corresponding pushboat, can pass through all the river locks between Regensburg and Kiev. Between Komarno in Slovakia and Danube mouth, even 4 barges can be arranged in single pushed formation.

![Diagram of Danube-Dnjepr universal barges](image)

Figure 2: Danube-Dnjepr universal barges

Each barge would have about 3000 tdw with draught of only 2.5 metres, i.e. could reach the harbours on upper Danube with pretty significant probability. Even in the extreme low water periods, some 1500 tdw could be transported per barge with draught of 1.5 m only. The loading volume should allow the stowage of about 240 TEUs in just three layers.

There is no doubt that such solution could decrease the specific transport price, at least because of two main reasons - the necessity of additional reloading in harbours on river mouths is avoided and because the bigger ship (standard Danube and Dnjepr vessel sizes have been already described) can offer the cheaper cargo capacity.

1.3.3 Building the special ships that could transfer the existing river barges over the Black Sea between Dnjepr and Danube estuaries

The third attractive possibility to overbridge the Black Sea between Danube and Dnjepr mouth is to introduce barge carriers that could perform shuttle service transfer of river barges between anchorages somewhere in vicinity of river mouths. Plenty of existing barge carriers (LASH, BACO, BACAT I & II, SEABEE)
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[5, 18] have all the same disadvantage - they are designed for transportation on long distances over the sea, and the corresponding barge units are too small to be utilized economically on big rivers like Danube and Dniepr. Besides, almost all these systems are designed for special barge type and size. On Danube and Dniepr can be often seen so-called "USSR Seabee" or "Interlighter" barges, the largest among the all aforementioned, but with the loading capacity of only 1070 tdw, i.e. about twice less as the standard "Danube-Europe II" barge. Furthermore, the existing barge fleets on Danube and Dniepr, and probably river Don (yields in Sea of Azov that has direct connection to the Black Sea), are too great to be simply replaced with the new "standardised" units. Therefore, the basic request for the new design shall be the adaptability to take aboard almost any of existing barge types and to perform service even so loaded, economically. Due to the short distance, the barge carrier should be able to be loaded and unloaded in very short time, not more than a couple of hours.

<table>
<thead>
<tr>
<th></th>
<th>LASH</th>
<th>Seabee</th>
<th>Interlighter</th>
<th>BACAT I</th>
<th>BACO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length over all (m)</td>
<td>18.75</td>
<td>29.72</td>
<td>38.25</td>
<td>16.82</td>
<td></td>
</tr>
<tr>
<td>Breadth max. (m)</td>
<td>9.50</td>
<td>10.67</td>
<td>11.00</td>
<td>4.67</td>
<td>up to 9.50</td>
</tr>
<tr>
<td>Depth (m)</td>
<td>3.96</td>
<td>3.81</td>
<td>3.90</td>
<td>3.30</td>
<td></td>
</tr>
<tr>
<td>Draught (m)</td>
<td>2.74</td>
<td>3.20</td>
<td>3.22</td>
<td>2.45</td>
<td>up to 4.06</td>
</tr>
<tr>
<td>Deadweight (tdw)</td>
<td>376</td>
<td>847</td>
<td>1070</td>
<td>147</td>
<td>800</td>
</tr>
<tr>
<td>Weight unloaded (tt)</td>
<td>87</td>
<td>147</td>
<td>230</td>
<td>40</td>
<td></td>
</tr>
</tbody>
</table>

Table II: Standard barge size for overseas transport

A very interesting and sophisticated concept has been recently offered by German company NAVTEC CONSULT GmbH from Emden. So-called TSL (Trans Sea Lifter) is SWATH concepted vessel [12] with a lot of originals. Among the undoubtedly advantage as e.g. low resistance in fast motion through the water, the TSL concept enables the least possible amount of ballast water for sinking their platforms deep enough to accept the floating barge or even the smaller motorship. Of course, there is no need for any harbour reloading device, i.e. the only investment is the barge carrier alone.

Considering the arisen political changes in the region and expected needs for cost effective and reliable transport of the goods along the route, it could be concluded that serious investigation regarding the three mentioned solutions for the Black Sea shipping between Danube and Dniepr have to be performed. Such investigation should comprise analyses of investment costs, exploitation costs for a variety of different kinds of cargo, reliability of each, as well as the comparative analysis with alternative traffic modes - railway and road trucks.
2 MIDDLE EUROPE - GREECE LINK OVER THE IONIC AND ADRIATIC

2.1 INTRODUCTION

The total amount of cargo being transported by road trucks between Germany and Greece is about 500,000 tons per year [14] in each direction. Simple calculation says that at least 25,000 trucks pass this route yearly from Germany to Greece and vice versa. The main Greek export commodities to the EU market, and particularly to Germany, are seasonal fruits and vegetables. Such goods have to be transported quickly and mostly in refrigerated containers. Besides the time losses, any reloading introduces increased risk of damage and increased percentage of refuse. Therefore, road trucks and refrigerated trailers have been found optimal for such transport task.
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2.2 TRAFFIC SITUATION NOWADAYS

Before the break-out of war in former Yugoslavia, the usual (probably the cost most attractive) truck traffic route between Athens and southern Germany, has been one over Yugoslavia and Austria. After political changes in Eastern block at the end of eighties, the new alternative route over north-east part of Yugoslavia and farther over Hungary and north-east Austria has been found interesting, too. With the declaration of independence of former Yugoslav Republic of Macedonia in the mid of 1992, conflict situation arises between Greece and newly-proclaimed state, and as a consequence, the Greek truck forwarders were forced to use roundabout way over Bulgaria and farther to merge onto the "traditional" route by Nis in Serbia. That has introduced some additional costs (one check point more, a longer distance and worse road conditions), but was still not the reason for alert. Presumably, the customers have paid the difference in transport price, qualifying the situation as temporary.

Eventually, the break of transit of any goods through the rest of Yugoslavia came in force on April 1993. The "path of road cruisers" has to be moved once more, this time on the route over Bulgaria and Romania. The existing road net, its service condition and duct capacity, prolonged distance, probably the duration of customs procedures, etc. was now the reason enough for alarm. Each trip of road truck between Greece and Germany costs now about 2500 DM more and lasts at least 3 days longer as before.

Together with before existing problems of limited quota of truck transpassings through Austria, Hungary and the Balkan states, prohibition of truck traffic over night through Austria, highway net over long distances far behind the necessities - the newest circumstances represent a good challenge for EBD to consider existing and possible alternatives, especially different Ro-Ro solutions. As the representative example, the alternatives for the route between Athens and Munich has been considered regarding transport duration. Some of the results of this rough analysis have been found very interesting and even a little bit surprising.

2.3 CHANCES FOR RO-RO TRANSPORT MODES

Theoretically, combined traffic (Ro-Ro) exist both over the Adriatic (from Piraeus, Igumenitsa or Patras to Brindisi, Bari, Ancona, Ravenna or Venice) [14] or over Danube (from Vidin or Ruse in Bulgaria to Passau or Regensburg in Germany) [13]. But the both had been not significantly in use due to the capacity shortage. Danube connection was practically 100% occupied by SOMAT GmbH vehicles, while Adriatic route besides the lack of capacity, comprise additional expenses through extremely high highway fees and fuel costs in Italy when the southern Italian ports (Brindisi, Bari) are being used.
Theoretically, according to the all ferry line capacities available nowadays, some 2600 trucks and trailers could be transferred weekly between Greece and Italian Adriatic ports, but practically (due to the occupancy by passenger cars and busses), the available truck capacity is far behind necessities [14]. Such status has brought an idea to compare two extreme possibilities: to use ferries on the shortest section over Adriatic (between Patras or Igumenitsa and Brindisi or Bari), or over the longest (in the same time shortest for the rest of road distance to be overcome) up to the port of Trieste.

The first alternative provides the shortest Adriatic route but uses the long section of Italian highway network. The number of ferries to be used are minimal, trip duration on board is only about 16 hours when existing 14 knot ferries are in use, and this alternative enables the fastest overcome of the whole route at all. But on the other hand, very long trip over Italy introduces enormous additional expenses due to the highway fees, expensive fuel, and usual traffic jams. Even Italian freight forwarders themselves are trying to release their own highway net introducing new 20 knot Ro-Ro vessels between Palermo and Genoa/La Spezia.

Another considered ferry line leads over Adriatic up to the port of Trieste. This alternative utilises the longest possible section over Adriatic, and as a consequence brings the shortest road section. Therefore, the number of required
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Figure 5: Ro-Ro vessel for Palermo-La Spezia line [11]

ferries for the same amount of trucks and trailers to be transported in the same time interval, is pretty higher than for the first solution. What is sure, is that only the extremely high investments in new sea-going Ro-Ro fleet could fulfil the necessities. Some feed-back information after experiences in exploitation of 5 new Italian Ro-Ro ships (specially built recently for Palermo-La Spezia/Genoa line and Catania-Bari-Venice line, in order to release jams on Italian highways) could be very useful [11]. These vessels have the capacity of 136 road trailers each, speed of 20 knots and the building investment was about 46 million US $ (80 million DM) per ship. The calculated costs for Palermo-Milan route using Ro-Ro mode (Palermo-Genoa) is about 3 million Italian Lire (3100 DM) compared with approximately 4200 DM over the corresponding road section. Forwarding speed was reported the same - 24 hours - for both versions, but only when there are no jams or traffic accidents along the road route.

2.4 EVALUATION OF DIFFERENT POSSIBILITIES

An attempt was done to evaluate the main characteristics of above mentioned Ro-Ro alternatives and existing road routes (together with those which are today due to the political situation out of use). The total distance, road distance, total forwarding time and forwarding speed have been calculated and the results are presented in Table 3. The following assumptions and estimates have been made:

<table>
<thead>
<tr>
<th></th>
<th>Highway</th>
<th>Motorway</th>
<th>Adriatic</th>
<th>Danube</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average truck speed</td>
<td>70 km/h</td>
<td>40 km/h</td>
<td>14 knots</td>
<td>16 km/h</td>
</tr>
<tr>
<td>Service speed of Ro-Ro ship</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Truck driving hours per day</td>
<td></td>
<td></td>
<td></td>
<td>16 hours</td>
</tr>
</tbody>
</table>

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Customs formalities on the road check point: 5 hours
Roll-on and Roll-off duration: 5 hours
Customs revisions on the Danube: 2 hours per revision

<table>
<thead>
<tr>
<th>Route#</th>
<th>Overall distance (km)</th>
<th>Road distance (km)</th>
<th>Total forwarding time (hours)</th>
<th>Forwarding speed (km/h)</th>
<th>Relative speed mark*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (road)</td>
<td>2272</td>
<td>2272</td>
<td>89.2</td>
<td>25.5</td>
<td>1.22</td>
</tr>
<tr>
<td>2 (road)</td>
<td>2588</td>
<td>2588</td>
<td>102.2</td>
<td>25.3</td>
<td>1.40</td>
</tr>
<tr>
<td>3 (RoRo)</td>
<td>1777</td>
<td>477</td>
<td>76.8</td>
<td>23.1</td>
<td>1.05</td>
</tr>
<tr>
<td>4 (RoRo)</td>
<td>2011</td>
<td>1431</td>
<td>73.0</td>
<td>27.6</td>
<td>1.00</td>
</tr>
<tr>
<td>5 (RoRo)</td>
<td>2296</td>
<td>1240</td>
<td>126.4</td>
<td>18.2</td>
<td>1.73</td>
</tr>
</tbody>
</table>

*) = Ratio between the corresponding total forwarding time and the shortest forwarding time of all

1 - Former route, at the moment not applicable due to the situation in ex-Yugoslavia
2 - Route today over Bulgaria, Romania, Hungary and Austria
3 - Ro-Ro section between Patras and Trieste
4 - Ro-Ro section between Patras and Brindisi/Bari
5 - Ro-Ro section over the Danube (not applicable at the moment)

Table III: Distances and trip duration (ref. Figure 4)

According to the available information [14], the average trip duration over the route #2 is even three days longer as over the routes #1, not only 13 hours as theoretically calculated and presented here. Probably the additional waiting time exists as a consequence of worse service and road condition through Bulgaria, Romania and eastern Hungary. Therefore, at least 50 hours have to be added to the total forwarding time for route #2. Comparing the corrected total forwarding time for route #2 (now about 150 hours) with others, it is obvious that Ro-Ro alternatives could be very competitive.

Some attempts have been made recently to organise forwarding of Greek fresh agricultural products in refrigerated railway wagons over Bulgaria, Romania, Hungary and Austria [14]. The reported records are about 100 hours from Athens to Munich. A couple of hours should be added for storage-to-rail transfer and reloading at the final destinations.

Reflecting the given examples, in certain particular occasions shortsea shipping can even significantly increase the forwarding speed of otherwise much faster road carriers.

Adriatic route #3 (Patras-Trieste) appears to be ideal (by-passes the most of Italian road network) and could be even faster than here presented, if the new 20 knot ships [11] should be implemented. The Danube route #5 could be also

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very attractive in some better political circumstances, especially with the faster Danube ships than today. For example, 22 km/h (service speed of some big riverine passenger ships on Danube) instead of today’s 16 km/h (existing Ro-Ro catamarans and pushed barge trains) could decrease the forwarding time over the route #5 for about one day.

The investment and exploitation costs have been roughly estimated (Table IV).

<table>
<thead>
<tr>
<th>Speed (kn)</th>
<th>Investment per ship (DM)</th>
<th>No. of 40' trailers</th>
<th>Investment cost (DM/trailer)</th>
<th>Investment cost (DM/trailer * knots)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adriatic ferry</td>
<td>20</td>
<td>80,000,000</td>
<td>136</td>
<td>588,235</td>
</tr>
<tr>
<td>Danuber Ro-Ro</td>
<td>12</td>
<td>22,000,000</td>
<td>49</td>
<td>448,980</td>
</tr>
</tbody>
</table>

Table IV: Investment costs for ro-ro ships for Adriatic and Danube

Assuming that the expected cost on Palermo - La Spezia line of about 3100 DM per trip and trailer is realistic, just a little bit higher has to be the cost per transshipped truck unit between Patras and Trieste - let’s say 3400 DM. That means that each kilometre costs about 2.6 DM per truck. Over the shorter Ro-Ro dis-
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tance (Patras-Brindisi) slightly higher costs per kilometre could be expected. On Danube, the cost estimates on respective section have given approx. 1.8 DM per truck-km.

On the other side, on German highways and road network, the average costs per truck-km are nowadays about 2.5 DM, but on Italian highways due to the road fees and higher oil prices it is over 3.0 DM. Regarding the tax fees for transpassing Balkan states, Hungary and Austria, as well as the worse road condition, the similar specific costs have to be expected on the road routes over these non-EU countries.

The estimated values appeared to be pretty high, but compared with required investments for building highways (8 - 11 million DM/km and the need for some 1300 km through Bulgaria, Romania and Hungary or about 650 km of missing highways along the route through the ex-Yugoslav states), exploitation cost difference between truck-km and Ro-Ro/truck-km and at last (but not the least) environmental pollution difference, it is obvious that Ro-Ro solutions on German-Greece truck routes have to be seriously investigated. With certain reorganisation in truck forwarding logistic, it could be possible to avoid, at least inside the European Union, the senseless transportation of drawing vehicles on board and as a consequence, to obtain more storage space on Ro-Ro ship. Assuming that the average length of truck with 40 feet trailer is 15.5 m and trailer alone only 12.2 m, the stowage savings of even 27% can be obtained. In the same time significant savings on salary costs of truck drivers could be achieved. Moreover, such logistic changes should not require the new investments for container terminals and costs for their handling.

3 CONCLUSIONS

It can be seen that in some occasions, new arisen circumstances can induce search for new transport solutions, or improvements of existing ones. In the both given examples the inquires are to find the missing or to replace the loosing link in existing transport chain. Sometimes, the obtained results can brought to the solutions that have been often neglected during the past. Shipping policy makers, freight forwarders, shipowners and shipbuilders have to leave their traditional and stiff way of thinking. The random event makes the situation, and the situation has to be utilised in the best possible manner. The mentioned parties should never forget the old Latin sentence "navigare necesse est", they have just to be always ready to adopt themselves for current market inquires.
Prerequisites for Improvements of the Shipping in South-East European Regions

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METRO COASTAL SHIPPING

By J. Truau

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METRO COASTAL SHIPPING

1 THE CONTEXT

The port of Marseille-Fos is the biggest in France and in the Mediterranean. It benefits from a central location in the Mediterranean Arc, at the outlet of the Rhône Valley, a major land transport axis in Western Europe for North-South traffic flows (Figure 1).

Figure 1: Mediterranean arc
Just two years ago, the French government began a reform of port facilities, the first stage of which was devoted to modernisation of stevedoring.

Our Chamber of Commerce decided to take this opportunity to initiate a "5 year Development Programme for the port of Marseille-Fos" in collaboration with all the port professions, to coincide with this reform. The programme's objective is to define the strategic positioning of our Mediterranean port faced with the changes in the European and world-wide competitive environments.

Within this framework, the geographic location of our port which I have just briefly described in my introduction, and its well-established vocation as a port handling land-based traffic led us to examine the potential for developing new land-sea transport systems along the Mediterranean Arc.

Indeed, this was a theme that had been mentioned more and more frequently during discussions about infrastructure policy on both a national and European level. From our point of view to a great extent it has become a reality as far as it concerns the Mediterranean Arc, on the basis of the following observations:

1. The progressive saturation of the coastal motorway routes running along the Mediterranean Arc between Spain and Italy via the Languedoc-Roussillon and Provence regions.

   The doubling of North-South motorways linking Europe to the Mediterranean and the coastal motorways between Spain and Italy comprises projects for tunnels in the Alps and Pyrenees. These projects are increasingly difficult to implement, because public opinion has become more sensitive to environmental deterioration.

2. The inevitable strengthening of administrative measures and cost constraints linked to road transport.

   Apart from the cost of new infrastructures made necessary because of congestion, calculations are made to evaluate the additional cost of the consequences of road use (noise, pollution, safety, etc.).

   As a result we can expect the cost of road use to increase further, although an exact figure cannot yet be determined.

3. The modernisation of stevedoring in the major Mediterranean ports.

   This makes it possible to increase substantially the level of reliability of transit via ports, which previously was a major weakness compared to the total reliability of road transport. This modernisation now makes it possible to develop projects for specialised terminals.

4. The development of exchanges within the European Community.
Section I - Shortsea Shipping Regional Analysis

In the last decade, the increase in demand for transport led to disproportionate development of road transport, due in part to this mode of transport’s flexible adaptation and continued low costs. Road traffic from Northern Europe to the South of France, from Italy and more recently from Spain is intensifying. Most of it is carried by the Rhône Valley, and is amplified by East-West flows near to the mountain transit points in the Alps and Pyrenees. The intensification of these flows will inevitably accelerate the saturation of the motorway routes.

It could be that the very magnitude of the road transport phenomenon could lead to more moderate and more intelligent use of roads in the next few years.

It is on the basis of these four observations that we have decided to propose a maritime solution that is complementary to land-based solutions and suited to the geography of the peninsulas in Mediterranean Europe.

Given the twin requirements of regularity of turnarounds and speed which this new coastal shipping concept would have to satisfy to integrate into a two-mode land-sea system, we have baptised it “metro-coastal shipping”.

2 HYPOTHESES AND METHODS

Although the solution we have envisaged aims to replace “road kilometres” with “nautical miles”, the programme also aims to ensure complementarity between these two modes of transport.

This complementarity is essential for sea transport, since the quay-side is rarely the final destination for goods.

It seems that complementarity is also becoming necessary for road carriers too, as I have just explained.

Naturally, this complementarity is only worthwhile if it means we can benefit from the advantages stemming from these two modes of transport, and reduce the disadvantages. The logistics envisaged must therefore ensure that we conserve the flexibility and speed of road transport while maintaining at least to some extent the cost advantages of sea transport.

From this point of view, the use of roll on/roll off vessels is the most effective solution since it minimises the costs generated by trans-shipment, in terms of both time and money.
In addition, the unit cost advantage of sea transport stems partly from the large volumes carried. Although it is developing quickly, with the complex logistics it requires combined transport still represents only a small proportion of all goods transport operations.

In this context, and in the light of the above hypotheses, we felt it was vital to proceed using the following method:

1. Verify that a market does exist, i.e. that the flow of goods to transport is sufficient to correspond to a target volume;

2. Examine the economic profitability of a maritime structure to transport these goods.

### 2.1 EVALUATION OF A TARGET VOLUME

We selected exchanges between France, Spain and Italy, according to their type (excluding heavy cargo), and their present route identified by the present border crossing point.

From an initial market of 51 million metric tons, this method of selection resulted in the identification of a target volume of 9.1 million metric tons of goods (Figure 2):

- 3 million between France and Spain;
- 3.5 million between Spain and Italy;
- 2.6 million between France and Italy.

It should be noted that this potential traffic is a minimum. We have seen that the development of combined traffic could lead to concentration of flows from Northern France and Europe via rail, and the avoidance of mountainous sectors by loading (unloading) at Marseilles. This assumes generalised use of mobile containers.

### 2.2 ECONOMIC PROFITABILITY

The aim of this stage was to estimate as accurately as possible the costs of transporting trailers or trucks on a roll on/roll off vessel, and to compare them with the cost of road transport.

Clearly the cost of a semi-trailer journey carrying 15 metric tons of goods depends on the distance covered. The cost of transporting this same truck or its trailer loaded on a vessel is different, and varies.
Section I - Shortsea Shipping Regional Analysis

Figure 2: Demand analysis

MAIN FLOWS AFTER SELECTION OF GOODS AND OF ORIGINS/DESTINATIONS

THE SELECTION LEADS TO REBALANCING THE FLOWS TO THE BENEFIT OF THE SPAIN-ITALY LINK. THIS IS CONSISTENT WITH THE POTENTIAL OF THE LINE ENVISAGED.
Metro Coastal Shipping

It doesn’t just depend on the distance to cover, because economies of scale also play a part. The proportion of fixed cost is clearly greater in sea transport (because of the size of the investment represented by the vessel), and so this cost must be divided up by transporting a large number of trailers.

The calculations and hypotheses presented below aim to evaluate this “large number”.

However, the operating cost of a shipping route is difficult to define because of the numerous parameters that are involved (Figure 3).

The projected diagram comprises the main parameters that must be taken into account in the calculation, and shows how they interact. This diagram shows the choice variables in dark characters, and the calculations of costs in which they are involved are shown in normal characters. The variables resulting from intermediate calculations are ringed.

The type of vessel (size and speed) modifies not only the cost of investment, the running costs and the port costs, but also the transport capacity and the number of turnarounds per year.

The route and in particular the selected ports of call affect the distances covered, the number of turnarounds and the port costs.

On the basis of this diagram, operating hypotheses were then established by interviewing specialists in shipping and ports.

The guiding principle in selecting the hypotheses was to choose those which are the most realistic at the present time. This means the vessels of the year 2015 are not included in our calculations. In this specific example, it would have been pointless to evaluate the purchase price of equipment which does not exist. However, certain parameters such as the handling costs were added to the model as variables, so that they can be changed.

As Figure 3 shows, the choice variables are:

- The vessels;
- The ports of call;
- The turnaround frequencies;
- The occupancy rates.

The vessels

We have shown that it is vital to conserve the speed and flexibility of the road transport mode. This means we must give priority to high turnaround frequencies and rapid vessels.
Figure 3: The offer

Line maximum capacity
  - distance
  - speed

Ports served
  - Service frequency
    - Port charges
    - Operating cost
    - Immobilization cost
  - Type of ship
    - Number of trailers transported
      - Handling cost
      - Immobilization cost of trailers and other truck-associated expenses
  - Ship loading rate
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However the faster the vessel the greater its size. The challenge is therefore to find, if it exists, a vessel whose speed and capacity enable it to compete with road transport costs for realistic quantities of transported goods, bearing in mind the overall volumes evaluated in the first stage of the study.

Three vessels were tested:

* A small RoRo vessel: 450 Im;
* A medium-sized RoRo vessel: 700 Im;
* A larger RoRo vessel: 2,000 Im.

The ports

As far as possible, the choice of ports must take account of two divergent parameters. On the one hand the selected ports must make it possible to reach a hinterland of activities and consumption that is as large as possible. On the other hand, the greater the distances covered on land, the more competitive sea transport becomes.

In the case of the Mediterranean Arc, the further you move towards the South of the peninsulas, the smaller the hinterlands of activity become. However, the further South you go the more the coastal geography favours the maritime solution.

The ports tested were Voltri, Genoa and Leghorn for Italy, Barcelona and Valencia for Spain and Marseilles for the French coast. Each combination involves the use of one port per country.

The occupancy rates and the frequency

The maritime unit cost is linked to its occupancy rate.

The occupancy rate hypothesis was added to our calculation model in the form of a variable. So the results I’m going to show you are based on occupancy rates of 50, 70 and 100%.

Similarly, the frequency of turnarounds depends on the vessel’s speed, the loading/unloading times, the opening times of the ports, etc...

For example, a vessel sailing at 17 knots cannot carry out more than 120 turnarounds in one year.
The costs

Each constituent element of the costs was carefully integrated into our calculation model, and validated by a steering committee made up of professionals. The following parameters were taken into account for the sea route:

* The vessel’s standstill costs, based on the chartering price, thus making it possible to include the maintenance and crew costs;
* The vessel’s running costs;
* The standstill costs for the transported trailers or trucks, which although they economise on fuel and tyres continue to generate a standstill cost and possibly salary costs if the drivers are on board;
* Port costs (port duties + handling costs).

Concerning the road route, the following parameters were taken into account:

* The standstill costs of the trailers and tractors;
* Their running costs, linked to the kilometres covered;
* The “annual” running costs: tax, insurance, salaries.

When put together, the road transport costs form a cost per kilometre which is constant for each trailer.

3 SIMULATIONS AND RESULTS

The figures I am going to show you give the transport cost for a trailer according to the annual frequency of the number of calls in each port and according to the average occupancy rate of the vessels.

The minimum frequency was set at 50, i.e. one call per week.

The maximum frequency is calculated according to the vessel’s speed and the duration of the call (itself dependent on the number of trailers to handle).

Three curves are shown corresponding to three possible occupancy rates: 50, 70 and 100%.

The horizontal line corresponds to the cost of road transport by trailer, which is constant and constituted by adding the road transport costs to each link on the envisaged route.

Given the extent of the differences between the road transport time and the sea transport time, especially for small vessels which are therefore slow, we felt it was necessary to represent the lost time as an additional cost of sea transport.
Metro Coastal Shipping

This corresponds to the diagram at the bottom. Here the calculation is only carried out for the 70% occupancy rate.

Example 1: Marseilles-Voltri-Barcelona route

(Figure 4) 450 Im RoRo vessel
(Figure 5) 700 Im RoRo vessel
(Figure 6) 2,000 Im RoRo vessel

Example 2: Marseilles-Leghorn-Valencia route

(Figure 7) 450 Im RoRo vessel
(Figure 8) 700 Im RoRo vessel
(Figure 9) 2,000 Im RoRo vessel

The graphics I have just shown you demonstrate the technical and economic feasibility of a “metro-coastal shipping” line in the Mediterranean, with a certain number of constraints.

These constraints are mainly linked to the technical characteristics of the vessels. Speed is essential, but if the size is too great it implies very considerable capacities, and the occupancy rate is a major factor contributing to profitability.

In the near future, high speed goods transport vessels should become available on the Mediterranean market. If they were used, the new metro-coastal shipping line in the Mediterranean would be an experimental operation.

In our present calculations, it is obvious that the highest profitability is obtained using the 2,000 Im vessel, on the route where the ports are at the greatest distance. However, the required occupancy rate (70%) means that it is essential to have a minimum load on call. A determined commercial effort will be required to obtain it.

Finally, the crucial factor remains fluidity, to be achieved through total reliability, competence and efficient organisation in the ports.

4 UNDERLYING ORGANISATION OF LOGISTICS

The results I have just presented - obtained from a calculation of profitability - correspond to the use of a vessel that carries trailers without tractors.
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MARSEILLES - VOLTRI - BARCELONA
450 ml ship

As per loading rate

LOADING RATE 70 %
AND TIME VALUE 100 FF/H

Figure 4: Marseilles - voltri - Barcelona, 450 ml ship
Figure 5: Marseilles - Voltri - Barcelona, 700 ml ship
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MARSEILLES - VOLTRI - BARCELONA
2000 ml ship

As per loading rate

LOADING RATE 70 %
AND TIME VALUE 100 FF/H

Figure 6: Marseilles - Voltri - Barcelona, 2000 ml
MARSEILLES - LIVORNO - VALENCIA
450 ml ship

As per loading rate

LOADING RATE 70 %
AND TIME VALUE 100 FF/H

Figure 7: Marseilles - Livorno - Valencia, 450 ml ship
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Figure 8: Marseilles - Livorno - Valencia, 7000 mi ship
MARSEILLES - LIVORNO - VALENCIA
2000 mi ship

As per loading rate

LOADING RATE 70 %
AND TIME VALUE 100 FF/H

Figure 9: Marseilles - Livorno - Valencia, 2000 mi ship
Section I - Shortsea Shipping Regional Analysis

However, at the end of this stage in which we had studied the pure economic profitability, we felt it necessary to examine the type of general organisational structure best suited to ensure the commercial success of a new "metro-coastal" shipping line.

Basically, two types of general organisation can be identified:

* The vessels load the trailers and tractors with their own driver;
  This solution has the advantage of minimising loading and unloading times. However, it also requires the vessels to be equipped to accommodate the drivers and is thus more costly. It should be noted that these vessels could be used to develop passenger transport (tourism) as an additional seasonal activity.

This type of organisation corresponds more to a heterogeneous and totally independent set of customers. It would be especially suitable for the present road transport structure in Italy, but to a lesser extent in the other countries involved.

* The vessels load the trailers only;
  This solution requires warehouses in each port and centralised international organisation. The tractors and drivers are not carried, they take over from each other.

This structure also requires close collaboration with one (or more) international carriers or forwarding agents to take charge of the goods' transport, as well as concentration of the flows and a minimum load on call.

This option is undoubtedly the most likely to overcome the reservations among haulage firms, who are still reticent about integrating multi-modal structures for transport of goods.

Clearly, the definitive organisational structure used could be mixed, and combine a minimum load on call comprising trailers plus additional cargo constituted by trailers and their tractor and driver.

In conclusion, the study of "metro-coastal shipping" has given birth to a new sea transport concept in the Mediterranean region.

Encouraged in our efforts by the results of the profitability study that I have just presented, we are now looking to define a commercial structure for this service.
Metro Coastal Shipping

that will live up to the requirements of road transport carriers, in a word sufficiently powerful to overcome existing habits.

At the European level the Brussels Commission will soon present a programme for action aiming to open up new short-distance sea routes and land-sea routes, following the work carried out by the Forum of Maritime Professions.

This means our project fits perfectly into the framework of European concerns.

We now intend to continue our work by mobilising all our European partners to open a "metro-coastal shipping" line, along the Mediterranean Arc as a first step.

This mobilisation will take place within the framework of the ASCAME (The Assembly of Chambers of Commerce and Industry of the Mediterranean, chaired by Marseilles), and may well lead to a widening of this transport concept to the whole of the Mediterranean Basin.
PART I - SHORTSEA SHIPPING: REGIONAL ANALYSIS

BALTIC BULK SHIPPING IN THE 1990S: HOW TO MATCH AN AGING SHORTSEA FLEET WITH INCREASING DEMAND

By L. Ojala, S. Lall and M. Svendsen

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INTRODUCTION

The purpose of this paper is to describe the market of shortsea bulk shipping in the Baltic region, and to analyse the possible outcomes of the current structure of supply and demand in this market towards the end of 1990s. The emphasis in the study is on the supply side, i.e. on the tonnage employed in the trade.

The type of tonnage under study consists of the dry bulk, general cargo and specialized dry bulk ships, together with dry bulk barges in the 1000 to 12000 DWT range, the typical size range of vessels employed on the Baltic trades. Countries of register include Germany, Denmark, Sweden, Finland, Russia, The Baltic States, Poland, Norway and the Netherlands. Tonnage from these countries form the core of the supply side in the Baltic (and the North Sea) market in the size range under study. By end-1993, the tonnage totalled 7 mDWT and over 1500 vessels (excl. Russian tonnage outside the Baltic area).

Data on tonnage, freight markets, insurance premiums and vessel markets is gathered for two indicative years, 1990 and 1993. The focal point in the market analysis is to compare the data within this very dramatic time interval in the Baltic region.

The Baltic bulk market has a strong potential in cargo demand for the 1990s. Data on cargo movements are gathered mainly within the Baltic basin only, while it is reckognized, that the market for the tonnage included in the study stretches also to the North Sea and beyond. For this reason, it is difficult to define the actual volume of the total trade. However, an attempt to assess the structure and the volume of the trade is made.

Despite of its importance for the Baltic countries, this ‘small tonnage’ market has largely been neglected by researchers (cf. Carlquist 1991). A number of papers have appeared on the restructuring of the former CIS and Baltic states’ maritime activities (see e.g. Peters 1993, Hayter 1993, Jenssen 1993, Holt 1993, Vanags 1993, Levikov 1993, Krzyzanowski 1993). However, studies treating this shipping market from both the supply and the demand side are non-existent. Furthermore, the Baltic bulk shipping market seems to have improved substantially as from September 1993. Studies published in 1993 have, of
Baltic Bulk Shipping in the 1990s

course, been unable to take such a trend shift on these highly turbulent markets into account.

This market could be described by a looming tripodization of the market (tripod = three legs). Firstly, there seems to be a growing interest in renewing tonnage in the 5000 to 10000 DWT range spurred by strong freight rates. Secondly, the smaller segment of the tonnage operated by Western shipowners, i.e. ships under 4000 DWT, is growing older, while there is little hope for newbuildings on current construction prices. Thirdly, the recent appearance of a large number of privatized/privatizing low-cost operators from the former Soviet fleet, including the Baltic states, are adding new dimension to this market in an unprecedented scale.

Our aim is, then, to analyze this market, and present conclusions as to which way the market is going, and whether there is a possibility to introduce technological innovations that would enhance the productivity of the fleet, thus reducing the need for major newbuildings which would otherwise seem inevitable. Finally, some policy recommendations are presented for shippers, shipowners, shipyards and countries involved.

2 MARKET SIGNALS

In this small chapter, a few recent news flashes and other market signals are presented. They are gathered from various maritime sources having one thing in common: they all are beams of light in the broad spectrum of issues in the Northern European shortsea bulk shipping markets in 1993/1994.

The purpose of this passage is in other words to "tune in" the interested reader, who already has "turned on"; and hopefully, to keep him or her "tuned in" till the end rather than let him or her "drop out" during the early chapters of the paper.

"Open for business - The Russian enclave of Kaliningrad, for years a fortress, has opened its doors to Western Europe and two shipping companies in particular are taking advantage of their freedom and geographical position." (Seatrade Review, August 1993, Ivan Berenyi)

"The shipping business has caught the wind in Finland - thanks to an rapid export growth by 15% in 1993." (Forum 2/1994, Christian Schönberg)

"A part of St. Petersburg's river port - Vasileostrovskij - turned into handling timber exports instead of incoming sand and macadam. 70 000 cubic meters exported to Sweden and Finland in 1993." (Ålands Sjöfart & Handel, 1/1994)
"Aged Swedish Coaster fleet. The Coaster M/S "Sydfart", built 1879 is 114 years old and still going strong with Swedish flag. The Swedish coaster fleet has an average age of 36 years." (The Scandinavian Shipping Gazette 31-32, 1993)

"Rise in P&I claims forecast - Forecasts of substantial increases in claims on P&I clubs, because of reinsurance changes, and tougher legislation in some parts of the world are made by the Britannia P&I Club in its outlook on prospects for the policy year running into next February." (Lloyd’s Ship Manager, August 1993).

"The observation made in many previous reports - that inadequate maintenance could be seen as the main cause of most deficiencies - is still valid." (Lloyd’s Ship Manager, September 1993)

"Financing costs are in the rise - raising funds for shipping is increasingly difficult as the banks become more risk averse." (Lloyd’s Shipping Economist, July 1993)

"It is not true to say that the older the ship, the more prone to structural failure. In ships, as in humans, middle-age is the problem! It is the 14-22 year-old ships that have most frequent major claims of this category." (The Anatomy of Major Claims - A Mariners Guide; UK P&I Club, 1994)

"DNV [Det Norske Veritas] Classes Latvian reefers with a previously Russian class" (Fairplay, February 1994)

"States face fleet renewal - a lot of restructuring and fleet replacement work still lies ahead for shipowners and managers in the Baltic republics." (Lloyd’s Ship Manager, September 1993)

3 MAJOR TRENDS IN THE SEABORNE BULK TRADE WITHIN THE BALTIC SEA

The democratic revolutions in the East European countries since mid 1989 have essentially changed the international context of Europe. The members of the European Community have to face up to their new role as the leader in the construction of a greater Europe - New Europe. Time stood still in Eastern Europe for 40 years. Before the World War II several of these countries were major European exporters of manu-factured commodities. What could be better for all these countries in the Eastern Europe than to have a large single European market as neighbour, and to provide it with goods on the basis of labour which is still cheap and raw material from huge natural resources. Available cargo statistics collected by individual Baltic ports during early 1990s does not
fully support the idea that exports from these countries would have picked up substantially yet.

Faltering economic growth in the West has caused major economic problems in Sweden and Finland. Especially for Finland, the almost simultaneous breaking-up of the key trading partner Soviet Union greatly affected the country's economy. Now in 1994 the Swedish and Finnish export industries appear to be back on track again. The Finnish cargo statistics for 1993 showed both an all time high of exports and of total cargo turnover in Finnish ports. Finland has also improved its position as major "gateway" for Russian cargoes. Although the turnover in Swedish ports has also been improving slightly, some ports of other Western Baltic, notably in Germany and Denmark still present a negative trend.

The market for seaborne transport in the Baltic is of such complexity that it is impossible to assess all aspects of the market in the short space of the report. Also the difficulty to get comparable commodity trade statistics is inconvenient for this type of study. Therefore, this part of the study concerning cargo movements in the Baltic, is especially focused on a few fundamental factors that exert strong influences on the Baltic shortsea shipping market. We are beginning with a brief look at the complex mix of cargoes transported within the Baltic region. Then we are studying major port traffic development in the Baltic focusing on the Eastern Baltic region including Finland.

3.1 THE COMPLEX CARGO MIX IN THE BALTIC SHORTSEA SHIPPING

To explain how the Baltic shortsea shipping industry approaches the task of transporting the complex mix of cargoes, we have to introduce an indicative list of commodities in the Baltic trade (Table I, Table II). The purpose is to describe which types of cargoes are included in the Baltic shortsea trade in terms of parcel size, handling and value category.

The typical size of the consignment describes the range of parcel size in which respective cargo is actually shipped (1000-4000 tons and > 4000 tons, respectively). The list is not complete, but it helps to understand the parcel size distribution for each commodity. Because several products are shipped both in bulk, general cargo and special vessels, the commodity list cannot be divided into bulk and general cargo. This is also the fundamental reason to the complexity of the Baltic shortsea shipping. The commodities are also divided into three CIF-value categories: low, medium and high value products. The transport requirements of these products and the demand they make on the Baltic shortsea shipping industry are very diverse. (For detailed discussion on parcel sizes, see e.g. Stopford 1992).
### Table I: The mix of cargoes in the Baltic shortsea trade (1)

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**European Shortsea Shipping**

81
Baltic Bulk Shipping in the 1990s

7. MANUFACTURES

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</table>

7.1. Paper
7.2. Construction material (bricks etc.)
7.3. Other construction material (wallboard etc.)

7. VARIOUS RECYCLED PRODUCTS

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<thead>
<tr>
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<th>B</th>
<th>C</th>
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</table>

8. Slag
8. Metal scrap
8.3. Waste paper

Legend:
A: Major commodities in Baltic trade parcelsize 1000-4000 t
B: Major commodities in Baltic trade parcelsize > 4000 t
C: Minor commodities in Baltic trade parcelsize 1000-4000 t
D: Minor commodities in Baltic trade parcelsize > 4000 t
E: Suitable for special vessels (self-discharging, Ro-Ro, etc.)
F: Suitable for push or conventional open deck-barge

Table II: The mix of cargoes in the Baltic shortsea trade (2)

3.2 CARGO MOVEMENTS IN INDIVIDUAL EASTERN BALTIC PORTS TO END-1993.

There are ten major ports along the coast starting from Szczecin-Swinoujscie in Poland up to North to St. Petersburg in the Gulf of Finland. The cargo statistics from this region is based on individual port data collected by the Baltic Port Organization (BPO). BPO was founded in early 1990s and its members counted 36 port authorities in 9 countries by the end of 1993.

St. Petersburg is located on the Eastern shore of Gulf of Finland and is an entry/exit point to the extensive canal system to the hinterland. However, the major Russian port in the region, St. Petersburg, has lost traffic in terms of the total cargo handled. The handling of dry bulk cargoes dropped by 31% from 1992 to 1993. On the other hand, the port of St. Petersburg managed to increase turnover of general cargo by 35% 1992-93. Port statistics in 1988-90 (Canfield 1993) support the positive results of the Russian policy to re-route transit cargo away from ports in Estonia, Latvia and Lithuania to ports located in Russia. However, the port of St. Petersburg did not succeed in increasing the handling of coal as planned after 1990.

The current trend, however, is that the Baltic State ports slightly outweighed St. Petersburg - the only major Russian port in the region during the period 1992-93 (Table III). The harbour has been badly operable due to lacking capacity to handle all necessary shipments and due to ice blockage from early November 1993 and shortage of icebreaker capacity.
### Part I - Shortsea Shipping: Regional Analysis

#### Port BPO data as per 1988-1993

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<td></td>
</tr>
<tr>
<td></td>
<td>export</td>
<td>4000</td>
<td>4914</td>
<td>22.9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>total</td>
<td>7500</td>
<td>7279</td>
<td>23.8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>dry bulk</td>
<td>3122</td>
<td>4382</td>
<td>40.4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>gen. cargo</td>
<td>2844</td>
<td>3256</td>
<td>23.2</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1) The original figures by Canfield were given in million of tons. *) Muuga and city port combined

The table is generated from:
- for the years 1991 for Klaipeda, all others for 1992 and 1993:
- BPO Cargo Statistics, 1994

---

### Table III: Breakdown of port statistics in the Eastern Baltic region 1988-1993 (1000 tons)

**European Shortsea Shipping**
Baltic Bulk Shipping in the 1990s

The major dry bulk ports in BPO statistics, Muuga (Tallinn), Gdynia and Swinoujscie accounted for a major increase in cargo turnover - mostly in coal. A major part of the transit cargoes passing Tallinn is coal from as far away as Kazakhstan and the Urals.

Tallin has actually three ports: Muuga, City port and Kopli. Muuga is newly constructed and it is the new main port of the Estonian capital. City port still plays an important role with a turnover of 4.4 Mtons in 1992, while Muuga and the City port accounted together for 10.1 Mtons in 1992 (and 9.0 Mtons in 1988). In 1993, Muuga reached a cargo turnover of 7.1 Mtons, an increase of 25.1 per cent from 1992. The port of Kopli is a fishing harbour.

The Baltic Republic ports are still playing a leading role as links in Russia's and other C.I.S. countries' transit (usually westward) traffic. The current transit traffic through Estonian, Latvian and Lithuanian ports is roughly 27 Mtons (Table V). The biggest losers in the competition on this traffic have been the ports of Riga and Klaipeda. Crude oil and petroleum commodities represent the main cargo categories affected in Klaipeda - a decrease of 2.8 Mtons from 1991 to 1992 (BPO statistics 1994). The liquid cargo turnover in the port of Klaipeda was 10.3 Mtons in the peak-year 1988, but only some 5.5 Mtons in 1993 according to BPO data (cf. Canfield 1993, Kryzanowski 1993).

The ports of Gdansk and Swinoujscie are the main ports in Polish coal exports, counting for about 70 per cent of all Polish maritime trade. The ports of Swinoujscie and Gdynia for which data is available in Table III, show high increases in cargo turnover. This is due to an increasing market in 1993 for Polish coal within the Baltic Sea and also an increasing trend for general cargoes for export. The Polish coal export increased by some 13 per cent from 1992 to 1993 (STINNES 1993).

In 1993, Poland exported about 22.1 Mtons of coal of which 19.6 Mtons was sold by the state-owned Weglokoks company. Notable increases in imports of this coal by Weglokoks were recorded in Finland: from 2.1 Mtons in 1992 to 3.7 Mtons in 1993, and in Denmark; 0.7 Mtons in 1992 compared with 2.1 Mtons in 1993 (International Coal Report, Jan. 24th, 1994).

3.3 GATEWAY FINLAND - C.I.S. TRANSIT TRAFFIC IS RISING

While cargo traffic in St. Petersburg has been declining, the traffic over Finnish-Russian border has been increasing. The decrease in transit traffic through Finland was very severe in 1990-1991. The decrease stopped in 1992 and the transit traffic rose significantly in 1993 (20%). The transit traffic through Finland, with its modern and highly operable ports, has a great potential of growth (Table V). The actual growth has been caused by the increasing market share of Finland in Russian transit.

The growth in transit traffic is mainly explained by that the Russia has lost nearly all its Baltic and Black Sea ports to the Baltic Republics and Ukraine where they are entailing new border-crossing formalities and extra costs for through traffic. The ports are, of course, still there, but there is also a considerable unwillingness by the Russians to use these ports. Consequently, the port of St. Petersburg, which has been Russia's only operable Baltic port in 1993, has been seriously congested.

After a few bad years in the early 1990s due to the break-up of the former Soviet Union, the Finnish industry appears to be back on track mainly thanks to the downward adjustment of the markka by about 30% since 1991. Now the Finnish business has caught the wind, which can be seen in the traffic figures for 1993 (Table IV).
Baltic Bulk Shipping in the 1990s

<table>
<thead>
<tr>
<th></th>
<th>Traffic Mt/y</th>
<th>Billion tonnekm/y</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Export</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Through Baltic ports</td>
<td>22.6</td>
<td>53.3</td>
</tr>
<tr>
<td>Through Finland</td>
<td>4.4</td>
<td>12.1</td>
</tr>
<tr>
<td><strong>Import</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Through Baltic ports</td>
<td>4.1</td>
<td>2.4</td>
</tr>
<tr>
<td>Through Finland</td>
<td>0.8</td>
<td>3.3</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>31.9</td>
<td>71.1</td>
</tr>
</tbody>
</table>


Table V: Current transit trades through Finnish and Baltic Republic ports.

3.4 OTHER BALTIC TRAFFIC

The Nordic countries Sweden and Finland are both substantially dependent on seaborne traffic within the Baltic. Shortsea shipping between Scandinavia and the continent is the dominant transport mode. Looking at the latest seaborne traffic reports from Sweden it shows a modest increase (Table VI.). On the other hand the figures are collected from a short period January - September. The period of growth within the export traffic is normally the late autumn September - December. Thereby these figures are not representative in general.

Other ports accounted for in the BPO statistics were ports in Denmark and Germany presenting a decline in cargo turnover (encl. 1. BPO cargo statistics 1992/1993). The current recession in the West has still an negative effect on the cargo turnover in other Western Baltic ports.

3.5 CONCLUSIONS - TRENDS IN THE CARGO MOVEMENTS IN THE EASTERN BALTIC

The brief look at the cargo statistics in Section 3.2. was not expected to give absolute answers concerning the prospects for cargo movement, but the results identify some major trends. Russian, Baltic and Polish ports will be competing in a market which will continue to be characterized by uncertainty and disruption of traditional trading patterns in a time with increasing foreign trade demands and reorganization of the transport patterns.

The Russian concept of developing and constructing new capacity ports and the gradual shifting of cargo flows to them, seems not to affect the traffic patterns in the near future. A study about the todays situation regarding transportation projects including ports in the St. Petersburg region, tells us that their impact on the trade routing is a vision of the future. Taking into account todays emerging
situation in the Russian Baltic cargo handling capacity, the competition for the traditional volumes of Russian and C.I.S. transit cargo between other Baltic ports will increase.

The transit cargo from and to Russia and C.I.S. is seeking for "gateways" and require reliable and secure transport channels based on well functioning ports in the Baltic sea. The Baltic ports and shipping services are important satellites of the C.I.S. countries, when they are building up their exports to and imports from Europe. Several signals present increasing movements of general cargo in the ports reported. Also the major dry bulk ports within the Eastern Baltic region are presenting an upward trend. Russia and Poland are still heavily dependent on energy exports to get hard currency.

<table>
<thead>
<tr>
<th></th>
<th>9/1992</th>
<th>9/1993</th>
<th>% change</th>
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<tr>
<td><strong>Export</strong></td>
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<td></td>
</tr>
<tr>
<td>Dry bulk</td>
<td>6872</td>
<td>5666</td>
<td>-17.5</td>
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<tr>
<td>Liquid bulk</td>
<td>8205</td>
<td>8186</td>
<td>-0.2</td>
</tr>
<tr>
<td>General cargo</td>
<td>11547</td>
<td>11827</td>
<td>+2.4</td>
</tr>
<tr>
<td>Other</td>
<td>9142</td>
<td>9604</td>
<td>+5.1</td>
</tr>
<tr>
<td>Total</td>
<td>35766</td>
<td>35283</td>
<td>-1.4</td>
</tr>
<tr>
<td><strong>Import</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dry bulk</td>
<td>6887</td>
<td>8031</td>
<td>+16.6</td>
</tr>
<tr>
<td>Liquid bulk</td>
<td>20520</td>
<td>21446</td>
<td>+4.5</td>
</tr>
<tr>
<td>General Cargo</td>
<td>6193</td>
<td>5886</td>
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</tr>
<tr>
<td>Other</td>
<td>7396</td>
<td>7037</td>
<td>-4.9</td>
</tr>
<tr>
<td>Total</td>
<td>40996</td>
<td>42400</td>
<td>+3.4</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>76762</td>
<td>77683</td>
<td>+1.2</td>
</tr>
</tbody>
</table>

(Source: Sweden overseas shipping during July-September 1993, Statistics Sweden, T 47 SM 9304)

Table VI: Swedish seaborne trade 9/1992-9/1993 (September), 1000 tons

After having suffered in the early 1990s from the break-up of the important trading partner the former Soviet Union, Finnsih exporters began seeking out new markets. Now the Finnish industry appears to be back on track and the exports in terms of tons has increased by 15% from 1992 to 1993. Sawn timber, pulp, paper, metals, chemicals are main export growth areas. Therefore, also the demand for raw materials has increased substantially. The bulk import has increased by 6% during the same period. At the same time the transit traffic of Russian cargoes has increaed substantially. There is also a slightly increasing trend in the seaborne trade of Sweden. Seaborne traffic in other Western Baltic regions presents still a negative development.
4 STRUCTURE OF THE SHORTSEA BULK TONNAGE IN THE BALTIC REGION

4.1 TONNAGE DEFINITIONS

The term 'shortsea shipping' is here understood as execution of shipping activities using relatively small ships in a limited geographical area. This is in contrast to deepsea shipping, where usually larger vessels are employed in worldwide trades across the deep oceans.

Vessels engaged in shortsea shipping are usually built, equipped and manned to satisfy the requirements in the (limited) trading area where they are meant to operate. For the Baltic and North Sea dry bulk trades this means in practice bulk or general cargo ships in the range of 1000 to 8000 DWT. The average size of spot trading bulk ships in the Baltic and the North Sea trades is roughly 3000 DWT. Formal standards in this respect do not exist, however. In the relatively short coastal and intra-Baltic trades, barges are also common in transports of low value goods.

A variety of specialized ships are also common in the Baltic trade. When gathering data for relevant vessel types for this study, the various tonnage data sources used partially different names or definitions for the vessels. The vessel types targeted for this study included bulk and general cargo ships (incl. single and multi deck ships; and the so-called multipurpose vessels), specialized bulk ships, and ships for specialized cargo, and barges.

4.2 DETAILS OF THE TONNAGE DATA SEARCH

The main source of tonnage data was Lloyd's Maritime Information Services (LMIS), which produced a detailed vessel list according to our specifications. Data was gathered for both end-year 1990 and 1993. This data is very detailed, but a major drawback was that the Russian (1993) and the Soviet (1990) data was not specified by regions. In this way, the whole of Russian (or Soviet) fleet of the actual type and size were included. (see Table VII)

Russian tonnage operating in the Baltic is almost entirely controlled by three major shipping companies. They are the Baltic Shipping company, North western River Shipping Co. and White Sea & Onega Shipping Co (see e.g. Peters 1993a). Complementary data for these three companies was gathered from the July 1993 edition of Lloyd's World Shipowning Groups (LWSG).
Part I - Shortsea Shipping: Regional Analysis

LMIS = Lloyd’s Maritime Information Services, London

<table>
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<tr>
<th>Register codes used</th>
<th>Ship groups in the study</th>
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<tbody>
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<td>FIN</td>
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<tr>
<td>Sweden</td>
<td>SWD</td>
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<tr>
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<td>DEN</td>
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<tr>
<td>Denmark, international</td>
<td>DIS</td>
</tr>
<tr>
<td>Norway, national</td>
<td>NOR</td>
</tr>
<tr>
<td>Norway, international</td>
<td>NIS</td>
</tr>
<tr>
<td>The Netherlands</td>
<td>NTH</td>
</tr>
<tr>
<td>Germany</td>
<td>GFR</td>
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<tr>
<td>Poland</td>
<td>POL</td>
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<tr>
<td>Latvia</td>
<td>LAV</td>
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<td>LTH</td>
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<td>Estonia</td>
<td>ETN</td>
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<td>Russia</td>
<td>RUS</td>
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<tr>
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<td>USR</td>
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<table>
<thead>
<tr>
<th>Size distribution</th>
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<td>1000-3999 DWT</td>
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<td>4000-7999 DWT</td>
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<td>8000-12000 DWT</td>
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<table>
<thead>
<tr>
<th>Type of data gathered</th>
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<td>No. of vessels</td>
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<tr>
<td>Total GT</td>
</tr>
<tr>
<td>Total DWT</td>
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</table>

<table>
<thead>
<tr>
<th>Tonnage data as per</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dec. 31.1990</td>
</tr>
<tr>
<td>Dec. 31.1993</td>
</tr>
</tbody>
</table>

Other principal ship type codes used by LMIS not included in the study:

12000 Roro Cargo 19030 Tanker 19008 Specialized service
13000 Gas Tanker 19040 Factory 19007 Laker
15000 Sail 19070 Naval Combat 19009 ORSV Supply
18000 Sand Carrier 19080 Dredger 19807 Bulk, Great Lakes
19100 Passenger 19001 Container 19232 OBO
19300 Gas Carrier 19002 Ore Carrier 19032 ORO
19400 Tug 19003 Specialized Tanker 19011 Container
19600 Research 19004 Ferry 12004 Ro/Ro Cargo Ferry
19700 Hopper 19005 Fishing 19409 Tug/Supply Ship

No sub codes on ship types were employed in the data search

Table VII: Details on the tonnage data search from LMIS employed in the study

European Shortsea Shipping

89
Baltic Bulk Shipping in the 1990s

This data refers to early 1993 only. Data on current newbuildings was gathered from Fairplay’s newbuildings supplement (27th January 1994). Bulk, general cargo and multipurpose ships were included from this data. The newbuildings included are due for delivery in 1993-1996. Despite of the fact that they do not represent identical ship type definitions than LMIS or LWSG data, they give a fair indication on the volume of tonnage now on order in this type and size range.

The newbuilding data is given by country of ownership (with data on the flag used). In this way, some other flags than the actual Baltic flags are included in this data. There are only two major groups of vessel orders being registered under ‘non-Baltic’ flags. These include ten 2750 DWT dry cargo ships ordered by Russian interests from the Volgograd shipyard under the Maltese flag, and nine 4250 DWT dry cargo ships ordered by the German Chr. F. Ahrenkiel shipping company from the Sava and Begej shipyards under the Liberian flag (Fairplay 27th Jan. 1994). A few other German orders in this category are registered under other flags (Cyprus, Singapore and Antigua), too.

In Lloyd’s Ship Manager (August 1993) the Russian interests behind the Maltese-flagged NB’s were said to be the North-Western River Shipping Company. According to the Swedish Shipping Gazette (SSG) in early 1994, the current name of the company is North Western Shipping Company, thus indicating the growing emphasis on sea-going tonnage operated by this company. According to SSG, such changes in names seem to interest other Russian river shipping companies, too.

4.3 STRUCTURE OF THE TONNAGE IN THE CHOSEN REGISTERS

The structure of the overall tonnage data in the 1000-12000 DWT ships size category for the bulk tonnage (see Table VII for tonnage details) in end-1990 and end-1993. It shows clearly that the bulk and general cargo vessels (the two bottom blocks in the diagram) form the core of this type of tonnage. Equally clear is the high proportion of elder tonnage in these categories; about half of the tonnage is at least 15 years old. The data does not allow a reliable calculation of the average age of the tonnage, however.

The total fleet of these bulk, general cargo, specialized bulk ships and barges was 10.7 mDWT as per Dec. 31, 1990, and 9.4 mDWT as per Dec. 31, 1993. There was a decrease of some 1.3 mDWT between the two dates.

The data includes, however, the total Soviet and Russian fleet in this category, respectively. In 1990, the total Soviet fleet was 6.3 mDWT, and in end-1993 the Russian fleet with a small remainder of Soviet-registered tonnage totalled 4.4 mDWT. Thus the Soviet-Russian fleet has underwent a reduction equal to 1.9 mDWT from end-1990 to end-1993.
This simple calculation indicates that the fleets of all other registers increased by 1.9 mDWT - 1.3 mDWT = 0.6 mDWT. But at the same time, the fleet of the newly independent Baltic states totalled 0.9 mDWT by end-1993. Most part of this tonnage was included in the Soviet data for end-1990. This leads us to the conclusion that the overall tonnage for all other countries than Russia (and the Baltic states) remained at a constant level, or even diminished slightly. Without doubt, the fleet grew older from 1990 to 1993. (see Figure 1)

Figure 1: Aggregated tonnage data by age for the surveyed vessel types; end-year 1990 & 1993, (Source: LMIS)

4.4 TONNAGE DATA BY COUNTRY OF REGISTRY

In this chapter, the tonnage data is given by country of registry as prepared by LMIS (see Table VII). It is recognized, however, that there is tonnage operated by shipowners domiciled in the countries included in the study that fly other, often FOC flags. Such data is very difficult to gather, and that effort has not been made here.
Baltic Bulk Shipping in the 1990s

FOC tonnage in the vessel range under study is owned e.g. by German, Dutch and Norwegian shipowners\(^1\), as well as lately by Russian owners/interests, too. One reason for the Russian flagging-out has been the inability to arrange ship mortgages within the weak commercial banking system in Russia, though legal arrangements for this have been established (Holt 1993). On the other hand, e.g. the Baltic Republics’ registers have been used by owners from mainly Germany and the Netherlands. For these reasons, even the most detailed data by country of registry is able to give only a partial picture of the reality.

The tonnage data is divided by the major tonnage sizes used in the Baltic (and the North Sea) trades. This division goes in practice roughly at 4000 DWT, so the tonnage range from 1000-3999 forms one group and the range from 4000 to 12000 DWT the other (cf. the parcel size table in Chapter 3). The countries with the largest fleet in these categories are Russia, Germany and the Netherlands.

The data for these countries includes also a number of river going vessels, which cannot be extracted from the data; for example the LMIS does not provide any sub-code to do this type of data search. On the other hand, such a division may not be realistic since part of these river-going vessels may be employed in coastal and other shortsea trades as well.

Because of the overwhelming size of the total Russian tonnage, separate data for the Baltic Russian tonnage was necessary for this paper. Such data is derived from LWSG data. It should also be stressed, that despite of strong evidence of falling traffic and excess capacity of the (total) Russian fleet proposed e.g. by The World Bank’s recent report (Holt 1993, 149-150), the subject matter in this paper is explicitly the Baltic trades, where rapid changes have occurred since late-1993 and early-1994.

To separate the Baltic Russian fleet from the total Russian tonnage is very important here; e.g. in the larger size group (4000-12000 DWT), the Baltic tonnage (approx. 0.2 mDWT) was only about 11 per cent of the Russian total fleet, which exceeded 1.6 mDWT as at December 31, 1993. In the smaller segment (1000-3999 DWT), the Baltic fleet amounts to almost 0.7 mDWT, or some 45 per cent of the total Russian fleet of some 1.5 mDWT at end-year 1993.

\(^1\)Examples of the Norwegian owners are the Jebsen Thun Shipping Group with some 15 bulk and general cargo ships in the 3000 to 7000 DWT range with a total tonnage of some 75 000 DWT, and the Paal Wilson & Co. A/S with some 7 general cargo vessels in the 2500 to 4700 DWT range under the Maltese flag, together with two cement carriers of 2000 and 3000 DWT, with a total tonnage of some 30 000 DWT.
In the following sub-chapters, only bulk and general cargo vessels are included in the data, since these vessel types form the core of the trading tonnage in this region. Specialized bulkers and barges are not included in Sections 4.4.1 and 4.4.2. These two ship classes count for less than 20 per cent of the total tonnage (see e.g. Figure 1), are mainly employed in industrial shipping, i.e. the tonnage is owned or controlled by the shippers (see e.g. Ojala 1993a).

4.4.1 Bulk and general cargo tonnage in the 1000 to 3999 dwt range

The age structure of the individual registers can also be clearly seen in the following Figure 2 and Figure 3. The larger fleets of Russia, Germany and the Netherlands are portrayed separately from the 11 other registers. Interestingly, these include the old Soviet register with 15 vessels (at 50000 DWT). The data is gathered as at December 31, 1993. In this deadweight range, the German tonnage is remarkably new compared to other countries' tonnage, the only exception being the DIS-registered fleet, which is also relatively large.

Figure 2: Bulk & general cargo tonnage in the 1000-3999 DWT range end-year 1993 (Source: For Baltic Rus - Lloyd's World Shipowning Groups, July 1993; For RUS, GEU, NTH = LMIS)
4.4.2 Bulk and general cargo tonnage in the 4000 to 12000 dwt range

In this larger size group the newest fleet is that of the Netherlands, followed by Germany and Russia. Finland, Norway (NIS) and Denmark (DIS) have also fairly young fleet in this group. (Figure 4 and Figure 5).

In absolute terms, a tonnage of some 0.7 mDWT in these registers were under 10 years of age. In these registers, there were altogether 353 vessels in the size range (for Russia, including only Baltic Russian ships).
Part I - Shortsea Shipping: Regional Analysis

Figure 4: Bulk & general cargo tonnage in the 40000-12000 DWT range end-year 1993 (Source: For Baltic Rus - Lloyd’s World Shipowning Groups, July 1993; For RUS, GEU, NTH = LMIS)

4.5 DATA ON NEWBUILDINGS

The latest available data on the newbuilding (NB) orders were gathered from Fairplay’s list from January 27th, 1994. This data refers to NBs from yards to be delivered in 1993-1996. Some of the vessels in this data have been delivered by end-1993, but the majority of tonnage is due for delivery in 1994 and beyond. The data includes dry cargo, multipurpose and bulk vessels in the size group 1000 to 12000 DWT, as defined by Fairplay.

In the Baltic range, the most NBs are ordered by German interests, followed by Norwegian, Danish and Dutch interests. Despite of the sizeable Russian orderbook, only six vessels were order by the three Baltic Russian shipping companies. (Figure 6)

Very few small ships are being ordered, strengthening the evidence that small bulk ships under 4000 DWT cannot find a feasible market under current construction prices and freight markets. Larger vessels (usually at 6000-7000 DWT) clearly dominate the orderbooks.
Germans are also registering some of their NBs to other flags than the German one. There is also one order by the Dutch Soertermeer on a 3200 DWT vessel to be registered under the Cyprus flag, along with the 11 vessels' order by Russian interests to the Maltese flag mentioned earlier.

4.6 PRICE DEVELOPMENTS FOR THE MINOR BULK VESSELS IN 1990 TO 1993

The price development of regular dry cargo/bulk ships could be characterized as a steep increase in both NB and second-hand (SH) prices. This is indicated in the Table VIII, which is gathered from reliable Norwegian shipbroking sources (Bredrup, Bergen Shipping A.S., February 1994). These indicative prices in the

Figure 5: Bulk and general cargo tonnage in the 4000-12000 DWT range, end 1993, (Source: LMIS, except for Baltic Rus; Baltic Rus = LWSG, July 1993)
Figure 6: Newbuildings on dry cargo, multipurpose and bulk vessels in the 1000-12000 DWT range, 1993-1996, (Source: Fairplay, newbuildings supplement, 27 Jan, 1994; LSM, Aug. 1993)

Northern European range are given for approximative vessel sizes of 1000, 3000 and 8000 DWT, respectively.

Table VIII: Indicative prices for newbuildings and second-hand ships, 1990 and 1993, in USD million
Baltic Bulk Shipping in the 1990s

5 FREIGHT RATES AND TRENDS IN SOME BULK SHIPPING COSTS

The freight rates for simple bulk vessels in the size group under study are given in Table IX. The data is collected from a number of Norwegian shipbrokers dealing in this particular market, and they reflect the spot market rates calculated in T/C equivalents for the Baltic/North Sea market for vessels approximately 1000, 3000 and 8000 DWT by cargo carrying capacity.

<table>
<thead>
<tr>
<th>Approx. size</th>
<th>1990</th>
<th>1990</th>
<th>1993</th>
<th>1993</th>
<th>% change</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average</td>
<td>December</td>
<td>Average</td>
<td>December</td>
<td>Dec. 90/Dec. 93</td>
</tr>
<tr>
<td>1000 DWT</td>
<td>1270</td>
<td>1500</td>
<td>1500</td>
<td>1600</td>
<td>6,7</td>
</tr>
<tr>
<td>3000 DWT</td>
<td>2550</td>
<td>2550</td>
<td>2750</td>
<td>3600</td>
<td>41,2</td>
</tr>
<tr>
<td>8000 DWT</td>
<td>4230</td>
<td>4740</td>
<td>4600</td>
<td>6200</td>
<td>30,8</td>
</tr>
<tr>
<td>NOK in USD</td>
<td>5,9</td>
<td>5,9</td>
<td>7</td>
<td>7</td>
<td></td>
</tr>
</tbody>
</table>

Table IX: Freight rate developments for three approximative vessel sizes in USD/day; sport rates calculated in T/C-equivalents

There are also seasonal fluctuations in the rates during the year. Figure 7. is indicating this type of fluctuations, where the average rate refers to 1993 freight level. In the long run (since 1990) the freight rates have been improving slightly, but especially during end-1993 andf early 1994, the freights seem to have been climbing ‘permanently’ to higher levels than during the previous years. Shipbroking sources seem to confident that this improvement in early 1994 is going to stay on in the market, raising the freights for the whole of 1994 clearly above the 1993 level (see Figure 7).

The authors have got confirmation by a number of shipbroking and shipping sources in the Baltic trade that a steady upward trend of the freight rates started in September 1993. This trend seems to be continuing for the rest of the year 1994, as far as the market expectations are concerned, keeping the rates some 20 to 30 per cent above the 1990-1993 average freights. One indication of this that the ongoing affreightment negotiations in February/March for coal for the rest of 1994 seem to settle for such levels, thus creating a firm reference point for all other cargoes in the Baltic, too.

Compared to the relatively stable levels of spot-rates throughout 1990 to 1993, the December 1993 indications are some 40 per cent up for the 3000 DWT range, and some 30 per cent up for the 8000 DWT range. Reflecting the supply
of smaller vessels (e.g. elder vessels from the Baltic Russian and NIS fleets) in the 1000 DWT range, this segment has not experienced any increases to speak of.

5.1 INSURANCE PREMIUMS

5.1.1 Cargo insurance

The effects of using aging tonnage for the shipper are exemplified by the following construction. Let us assume that, for the sake of simplicity, we have a 10,000 ton consignment. The value of the cargo could be characterized as low (like e.g. 15 USD/ton for minerals), medium (say e.g. 170 USD/ton for clay) and
Baltic Bulk Shipping in the 1990s

high (e.g. 510 USD/ton for pulp; all values indicating the CIF value of the cargo). Further, we have two types of owners, the A type representing a standard owner and the B type standing for an owner with good records. These are standard terms used in Institute Cargo Clause (ICC) cargo insurances.

The subject under study is the age of the vessel and its effect on these combinations of cargo and owners. By regular ICC practices, an additional premium is placed on shippers using vessels over 10 years of age. This additional premium is increased after every five years, as shown in the figure.

Putting all this data together, we can conclude that in the worst case, a pulp shipper with the 10,000 ton consignment would be liable for an extra premium exceeding USD 40,000 when relying on a A type shipowner running a 26 to 30 year old vessel. This would mean more than 4 USD/ton in freight terms, which means in practice that this option is completely unfeasible.

![Figure 8: The difference of cargo insurance premiums on elder vessels and A and B type owners vs. normal insurance premiums in USD for a 10000 ton shipment](image-url)
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Alternatively, for low value shippers of mineral, additional premiums do not constitute any major problems in absolute terms. The type of cargo is also such that it is not easily affected by poor cargo space or hatch cover standards. But even for medium valued cargoes, old vessels are not very attractive, with additional premiums ranging at USD 10,000 for both A and B type shipowner options.

5.1.2 Hull and P&I insurances

Shipowners’ insurances on the vessel and cargo claims have soared dramatically for the operators of small bulk vessels between 1990 and 1993. Descriptive market indications on hull insurance for a gearless bulk vessel, single-decker with 2000 DWT and 999 GT, Scandinavian flag, Germanischer Lloyd class, built 1970, average good condition and with average insurance statistics runs at following premiums (separately for 1990 and 1993, respectively (Kystskipsassuransen, February 1994):

<table>
<thead>
<tr>
<th>Premium (USD p.a.)</th>
<th>Franchise (USD p.a.)</th>
<th>NOK in USD (currency conversion rate used)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>31,000</td>
<td>5,9</td>
</tr>
<tr>
<td>1993</td>
<td>40,000</td>
<td>7,0</td>
</tr>
</tbody>
</table>

During the same interval (1990 to 1993), the average increase in the P&I premium for a similar type of vessel has been in the range of 85 to 100 per cent (Assuransforeningen Gard, February 1994). On top of this, both off-hire and cargo insurance premiums have been showing a similar trend.

5.2 SOME INDICATIONS ON RUNNING COST DIFFERENCES BETWEEN DIFFERENT REGISTERS

Differences between various registers are clear when the daily running costs (DRC) are compared. The major cost component of DRC is the crew cost, the other components being repairs and maintenance, insurance and administration.

The crew cost includes costs for repatriation and some other crew related costs, but the major cost is, of course, the wages incl. social insurance and pensions costs. In this study DRC, or crew costs, for that matter, are not compared with other major costs, such as the capital costs. Generally speaking, capital costs account for a larger share of shipowners’ costs with small vessel than with large vessels. Similarly, capital costs for NB’s tend to be higher than for SH vessels.
Figure 9: Crew cost indexes in end-1992 for small ships in five registers (NIS with Filipino crew), (Source: Frakteman, 1/1993, Norway (Original: Norwegian Shipowners’ Association))

Differences in crew costs (wages) in end-1992 between Norwegian, Swedish, Dutch and Danish (DIS) registers are portrayed in Figure 7. The original source of the data is the Norwegian Shipowners’ Association.

Small tonnage ship is not explicity defined in the source, but it is assumed to reflect a standard dry bulk vessel in the 5000-8000 DWT range. The differences between the ordinary Norwegian (NOR), Swedish and the Dutch registers is very large vis-a-vis the DIS and NIS (with Filipino crew) operating ships. However, it is not clear, whether the Swedish data includes any direct subsidies available in Sweden (cf. MARAD 1993).

5.3 CONCLUSIONS ON CHAPTER 5

As a conclusion for the freight rate development, there is a strong indication that the current supply and demand situation is pushing up the freights especially for the larger tonnage in the size range under study. Newbuilding indications (Figure 6) are strongly in line with this observation based upon the freight rate development.

The freight rate development of small tonnage in the 1000 DWT range indicates, that these vessels are in much ampler supply than the larger tonnage. The data also reflects the age structure of the 1000 DWT tonnage; it is usually
very old tonnage, and growing ever older, since the rates do not allow the current NB prices. The practical consequences of this aging tonnage segments are more frequent cargo damages due to e.g. old and leaky cargo hatches, which, in turn show up steeply rising (cargo) insurance costs for the shippers as well as high (hull and P&I) insurance costs for the shipowner. The outranging and scrapping frequency is very low in this segment of ships under 3000 DWT. This tendency has went on for the past 15 years (Svendsen 1993 a) and b)). In this segment of the industry, the shipowners usual means of staying in the business could be characterized by three measures: reconditioning, upgrading and rebuilding.

6 CONCLUSIONS: ON A VERGE OF A NEW ERA IN BALTIC BULK SHIPPING

In this chapter, a collection of conclusions are presented under separate headings for the focal issues of the paper.

Cargo movement developments

The prospects for the future of Baltic bulk shipping will depend on trade developments in the Eastern Baltic and the Nordic Countries around the Baltic Sea. Several signals by end 1993 and early 1994 indicate increasing movements of bulk cargoes within the Baltic. The major dry bulk ports in the Eastern Baltic region covered in the study are showing an upward trend in the cargo turnover. However, the ports in the Eastern Baltic, data for which was shown in Chapter 3, are still far away from their peak cargo turnover years in the late 1980s.

At the same time the industry in Finland and also Sweden appears to be back on track. The exports of mainly general cargo consisting of paper, pulp, steel and sawn timber has increased substantially in terms of tons during the period from 1992 to 1993. Consequently, also the import of raw materials to Sweden and Finland increased substantially in the same period. The cargo demand in the dry bulk segment has remained rather constant in Germany and Denmark as a whole. For the unified Germany, there has been a shift to North Sea ports and some Baltic trades of the former GDR ports have evaporated altogether.

Even a limited growth of bulk cargoes in the Baltic shortsea trade, has very rapidly caused a shortage of of small bulk tonnage, mainly in the market for bulkers in the range of 3000 to 8000 dwt. A real and rapid increase of the freight level vessels in this range, started in September 1993. In average, the freight rate level has increased by 30-40% through the last 5-6 months from the "normal" level which has been virtually stable during the past 10 years. This
Baltic Bulk Shipping in the 1990s

trend is still keeping up in February 1994 despite of the anticipated cyclical slump in the beginning of the year (see Figure 6).

Tonnage developments

The bulk vessel category 1000-12000 dwt size in the Baltic region has remained at a constant level during the last years. There has been a long period with a very low newbuilding activity and a very low outranging and scrapping frequency. The average age of these vessels operating in the Baltic and North Sea range has been increasing. However, this aging fleet must meet ever stricter quality and safety requirement.

Over the next few years, scrapping or outranging is likely to increase as a larger proportion of the fleet is no longer able to meet the more rigorous requirements set by insurance companies and classification societies, thus making them less interesting for many Baltic shippers. Despite of mounting interest among some Western shipowners, no real upsurge in newbuildings to replace the aging fleet can be seen yet. Therefore, the supply of ships is expected to go down in the short term.

Freight rate developments, newbuilding prices and ship finance

Despite of the optimistic freight rate trends in the 3000-8000 DWT range, it remains very difficult for shipowner operating in the Baltic market to make both ends meet with a newbuilding. This is mainly because of unrealistically high newbuilding prices, backed up by increases in shipowners’ insurance premiums (see Chapter 5). With small tonnage like this, even the minimum of low cost crew members will not make any difference, since the number of crew is already small. And, similar low cost crew options are equally available to operators of second hand tonnage.

Under such circumstances, it is extremely difficult to get any commercially sound financing for renewals that would go to the competitive spot market. In Russia, Poland and the Baltic republics, capital is scarce. In Finland and Sweden, financing institutions have traditionally had limited interest in shipping finance. This interest is further diminished by a severe banking crisis in 1991-1993, from which the countries are slowly recovering. Banking crisis occurred in Norway, too, but there ship finance has a completely different standing than in Sweden and Finland.

Ship finance is possibly heading for very difficult times even globally and with the deepsea tonnage, too, making it increasingly difficult to allocate capital even within the shipping industry (cf. Peters 1993b). According to Peter’s estimates, the total cost of ocean tonnage repair and conversion will be around USD 52 billion during the period between 1993 and 2000.
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No such estimate was calculated for the Baltic bulk tonnage, since the adoption of feasible technological innovations (see scenario 2 below) enabling efficient refittings and the of this tonnage group as well as adoption of modern barge technology are focal parameters in such calculations. However, a rough estimate of the need for new bulk and general cargo ships in this category could easily go up to 100 to 200 ships (some 7 to 15 per cent of the fleet) by the year 2000. At current NB prices, this would mean a total cost of some USD 1.5 to 3 billion, which is a crude estimate.

Apparently, a basic requirement for (Western) shipowners to arrange finance for ships in the range under study are sizable subsidies. Sizeable construction subsidies are available especially in Germany, but they are also found in Denmark and the Netherlands. These countries also currently support operational subsidies that surpass those endowed in Sweden, and in Finland, too. (MARAD 1993 a) and b) for the Danish system: see ‘Det blå Danmark,’ 1991).

Generic competitive strategies and national advantages

From such a starting point it is also extremely difficult to get any commercially sound financing for renewals that would go to the competitive spot-based market. Mainly two types of investment in this bulk ship range can be identified. Firstly, they include (often) specialized ships employed in industrial shipping. These ships are seldom exposed to spot market competition. Secondly, there have been emerging interest among German, Dutch and Danish shipowners in this range.

Shipowners in these countries have also been able to combine the market in the Baltic with that of the North Sea, and while operating from an EU country, they have also been able to benefit from EU cabotage.

As a part of the EEA talks (and later, of the EU membership negotiations concluded on March 2, 1994, Scandinavian time) the EU cabotage is likely to be enlarged to Finnish and Swedish waters by July 1994. Especially the Swedish small bulk tonnage seems to be poorly equipped to compete against competitors from EU member countries. The same applies for Finnish small tonnage not engaged in industrial shipping, too. This, in turn, may call for further actions in the maritime policies for these countries (cf. Ojala 1994).

The cost leadership strategy may, on the other hand, be pursued by operators from Russia and the Baltic Republics. They are operating vessels with very low daily running costs, and often with minimal capital costs, at least for the elder part of their fleet (cf. Vanags 1993, and Sletmo & Holste 1993). These low cost elements may also be effectively combined with the shipping know-how and available capital from Western countries. This option is likely to be more widespread as the level of transaction costs (e.g. costs for uncertainty, the working of the banking system) are getting lower in these low cost countries.
Baltic Bulk Shipping in the 1990s

Shippers' options and shipowners' responses

The industries around the Baltic Sea rely heavily on shortsea maritime transports and they have a pronounced need for serious and reliable bulk as well as general cargo transports to and from the continent (cf. Ojala 1993b). Due to this development in the Baltic bulk shipping combined with the shippers increased awareness to total cargo-handling economy and environmental requirements, it is expected that contract market shipping will increase. These shippers will develop a long term partnership with experienced and high quality shipping companies.

The increase of the freight level, if enduring, will pretty soon cause dramatical shifts in the traditional market segmentation. Flexible bulk vessels will enter more profitable segments with high-value commodities. This will have a tremendous effect especially on the freight level within the segment for "rock bottom" cargoes as minerals and coal.

One group of shipping companies consists (and will consist) of serious shipowners, who operate a competitive fleet of flexible rebuilt second hand bulkers. They will be active mostly in the spot market, but the next step can also be also longer contracts of affreightment.

Yet another segment of shipping companies in the Baltic bulk shipping will be there to stay. This segment consists of shipowners with only a few low-standard, old vessels mainly in the 1000 - 3000 dwt range. Such companies exist in all of the countries studied here, but the segment will be dominated by Russian, Estonian, Latvian, Lithuanian and Polish operators. Operators from these former socialist countries, if succesful in pursuing their cost leadership option, will probably enter the first-mentioned segment pretty soon.

Two possible scenarios of tonnage development

Two scenarios of tonnage development and usage emerge as likely alternative outcomes in this market. The following figure illustrates the case.

Scenario 1 exemplifies a case with a steady increase in transport demand for bulk cargoes in Baltic shortsea bulk trades with limited newbuilding and refitting activities.

In scenario 2 we assume a steady increase in the transport demand followed by active and numerous newbuilding and refitting programs.

In scenario 1, the usage of tonnage will, by and large, remain as it is now, but there will be substantial increases in freight rates for high-quality tonnage, especially for tonnage in the 4000+ DWT range. Newbuilding activity may be directed to specialized tonnage instead of competitive (multipurpose) tonnage.
In scenario 2, new innovations in refitting technology dealing with more efficient self-discharging methods and novel hatch construction designs could play a pivotal role in supplying (i.e. refitting) tonnage to the higher-valued cargo segments. One such solution, the so-called LIFTUP vessel system could prove very efficient in this respect. (see e.g. Svendsen 1993 a) and b))

In scenario 2, however, new capacity suitable for lower-valued goods could be generated fairly economically by increasing the use of open sea going and ice classed pusher-barge technology. This technology has been successfully used in Finnish industrial shipping since mid-1980s. These pusher-barges with shallow draft also combine efficient and cheap roll on - roll off cargo-handling, a feature that is definitely an asset in poorly equipped ports as it is in well equipped ports, too.

### 7 POLICY RECOMMENDATIONS

A number of policy recommendations emerge from the analysis above. Only some major issues are presented under this last heading.

Firstly, the immense importance of the Baltic bulk shipping should be recognized as it counts for a major part of the Baltic/North Sea commodity trade volume. Also the tonnage employed in this traffic is impressive: some 1500 ships and a total of some 7 mDWT and more than 1500 ships.

Secondly, the fleet is aging, while at the same time the newbuilding (NB) prices are unrealistically high compared to current freight rates and operating costs. To compensate for the rising average age, roughly 100 to 200 ships would have to be built by the year 2000. At current NB prices this would mean a total cost in the range of USD 1,5-3 billion, as a crude estimate. To lower the average age of the fleet would need another 100 to 200 ships to be built in the 1990s.

Thirdly, as a consequence of the above-said, freight rates may continue to rise in this market, provided the improvements since September 1993 in the Baltic traffic are enduring, for which there is strong confidence in the market.

Fourthly, three different types of successful operating modes of shipowners seem to stabilize in the market: i) the high-quality competitive operators at present from the Western countries, notably from Germany, the Netherlands and Denmark, but possibly later on from the Baltic republics, Poland and Russia, too; ii) low-cost, low-quality operators mainly from Russia, the Baltic republics and Poland, and, finally iii) specialized operators engaged in industrial shipping either on long term contracts with multipurpose tonnage, or in specialized trades with special tonnage, which is often (part-)owned by shippers.
Figure 10: Generic cargo markets and corresponding vessel types in the Baltic bulk shipping with scenario outcomes.
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The German, Dutch and Danish as well as Norwegian shipowners seem relatively well equipped for the competition in operation modes i) and ii), whereas the Swedish competitiveness in these modes seems poor. The Finnish competitiveness is fairly good in mode iii), but it could probably reach competitiveness in mode i), too, if Finnish small tonnage operators could effectively operate with mixed crews under the Finnish flag.

The low cost option is likely to remain the option for the rest of the 1990s for operators from Russia, Poland and the Baltic states, unless they form joint ventures or other management contracts with Western counterparts. The major problem for low-cost operators is the lack of capital at the present combined with the difficulty to accumulate capital in the long run to enable the purchase of modern ships.

The need for new innovations in developing more efficient cargo-handling techniques (e.g. self-discharging methods) and solutions to upgrade elder tonnage to high-cost cargo segments with limited capital (e.g. new hatch constructions) seems obvious. Also the potential of modern sea-going and ice-classed pusher-barge technology seems very promising. These approaches could provide a cost-efficient solution for the Baltic trades in the 1990s substantially reducing the need for capital in ship finance.
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SHORTSEA SHIPPING FROM HINTERLAND PORTS BY SEA-RIVER GOING VESSELS: STUDY OF THE INFLUENCE OF A FREE CABOTAGE POLICY

By J.L.J. Marchal

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5 CONCLUSION .............................................. 132
This paper deals with the appraisal of intermodal transport projects taking into account the shortsea shipping and the inland navigation. The main objective of this economic appraisal is to evaluate the economic costs and benefits at the level of a region, a country or a continent.

At a financial level, an example of container transport will illustrate the cost computation of an intermodal transport system. The container transport on waterways can be made by adapted material; so, several river terminals are under development. Well adapted inland boats can connect these terminals with sea harbours located on the same inland waterway network. Sea-river going vessels can also be used to connect river ports with sea harbours which need a travel on sea. Through an example of containers’ transport between the Liège hinterland port and England or Scandinavian harbours, a comparison study is presented between the sea-river going vessel mode and several intermodal transport alternatives as:

* By truck with transfer to a ferry-boat;
* By truck up to the inland port, then by an inland boat up to a sea harbour, and by a sea vessel with redistribution by truck;
* By truck up to the inland port, then by sea-river going vessel and redistribution by truck.

This comparative study will answer by an economical computation at the two following important questions:

* Is the waterway competitive in comparison with the road transport if only continental transport is considered?
* In a transfer which needs a travel on sea, what are the conditions to use efficiently sea-river going vessels?
Shortsea Shipping from Hinterland Ports by Sea-River going Vessels

The influence of the free cabotage is considered in the different prospected alternatives by considering different loading rates for each mode.

Through the example of containers transfer between Liège Port and London, the optimum port hinterland has been located.

In the transport field, the program choice and preparation is an important prerequisite of economic growth.

The government authorities have to use a good evaluation methodology to realize careful economic choices of important investments required in the transport sector which has a strategic role in any country's economic development. This paper aims to present a methodology based on financial and external costs and benefits to evaluate intermodal transport projects including the shortsea shipping mode.

1 INTRODUCTION

This paper deals with the appraisal of intermodal transport systems including the inland navigation to compare with sea-river going vessel solutions.

The main objective of this economic appraisal is to evaluate the economic costs and benefits at the level of a region, a country or a continent. The government authorities have to use a good evaluation methodology to promote careful economic choices of important investments required in the transport sector which has a strategic role in any country's economic development.

The first step of such an evaluation is to realize comparisons at the financial transfer costs level. The present paper will present first transport costs computation technics mode per mode, except for the railway for which direct door to door official prices will be taken into account.

Comparisons will be considered to define, through an example of containers' transport, the size of the hinterland of a river port necessary to promote the short-sea shipping with sea-river going vessels.

Taking into account the financial results, comments will then be presented at the economic level to take care of all the external economic benefits and costs which are important to consider in order to promote a strategy of goods transfers in a region, a country or a continent.
2 TRANSPORT COST COMPUTATION

2.1 INLAND NAVIGATION

The general case is to consider a unit with a capacity of Z containers which is moving during a certain time on the following successive distances: \( d_1, d_2, d_3, \ldots \) km in different waterway sections. We suppose that the following parts \( n_1 d_1, n_2 d_2, n_3 d_3, \ldots \) km are done in loaded conditions at the relative speeds of \( v_1, v_2, v_3, \ldots \) km/h.

The boat is then unloaded. The rest of each distance, it means: \( (1-n_1) d_1, (1-n_2) d_2, (1-n_3) d_3, \ldots \) km is covered in light condition with the relative speeds \( w_1, w_2, w_3, \ldots \) km/h.

The renumerated distance for the considered time is thus: 
\[
D = \sum n d \text{ km}
\]

The number of navigation days in loaded conditions is:
\[
N = \sum \frac{n d}{h v}
\]
where: \( h \) = the number of navigation hours per day and \( v \) is the relative speed in loaded conditions.

The number of navigation days in light conditions is:
\[
I = \sum \frac{(1-n) d}{h w}
\]

The number of days spent in the ports is computed by the following formula:
\[
H = \sum \left( \frac{Z}{T_d} \right) + \sum \left( \frac{Z}{T_c} \right)
\]
where: \( T_d \) = the rate of unloading in the successive parts (containers/day) 
\( T_c \) = the rate of loading (containers/days).

The number of waiting days is equal to: 
\[
J = \sum j
\]
where: \( j \) = the number of waiting days in each port of the travel.

The transport of \( Z . D \) (Ton.km) needs fixed expenses during a number of days equal to:
Shortsea Shipping from Hinterland Ports by Sea-River going Vessels

\[ X = N + I + M + J + \Sigma \left( \frac{nd}{hv} \right) + \Sigma (1-n) \frac{d}{hw} + \Sigma \left( \frac{Z}{T_d} \right) + \Sigma \left( \frac{Z}{T_c} \right) + \Sigma j \]

The amount of fixed expenses per Ton.km is: \[ \Phi_f = \frac{F + F'}{ZD} \]

where:
- \( F \) = fixed expenses per day for the unit without the propulsion installation
- \( F' \) = fixed expenses per day for the propulsion installation (the redemption time of the propulsion installation is less than for the unit structure).

In fact:
\[ F = \frac{Au + S}{365} \]

where:
- \( A \) = unit construction cost without the engine
- \( u \) = rate of fixed expenses corresponding to this cost (%)
- \( S \) = annual total salary of the crew.

The fuel expenses are defined by the following expression:
\[ \Phi_c = \frac{Q \cdot cp \cdot N \cdot h + Q' \cdot c' \cdot p \cdot h}{Z \cdot D} \]

where:
- \( Q \) = shaft power in loaded condition (HP)
- \( c \) = specific consumption in loaded condition (kg/HP/hour)
- \( p \) = fuel cost per kg.

The index ' is concerning with the navigation in light conditions.

Finally, the total value of exploitation expenses per container.km is:
\[ \Phi = \Phi_f + \Phi_c + d + d' + \frac{\Sigma (1-n) d}{\Sigma nd} + \frac{\Sigma f}{\Sigma nd} \]

where:
- \( d \) = navigation dues in loaded condition per container.km
- \( d' \) = navigation dues in light condition per containers.km
- \( f \) = port dues per ton

The number of container.km realized per year is given by:
\[ Z_a = Z \left( \frac{365}{X} \right) \Sigma (nd) \]
In order to normalize the calculations, Table I can be used for each river transport unit.

2.2 ROAD TRANSPORT

The cost price of road transport includes the following terms:

1. The annual fixed costs including:
   - The redemption and financial fees depending on the mean purchase cost, the pneumatic value, on the value without pneumatic (V) and on the residual value (R);
   - The annual redemption is computed by the formula \((V-R)/n\) \((n = \text{number of life years of the truck})\). The financial fees are given by the expression \((V + R/2)i\) \((i = \text{rate in \%})\);
   - The insurances including burning of the vehicle and goods;
   - The drivers’ salaries and their fees;
   - Taxes.

2. The kilometric expenses (fuel, oil, pneumatic, repairing...);

3. General fees.

2.3 MARITIME TRANSPORT

2.3.1 Exploitation cost

The annual exploitation cost of a chip is composed by three fundamental terms:

* A term proportional to the investment with:
  - the financial expenses \(a_1\);
  - the insurances, \(a_2\);
  - the maintenance expenses, \(a_3\);

* A term function of the exploitation degree, including: \(C=njmc\cdot P\)
  where: \(n = \text{number of annual trips,}\)
  \(j_m = \text{number of days on sea per trip,}\)
  \(c = \text{consumption in tons per day,}\)
  \(P = \text{the cost of one ton of fuel corrected to take the oil into account.}\)

For a type of machinery, the factor \(c\) is proportional to the continuous service speed.
Shortsea Shipping from Hinterland Ports by Sea-River going Vessels

<table>
<thead>
<tr>
<th>No.</th>
<th>A: Items</th>
<th>B: Formulas</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>type of unit</td>
<td>data</td>
</tr>
<tr>
<td>2.</td>
<td>origin - destination</td>
<td>data</td>
</tr>
<tr>
<td>3.</td>
<td>possible navigation duration (hours/day)</td>
<td>data</td>
</tr>
<tr>
<td>4.</td>
<td>number transported per unit</td>
<td>data</td>
</tr>
<tr>
<td>5.</td>
<td>of containers transported per year</td>
<td>data</td>
</tr>
<tr>
<td>6.</td>
<td>barge number per unit</td>
<td>data</td>
</tr>
<tr>
<td>7.</td>
<td>propulsion power (HP)</td>
<td>data or evaluation</td>
</tr>
<tr>
<td>8.</td>
<td>distance (km)</td>
<td>data</td>
</tr>
<tr>
<td>9.</td>
<td>investment value of the pusher</td>
<td>data or evaluation</td>
</tr>
<tr>
<td>10.</td>
<td>investment value of the barge(s)</td>
<td>data or evaluation</td>
</tr>
<tr>
<td>11.</td>
<td>life duration of the pusher</td>
<td>evaluation</td>
</tr>
<tr>
<td>12.</td>
<td>life duration of the barge(s)</td>
<td>evaluation</td>
</tr>
<tr>
<td>13.</td>
<td>redemption cost of the pusher per year</td>
<td>evaluation</td>
</tr>
<tr>
<td>14.</td>
<td>redemption cost of the barge(s) per year</td>
<td>evaluation</td>
</tr>
<tr>
<td>15.</td>
<td>navigation crew salaries per year</td>
<td>data</td>
</tr>
<tr>
<td>16.</td>
<td>pusher insurance per year</td>
<td>data or evaluation</td>
</tr>
<tr>
<td>17.</td>
<td>barge insurance per year</td>
<td>data or evaluation</td>
</tr>
<tr>
<td>18.</td>
<td>fixed cost per year</td>
<td>B13 + B14 + B15 + B16 + B17</td>
</tr>
<tr>
<td>19.</td>
<td>navigation speed against the current (km/h)</td>
<td>data or evaluation</td>
</tr>
<tr>
<td>20.</td>
<td>navigation speed with the current (km/h)</td>
<td>data or evaluation</td>
</tr>
<tr>
<td>21.</td>
<td>navigation time against the current (days)</td>
<td>B8 / (B19 x B3)</td>
</tr>
<tr>
<td>22.</td>
<td>navigation time with the current (days)</td>
<td>B8 / (B20 x B3)</td>
</tr>
<tr>
<td>23.</td>
<td>waiting-round time (days)</td>
<td>evaluation</td>
</tr>
<tr>
<td>24.</td>
<td>turn-round time (days)</td>
<td>B 21 + B 22 + B23</td>
</tr>
<tr>
<td>25.</td>
<td>possible navigation time (months/year)</td>
<td>data</td>
</tr>
<tr>
<td>26.</td>
<td>number of turn-rounds per year</td>
<td>30.5 x B25 / B24</td>
</tr>
<tr>
<td>27.</td>
<td>fixed cost per turn-round</td>
<td>B18 / B26</td>
</tr>
<tr>
<td>28.</td>
<td>fixed cost per container</td>
<td>B27 / B4</td>
</tr>
<tr>
<td>29.</td>
<td>annual transport capacity per unit (containers)</td>
<td>B4 x B26</td>
</tr>
<tr>
<td>30.</td>
<td>number of necessary pushers</td>
<td>B5 / B29</td>
</tr>
<tr>
<td>31.</td>
<td>number of necessary barges</td>
<td>B30 x B6</td>
</tr>
<tr>
<td>32.</td>
<td>fuel cost per liter</td>
<td>data</td>
</tr>
<tr>
<td>33.</td>
<td>fuel and oil cost per year</td>
<td>a x B3 x B7 x B26 x B32(B21+B22)</td>
</tr>
<tr>
<td>34.</td>
<td>maintenance cost of the pusher per year</td>
<td>b x B9</td>
</tr>
<tr>
<td>35.</td>
<td>maintenance cost of a barge per year</td>
<td>c x B10</td>
</tr>
<tr>
<td>36.</td>
<td>cargo insurance cost per container.km</td>
<td>data</td>
</tr>
<tr>
<td>37.</td>
<td>cargo insurance cost per year</td>
<td>B36 x B4 x B26 x B8</td>
</tr>
<tr>
<td>38.</td>
<td>variable cost per year</td>
<td>B33 + B 34 + B35 + B37</td>
</tr>
<tr>
<td>39.</td>
<td>general cost per year</td>
<td>(B18 + B38) x d</td>
</tr>
<tr>
<td>40.</td>
<td>total cost per year and per unit</td>
<td>B18 + B38 + B39</td>
</tr>
<tr>
<td>41.</td>
<td>total cost per turn-round</td>
<td>B40 / B26</td>
</tr>
<tr>
<td>42.</td>
<td>total cost per container</td>
<td>B41 / B4</td>
</tr>
<tr>
<td>43.</td>
<td>total cost per container.km</td>
<td>B42 / B8</td>
</tr>
</tbody>
</table>

a. fuel and oil consumption in liter per HP and per hour
b. percentage of the pusher cost
c. percentage of the barge cost
d. percentage of the transport cost.

Table I
- The harbour expenses \( p' \) per ship means the harbour fees, the towing and pilotage fees etc... excluding the stowage and handling expenses:

\[
p' = p_0 + b_j \text{ per trip} \quad \text{or} \quad p' = n(p_0 + b_j) \text{ per year}
\]

where: \( j = \) tonnage and \( p_0 = \) fixed cost

- A fixed term per ship \( F \) for the crew expenses.

* A fixed term per service \( G \) representing the management fees supported by a given service (for a fleet)

The total annual exploitation cost for a given service is thus:

\[
N(a + nj_{mp} + n(p_0 + bj) + F) + G
\]

where: \( N = \) number of ships in operation.

### 2.3.2 Transport capacity

The annual transport of containers \( Z \) will be assured by \( N \) units for \( n \) trips per year with a capacity of \( V \) containers, thus:

\[
Z = N \cdot n \cdot V
\]

### 2.3.3 Specific investment

The first term of the general equation of the exploitation cost is:

\[
NaI = \frac{Z}{nV} aI
\]

If I suppose that each ship is effectively in operation during 360 days per year, the number of trips per year is:

\[
n = \frac{360}{D \cdot v + j_p}
\]

where \( D = \) the total distance per trip
\( v = \) the mean speed per hour
\( j_p = \) the number of days in the harbour per trip.
Shortsea Shipping from Hinterland Ports by Sea-River going Vessels

This last term can be considered as proportional to the ship capacity at least when it is a bulk ship with regular handling operations:

\[ NaI = Z \frac{D + 24 V^2 (V)}{8640} \frac{al}{vV} \]

This relation shows a ratio which is the specific investment or the unit cost of "dynamic capacity" of transport.

An experimental formula for I is the following:

\[ I = k_c V^{0.8} + k_m (V^{0.6} \cdot v)^{0.6} \]

Where: \( k_c \) and \( k_m \) are cost coefficients. The first one is concerned with the hull and its general equipment, the second with the machinery which depends on the speed and the capacity. The specific investment can thus be:

\[ \frac{I}{vV} = k_c V^{-0.2} - 1 + k_m V^{-0.6} \cdot v^{1.4} \]

The speed corresponding at the minimum specific investment is:

\[ v = \sqrt[2.4]{\frac{k_c}{1.4k_m}} \cdot V^{1.6} \]

where: \( V \) = the capacity.

2.3.4 Fuel and oil consumption, specific power

The second term of the annual exploitation cost is:

\[ cpNnj_m = \frac{Z \cdot D}{V} \frac{pc}{24v} \]

2.3.5 Ship fixed expenses

The last term in brackets in the annual exploitation cost formula is:
Section II - Multimodal and Modal Split

\[
NF - \frac{Z}{nV} = \frac{ZD}{8640} \left(1 + \frac{24fV}{D}\right) \frac{F}{vV}
\]

This term contributes to increase the optimum speed. This increasing is as lower as the ship is bigger.

2.3.6 Harbour fees

This term is: \( Nn(P_0 + bj) = \frac{Z}{V} (P_0 + bj) \)

As the tonnage is, in first approximation, proportional to the capacity of the ship, we can write:

\[
Z\left(\frac{P_0}{V} + b_i\right)
\]

This term has no influence on the optimum speed; an increasing of the ship size does not generate a substantial economy.

3 COMPARISON OF CONTAINERS TRANSFER COSTS (door to door) BETWEEN SEVERAL TRANSPORT ALTERNATIVES USING SHORTSEA SHIPPING

3.1 ALTERNATIVES DEFINITION

The transport of a container from an inland port to a destination located in another continent or along a sea coast can be done by several transport modes:

* By truck with transfer to a ferry-boat;
* By truck up to the inland port, then by an inland boat up to a sea harbour, and by a sea vessel with redistribution by truck;
* By truck up to the inland port, then by sea-river going vessel and redistribution by truck.

3.2 COMPUTATION EXAMPLE
3.2.1 Continental transportation

The preceding theory will be applied at the case of the Port of Liège, the third inland port in Europe. This port is located at 120 km from the sea harbour of Antwerp. The transfer costs of containers from Liège to Great-Britain, Ireland and Scandinavian countries, will be compared. The handling costs of a container are represented in Table II.

<table>
<thead>
<tr>
<th>TRANSPORT MODE</th>
<th>INLAND PORT</th>
<th>SEA HARBOUR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Truck</td>
<td>500</td>
<td>2,500</td>
</tr>
<tr>
<td>Inland Boat</td>
<td>1,000</td>
<td>5,000</td>
</tr>
<tr>
<td>Sea-River going vessel</td>
<td>1,000</td>
<td></td>
</tr>
</tbody>
</table>

Table II: Container handling costs

The rapprochement by road in a maximum radius of 30 km costs 3,000 BEF. The first question to solve is to know in which conditions the waterway can be competitive in comparison with the road if only continental transport is considered. Table III gives a first comparison between different transport modes: it defines the container.km costs taking into account the mean annual distance normally realized by each mode and the different loading rates.

The mean cost per container.km for the waterway transportation takes into account that 75% of containers have 20’ length and 25% of them have 40’. The number of crew for an inland boat is around 4 men and 8 men for a sea-river going vessel.

The results show that in general the waterway transport is more interesting than the road for displacements higher than 600 T, if nonstop travels are considered. It will be assumed that the loading rate for the waterway is 60%. The following Table IV defines the distance over which the waterway is competitive in comparison with the road for two loading rates (50 and 100%) and if the road transport up to the inland port is taken into account or not.

If the loading rate for the road transport is 100%, the inland boat with a loading rate of 60% will never be competitive for a line between Liège Port and Antwerpen harbour. To be competitive with the road transport, the breaking of load at Antwerpen harbour must be avoided.
Table III: Container.km costs (BEF 1984)

<table>
<thead>
<tr>
<th>TYPE OF BOAT</th>
<th>Distance of which the waterway is competitive (km)</th>
<th>Loading rate of the road mode</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>50%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Road rapprochement</td>
</tr>
<tr>
<td></td>
<td></td>
<td>With</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Without</td>
</tr>
<tr>
<td>300 T</td>
<td>never</td>
<td>never</td>
</tr>
<tr>
<td>600 T</td>
<td>85</td>
<td>169</td>
</tr>
<tr>
<td>2250 T</td>
<td>68</td>
<td>135</td>
</tr>
<tr>
<td>3500 T</td>
<td>55</td>
<td>110</td>
</tr>
<tr>
<td>9000 T</td>
<td>53</td>
<td>106</td>
</tr>
</tbody>
</table>

Table IV: Minimum competitive distances for the inland waterway transport mode

It is thus necessary to study now in which conditions the use of sea-river going vessels will be interesting.
Shortsea Shipping from Hinterland Ports by Sea-River going Vessels

3.3 TRANSPORTATION FROM AN INLAND PORT TO A SEA HARBOUR WITH A TRAVEL ON SEA

As examples (see Table V), several lines between the Port of Liège and Great-Britain (London, Liverpool), Ireland (Dublin) and Scandinavian countries (Oslo, Stockholm, Helsinki), will be considered.

The rapprochement cost to Liège Port by road and the distribution by road from the arrival harbour is taken into account in the following computations of the sea-river going vessel cost of a container transport.

The loading rate of the trucks is assumed to be 100%.

For the sea-river going vessel two rates are considered: 80 and 90%.

<table>
<thead>
<tr>
<th>Lines</th>
<th>Transfer cost - (BEF - 1984)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Truck + container + truck</td>
</tr>
<tr>
<td></td>
<td>Truck + ferry boat + truck</td>
</tr>
<tr>
<td></td>
<td>Sea-River going vessel</td>
</tr>
<tr>
<td></td>
<td>Railway</td>
</tr>
<tr>
<td>Liège-London</td>
<td>35,900 30,200 24,500 22,900</td>
</tr>
<tr>
<td>Liège-Liverpool</td>
<td>43,000 53,800 54,500 49,500</td>
</tr>
<tr>
<td>Liège-Dublin</td>
<td>52,750 62,700 50,000 45,500</td>
</tr>
<tr>
<td>Liège-Oslo</td>
<td>52,000 60,000 56,600 46,000</td>
</tr>
<tr>
<td>Liège-Stockholm</td>
<td>56,550 61,500 60,400 55,000</td>
</tr>
<tr>
<td>Liège-Helsinki</td>
<td>55,000 102,350 73,000 66,000</td>
</tr>
</tbody>
</table>

Table V: Transfer costs per container

Following these results, it clearly appears that the sea-river going vessel transportation from Liège Port is almost the best one for all the destinations even when the best conditions for this transportation mode are not chosen.

However, an important parameter is the loading rate which is greatly influenced by the cabotage policy: it could be observed that a free cabotage policy will increase the waterway transport competitiveness.

3.4 OPTIMUM LOCATION OF THE LIÈGE PORT HINTERLAND FOR THE TRANSPORT OF CONTAINERS TO LONDON

3.4.1 General data

In Liège region, the customer has two alternatives to transfer containers to London:
Section II - Multimodal and Modal Split

* The traditional solution by road and ferry-boat on container ship;
* By sea river going vessel.

The two solutions will be compared in order to define the minimum sizes of the influence zones around Liège port for the sea-river going vessel mode to collect containers.

From the data and hypothesis on annual fees of each transport alternative, the unit costs have been evaluated to compute the travel costs. Mean cost values have been collected near Transport Companies, builders, shippers, ...

The main computation data for the two alternatives are represented in Table VI.

<table>
<thead>
<tr>
<th>ITEM</th>
<th>SEA-RIVER GOING VESSEL</th>
<th>TRUCK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investment cost (BEF)*</td>
<td>140,000,000</td>
<td>5,800,000</td>
</tr>
<tr>
<td>Loading capacity (containers number)</td>
<td>80 (20')</td>
<td>1.125 (75% of 20' and 25% 40' containers)</td>
</tr>
<tr>
<td>Redemption time (year)</td>
<td>15</td>
<td>7</td>
</tr>
<tr>
<td>Offered mean annual production (TEU.km)</td>
<td>3,500,000</td>
<td>112,500</td>
</tr>
<tr>
<td>Crew number (men)</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>Fuel consumption (BEF/km)</td>
<td>130</td>
<td>5</td>
</tr>
</tbody>
</table>

*1987 value

Table VI: Cost computation data of the two alternatives

Other general data have been considered as administration, maintenance, port, navigation and financial fees.

The global unit costs of realized production in function of the exploitation efficiencies are represented in Table VII.

3.4.2 Definition of the alternatives assumptions

As the exchanges with England are not in equilibrium, it is supposed that the loading rates are 90% from Liège and 70% from London. The rapprochement costs per truck in a radius of 30 km are respectively 500 BEF and 6,000 BEF around Liège and London; the computed unit cost is 38,214 BEF/TEU.
As the transport alternative "truck + ferry" is concerned, 4 cases are considered:

a. A normal production (100 000 km/year; unit cost = 44,249 BEF/TEU);
b. A higher production (140 000 km/year; unit cost = 38,619 BEF/TEU);
c. In case b, the ferries company allocates a 10% discount due to the regularity and the number of crossing travels (unit cost = 36,629 BEF/TEU);
d. Same than case b. except that the discounting rate is 20% (unit cost = 34,640 BEF/TEU).

The considered loading rate is for each case equal to 50%.

The unit costs are related to the travel from Liège area to London area and the back travel. Taking into account the difficulty for the sea-river going vessel mode to collect enough containers around Liège and the possibility for the road mode to have the advantage of discounting rates (case c. end d.), the competitiveness of the full waterway transport mode is low.

In a policy of intermodal transfer, it is thus important to define the Liège hinterlands in the different preceding studied-cases of competition. In this purpose, equivalence curves have been computed between the two proposed options; the following formula has been used (Figure 1):

\[ A + K_1 C_1 = B + K_2 C_2 \]

Where: A, B = constant transport costs;
K_1, K_2 = distances from the customer company;
C_1, C_2 = unit costs for the road rapprochement to the ports.

The Figure 2 shows the equivalence curves for each cases.
A regular line of transport by sea-river going vessels from Liège port is mainly concerned (case c, and d) with the extreme east part of Belgium, the Germany border and Luxembourg areas: the commercial policy objective is to find important potential customers in this hinterland to assure a regular containers feeding.
Shortsea Shipping from Hinterland Ports by Sea-River going Vessels

This policy needs to promote the intermodal transport supported by a rigorous logistic approach.

4 ECONOMIC EVALUATION

4.1 GENERAL COMMENTS

The preceeding considerations point out the competitiveness conditions of the waterway transport at a financial level. A transport policy has to be founded at this level but it must be completed by economic evaluations.

4.2 SUMMARY OF THE WELL KNOW METHODOLOGY FOR AN ECONOMIC RATIONAL CHOICE BETWEEN SEVERAL TRANSPORT SCENARIOS

In order to establish priorities in intermodal transport chain including the waterway transport mode, leading to ranking of projects in terms of their value and to optimize a particular project amongst various possible alternatives, it is very important to follow a well adapted method of study.

One of the more appropriate assessment criterion is the economic benefit/cost ratio for ranking the projects. The numerator of this ratio is composed by the sum of all the effects of project implementation and its denominator the sum of all the costs involved in project implementation.

As the benefits and costs are evaluated at different steps of the projects, they need to be discounted from a common reference date by application of an appropriate discounting rate: it corresponds generally to the date when the decision could be taken to go ahead with the project.

The different proposed alternatives must be compared with a fixed competitive situation of reference.

The transport flows must be forecast by considering directly the cargo categories and the transport flows and by defining origine-destination traffics. The situation prevailing at the time of preparation the project design must be considered and must be complemented by a higher precision analysis of forecast changes in traffic in the years to come.

A part from investments, the costs must also naturally include future operating, maintenance and general costs.
Section II - Multimodal and Modal Split

In order to appreciate the real effects resulting from the eventual investment decision, it is necessary to subtract, from the total cost, the costs involved in the situation of reference which give rise to a variety of inevitable costs.

By determining the benefit/cost ratio following this methodology and after an overall comparison, a final decision can be taken.

If the results of the two cheapest alternatives are very close one from the other, the study of each of them must be pursued in more details.

4.3 INFLUENCE OF A REAL TRANSPORT POLICY AT A LEVEL OF A CONTINENT LIKE EUROPE

4.3.1 Economic advantages of the waterway transport mode

To evaluate the economic benefits of investments in waterway infrastructures and navigation materials, it is important to point out the following well known considerations:

* The waterway has several functions: transport, irrigation, energy production, water supply, flood control, leisure, industrial development (only 50% of the infrastructure investments along Seine river in France were concerned with the transport function);

* The waterway transport mode has several advantages in comparison with other modes: less energy consumption, better environment protection, higher transport security (traffic accidents, dangerous goods...) and reliability, possibility to transfer important indivisible loads, offer of additional storage capacities;

* The use of the waterway mode reduces the road traffic.

It is thus important to take into account both direct and indirect preceeding advantages to assure an economic rational choice: many studies allow now to evaluate these effects with a higher accuracy.

4.3.2 European Community policy

The commission has drafted outline plans and proposed decisions, either adopted already by the Council or under discussion, which will influence very strongly the transport infrastructure and networks in Europe. These concern high-speed trains, the road networks, inland waterways and ports and combined transport.

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With regard to the promotion of intermodal transport, two areas have priority:

* Combined transport of goods;
* Collective transport in urban areas.

Special attention shall be given to improving freight transport for the efficient distribution of goods to bring economic benefits to business and consumers, as well as to residents affected by environmental nuisance. In multimodal operation, freight terminal operation is the crucial issue.

The maritime industries forum has considered that the maritime transport on short distances has to be developed in a free internal cabotage market and that it has to be classify among the priority actions. A more intensive use of inland navigation and shortsea shipping must be encouraged. These transport modes must be more integrated in the combined or multimodal transport chains.

For European seafarers' unions, it is important that simulation of short sea transport in Europe occurs under European conditions. In view of the fact that European coastal shipping is constantly switching to flags of convenience, there is a danger that conditions similar to those in international tanker shipping will soon be predominant. In the interest of maritime safety, environmental protection and maintenance of maritime know-how in Europe, the European seafarers' unions attach great value to short sea transport existing within an EC-cabotage - similar to that of the other two great industrial centres of the world: the USA and Japan.

It was further observed that both road and rail transport enjoy substantial benefits from the government-funded infrastructures, costs of which are only partially charged, resulting in unfair competition for short sea transport.

Traffic management and control systems should be developed which are able to react in real time to incidents and causes of delay, and are able to optimise transfers between the different transport modes. The mission of the Transport Telematics Requirement Board is to address at a strategic level future requirements and options in Transport Telematics and resulting services for all modes of transport and the interfaces between them.

5 CONCLUSION

The presented advantages of the inland navigation and the EC policy will encourage the development of shortsea shipping and increase the sea-river going vessels traffic.
Section II - Multimodal and Modal Split

Even on a strict financial level, this mode is already competitive in certain conditions, as demonstrated in this paper. The EC promotion policy to promote multimodal transport systems has to be put in concrete form. The external and indirect costs of each mode have to be integrated in the total costs.

A free cabotage policy has to be really implemented to increase the production efficiency which is a more sensitive factor for the waterway transport mode.

The policy of modernization of the West European waterways network will increase the navigation production of bigger sea-river going vessels which will penetrate more deeply in the continent.

This direct transport mode, which avoids transhipments at the sea harbour and goods damages, will increase its market if a policy is really implemented, increasing the role of the inland ports in the international foreign trade.
Shortsea Shipping from Hinterland Ports by Sea-River going Vessels

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AN ALTERNATIVE SYSTEM FOR SHORTSEA SHIPMENT OF ROAD VEHICLES

By J. Igielska

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AN ALTERNATIVE SYSTEM FOR SHORTSEA SHIPMENT OF ROAD VEHICLES

ABSTRACT

The present transport system of vehicles in short sea trade is not satisfactory in various respects:

* Safety in securing of road vehicles for sea voyages;
* Extent of necessary manual work on board;
* Broad variety of vehicle types and general absence of standard lashing points for securing on board;
* Degree of ship capacity utilisation.

The new concept based on a special cassette for intermodal transport of a wide variety of road trailers is proposed. The idea mainly aims at elimination of stevedoring work on board, higher safety at sea and cargo handling cost and time reductions in the long term.

The trailer cassette concept might be explained as an idea for cutting off the particular area of the roll-on/roll-off deck needed for stowage of a single trailer and separating it from the ship hull structure.

It is assumed that securing of the trailer to the cassette would be carried out in port terminal before ship arrival and stevedoring work on board should be eliminated completely.

The cassettes will be stowed on board in the cell guide system and on special supports built into the ship's structure. The design principles of the guide system are similar to those proven on container carriers with some modifications regarding slot dimensions and support arrangement for cassettes. The guide system would be adjustable in order to stow other unitised cargo as containers of various lengths and widths if such flexibility is required.

The ship would be of the "hatchless" type which could additionally decrease both capital and operating costs.

The trailer cassettes may fill up the whole depth of the ship and consequently the stowage factor is much higher in comparison with roll-on/roll-off vessel, as well as cargo handling production rates of lift-on / lift-off mode are generally higher, especially if two container gantry cranes with good performance are engaged. It would additionally improve the efficiency of the ship by reduction of required port time.
An Alternative System for Shortsea Shipment of Road Vehicles

1 GENERAL

A road vehicle moves on its own wheels and fits well into a whole transportation chain, i.e. from door to door. There is access to roads everywhere, and road vehicles carry all sorts of goods, from valuable industrial products unitized in small parcels to high cube containers, and bulk cargoes.

With the introduction of combi-trains for trailers in the mid-80s, linking remote industrial areas with port terminals, road vehicles became important elements of intermodal transport systems.

Wheeled cargo units are carried often in shortsea shipment but there are important reasons why sea transport is unfavourable in comparison with other transportation modes.

The competitiveness of sea transport should be improved, as there are circumstances in its favour, including growing road congestion, public expenditure cuts, and increasing public awareness of the environmental cost of road haulage. There are also needs for improvement of the whole transportation chain of cargo from manufacturers to consumers in order to decrease costs and shorten transit times. This requires general analysis of all linkages in transportation process which should lead to formulation of requirements for unification of road, railway and sea transport systems.

2 TYPES OF ROAD VEHICLES

There are many types of road vehicles. In accordance with the ISO Standard (No 3833) these include:

1) Commercial vehicle, a motor vehicle which, on account of its design and appointment, is used mainly for conveying goods. Its may also tow a trailer;

2) Special vehicle, a motor vehicle which on account of its design and appointment, is intended:
   - only for conveying persons and/or goods for which special arrangements are necessary;
   - only for performing a specific work function.

3) Trailer towing vehicle, a motor vehicle which is designed exclusively or principally for towing trailers;

4) Semi-trailer-towing vehicle, a motor vehicle which is designed for towing a semi-trailer;

5) Trailer, a vehicle of which, on account on its design, no substantial part of its total weight is supported by the towing vehicle;
6) **Semi-trailer**, a trailer which is designed to be coupled to semi-trailer towing vehicle and to impose a substantial part of its total weight on the towing vehicle;

7) **Combination of vehicles** with one or more independent trailers connected by a draw-bar or semi-trailer-towing vehicle with a semi-trailer.

### 3 PRESENT SEA TRANSPORT SYSTEM OF ROAD VEHICLES

Road vehicles are often transported over sea by ferries for relatively short distances, and by roll-on/roll-off ships within European trade. Motor vehicles do not need any cargo handling equipment for stowage on board, such as terminal tractors. The drivers follow their vehicles and are treated as passengers during the sea voyage. Semi-trailers released from towing vehicles, as well as such roll-on/roll-off equipment (not allowed in road traffic) which are only used in port-to-port operation i.e. mafi, terminal trailers, and special cassettes are often transported on sea routes.

The present transport system of wheeled vehicles in shortsea trade is not satisfactory in various respects:

* Safety in securing of road vehicles for sea voyages;
* Extent of necessary manual work on board;
* The broad variety of vehicle types and general absence of standard lashing points on the chassis for securing on board;
* The degree of ship capacity utilisation.

#### 3.1 SAFETY

Road vehicles are transported by roll-on/roll-off ships on strong, fixed decks. The ISO Resolution A.714(17) states requirements regarding stowage, lashing and securing of trailers for sea voyage. Application is made to roll-on/roll-off ships which regularly carry road vehicles on either long or short international voyages in unsheltered waters. The ship should be provided with a Cargo Securing Manual in accordance with ISO resolution. The decks of a ship intended for road vehicles should be fitted with securing points. The minimum required securing points are recommended in ISO resolution but their exact spacing is left to the discretion of the shipowner/shipbuilder.

Generally the securing system should be such that road vehicles are safety secured for sea voyage. ISO Guidelines for Securing Arrangements for the Transport of Road Vehicles on Ro-Ro Ships specify general requirements only. The guidelines do not totally prevent casualties. The accident record of
An Alternative System for Shortsea Shipment of Road Vehicles

roll-on/roll-off vessels exceeds any other type of ships. There are many reasons for the high frequency of serious accidents, including the following:

1) The road vehicle lashed on board a ship constitutes a complicated system which, when described in a mathematical model, is assumed to consist of girders and springs with varying stiffness, spring constants and damping coefficients. The excitation variables in the calculation model are the ship's motions in six degree of freedom. Furthermore, due to spring suspensions, friction between the trailer wheels and the steel deck may vary substantially. Therefore, the mathematical model for calculation of lashing forces is based on simplified assumptions.

2) The roll-on/roll-off ship in a damaged condition has generally lower survival probability that any other type of vessels, owing to her nature i.e. spacious holds subdivided by horizontal decks. Stern, bow and side access through watertight doors seriously affect integrity of the hull. Technical features and operational procedures of such equipment often cause dangerous near-accident situations.

3) There are often human errors in securing the road vehicles or complete negligence of lashing for sea voyages as well as poor observance of instructions regarding closing access doors.

4) The relatively small vessels engaged in shortsea trade with rather limited seaworthiness in adverse weather conditions at the North Sea, the Aegean Sea, the Bay of Biscay etc., are exposed to higher risks caused by poorly lashed cargo.

3.2 MANUAL LASHING ON BOARD AND CARGO HANDLING LOGISTICS IN PORT TERMINALS

Generally, there is no need to carry out any work regarding preparation of road trailers in port terminals for stowage on conventional roll-on/roll-off ships. The only thing that must be done is to make sure that the trailers are parked on the quay in the right order to stow them on the respective decks. All the work of securing and lashing the trailers is done on board. The time required for unlashing of units to be discharged as well as for securing loaded trailers for sea trips must be included in the vessel's round trip schedule. Consequently, there is a huge amount of work on board during the time when ship is in terminal and high costs for cargo securing are involved. Each operator, especially in liner traffic, is interested in shortening port time of his fleet as much as possible by introduction of improvements in cargo handling and utilisation of the ship's operational time in the most effective way. In this manner the vessel could have increased cargo carrying ability, shortened transit
time, higher voyage frequency and increased competitiveness in relation to other operators. Furthermore, all operators are constantly aiming at cost reduction and all activities in terminals are regularly scrutinised. Here a comparison can be made with a container carrier fitted with a cell guide system, which secures containers for sea voyage without any need of lashing. Time in port depends on crane performance and organisation of stevedoring work in terminal. Stowage patterns of containers in cargo holds for loading and discharging in consecutive ports govern a number of cranes which could be engaged simultaneously and generally on the whole logistics interface from ship to quay. Thus are important part of stevedoring activity is to prepare optimal container stowage plans as far as possible and to organise the stream of the boxes to and from shipside for crane operation in the best possible way in order to decrease crane waiting time to a minimum.

### 3.3 LASHING STANDARDS

Many different road vehicles are used in transport systems generally classified by the ISO, but not all have been designed for sea transport conditions i.e. ship motions, excitations and accelerations. The trailers do not have enough lashing points of sufficient strength fitted in proper places for securing them on board for sea voyages. Therefore, many road vehicles are secured to ships’ decks in improvised ways and often the lashing used is not sufficient in case of severe weather conditions at sea. It has been also observed that in extreme cases, where a valuable heavy vehicle is transported on board roll-on/roll-off ship special precautions are taken and many lashing chains are used, although not in a proper way, and some of them play a more psychological role for the crew than securing the trailer against shifting.

A study regarding standardisation of seagoing trailers was undertaken more than ten years ago in Sweden but today hardly any improvement has been in this field has been observed. In present intermodal transport systems all vehicles should fulfil requirements for safety for securing them to roll-on/roll-off decks.

The trailer lashing system for transport on roll-on/roll-off decks used today is shown in Figure 1 and consists of trestles, jacks and lashing chains the numbers varying depending on lashing points fitted on trailers and the ship as well as on individual lasher skills. The system has many deficiencies and is time consuming and expensive. Generally lashing points on trailers are more or less casually positioned by vehicle manufacturers. Trailer lashing point locations should be designed more systematically for each vehicle type depending on its dimensions (especially length and height), having in mind the worst possible combination of ship motions.
3.4 SHIP CAPACITY UTILISATION

The roll-on/roll-off vessel has a high flexibility for stowage of various types of cargo. However, this flexibility is at the expense of utilisation of cargo hold capacity. Holds of the roll-on/roll-off ship are subdivided by fixed horizontal decks and have constant headroom for stowage of road trailers and other cargo. The most often free heights of fixed decks on the existing ships are 6.3 m, 5.8 m and 4.5 m. The highest free height makes it possible to stow on deck even containers in two layers or to transport "project cargoes" of extreme dimensions. For most voyages road trailers are transported on these decks. The vehicle heights also vary but generally do not exceed 4.3 m. For free and unobstructed access and stowage such trailers require 4.5 - 4.6 m headroom. Non-utilised space above a vehicle may be as much as 1.8 cu.m per each sq.m of fixed deck. Utilisation of deck area is also low. The deck is subdivided into trailer lanes of widths 2.8 - 3.2 m, i.e. wider than vehicles, because there must be sufficient space for securing points and lashing equipment. Wasted deck areas also include internal fixed ramps, with headrooms varying with slopes of the ramps.
4 NEW CONCEPT OF THE VEHICLE TRANSPORT SYSTEM

4.1 THE PRESENT SITUATION AND GENERAL TRENDS IN SEA TRANSPORT SYSTEMS

During the last decade liner operators in world wide trade faced substantial increases of stevedoring costs and, at the same time, heavy market pressure for widening of intermodal services. In order to cope with such developments under fierce competition and of low freight rate levels, shippers have expanded containerisation of traditionally non-unitised cargo commodities. In consequence, pure container carriers are dominant in transoceanliner shipping nowadays and also even in shortsea trade new ship designs which aim at further cargo unification and lift-on/lift-off handling systems have been observed. Cargo handling of cellular container vessels is much simpler, take generally less time and does not require lashing of cargo when containers are secured by fixed cell guide system. Trends towards unification of cargo and steady growth of the number of containers in sea transport systems are observed. In accordance with the latest statistic, there are more than 7 M TEUs in operation. This cargo carrying equipment dominates the market. Not only general cargo but all kind of break bulk cargoes are transported in containers and even road vehicles are loaded on container platforms fitted with gables. It is also possible to transport off-size cargo, which was traditionally shipped in roll-on/roll-off mode, in the top layer of container stacks.

The general tendency to expand lift-on/lift-off operation modes in port terminals, the latest container ship design of hatchless type as well as a newly developed "CASH" vessel for transport of forest products on cassettes are compelling shippers to consider an alternative system for shortsea shipments of road vehicles.

4.2 TRAILER CASSETTE CONCEPT

The concept for intermodal transport of a wide variety of road trailers is based on a special cassette system.

The idea mainly aims at elimination of stevedoring work on board, higher safety at sea and cargo handling cost and time reductions in the long term. The trailer cassette concept might be explained as an idea for cutting off the particular area of the roll-on/roll-off deck needed for stowage of a single trailer and separating it from the ship structure.

It is assumed that securing of the trailer to the cassette would be carried out in the port terminal before ship arrival, and stevedoring work on board would be eliminated. The proposed cassette is shown in Figure 2. The frame is about 14.0 m long and 2.6 m wide. The cassette would incorporate such features as
An Alternative System for Shortsea Shipment of Road Vehicles

driving channels and built-in trailer supporting and securing arrangement, which is hardly possible on a conventional roll-on/roll-off deck.

The trailer will be drawn into wheel channels, which will protect it against side movements and absorb horizontal lateral forces (Figure 3). The channel width will be fitted to most common trailer wheels and the distances between them. The depth of the channels has to be sufficient to take lateral loads not only from the rubber tyres but also from the wheel rims.

The cassette will be fitted with built-in trestle or collapsible fifth wheel support against longitudinal movements of trailer. Anti-tipping tensions and lashin fittings will be also permanently attached to the cassette. An introduction of the trailer cassette system means a departure, complete or in part, from roll-on/roll-off handling mode. In the basic concept, the cassettes are to be
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handled in the same way as containers, by a shore crane or, if necessary, by a gantry crane installed on board.
The cassette design features depend on the handling system in the port terminal area. In the basic form cassettes would be handled by straddle carriers or equivalent mobile equipment with a special built spreader arrangement. It is believed that basic design will be most cost effective and will fit the majority of the port terminals. Container handling by means of straddle carriers is proven technology and is for many reasons superior to other systems.

4.3 PORT OPERATIONS IN THE FUTURE

The right organisation of terminal work and preparation of trailer-cassette units prior to vessel arrival is the important element in this system. The system will avoid shifting of units or double handling and, as far as possible, will restrict use of terminal cargo handling equipment.
The vehicles transported to terminal by road might be loaded on cassettes by the same towing vehicle which would be released after that operation. If trailers are delivered to terminal by railway trains, the straddle carrier, gantry crane or other discharging equipment should be used for stowing trailer directly on cassette.
When more advanced design of cassettes will be used i.e. cassettes fitted with bogies, the empty units should be stowed at a ditch-station in order to simplify trailer driving-on procedure (Figure 4).
The trailer-cassette units should be stowed in blocks on the quay and pushed or towed by terminal tractor to the shipside for lift-on/lift-off handling or stern/side ramp for stowage on roll-on/roll-off deck.
Generally the cassettes could be even used for transport of swap bodies, containers, cars and other cargo.

4.4 LIFT-ON/LIFT-OFF VESSELS

The basic idea of the trailer cassette is to replace the strong roll-on/roll-off deck with much simpler, cheaper, fitted with cargo securing system structures.
The proposed ship for trailer cassette transport is of the lift-on/lift-off type with cell guide structures for securing units for sea voyage as in Figure 5.

Most effective loading and discharging of cassettes will be performed by the terminal cranes. A gantry crane might be fitted on the ship, if required by the trade.
The cassettes will be stowed on board in the cell guide system and on special supports built in the ship structure. The design principles of the guide system are similar to the ones used on container carriers with some modifications regarding slot dimensions and support arrangements for the cassettes. The
guide system would be adjustable in order to stow other unitised cargo as container of various length and width. Such flexibility is rather expensive but might pay in the long term.

As can be seen in Figure 5, the trailer cassettes fill up the whole depth of the ship and, consequently the stowage factor is much higher than on a roll-on/roll-off carrier. Furthermore, a cellular carrier built with lower block coeffi-
Section II - Multimodal and Modal Split

cient has better capacity utilisation than a roll-on/roll-off ship. The shape of roll-on/roll-off decks in the forward part of the ship is less suitable for block stowage of cargo and considerable deck areas and hold volumes are left empty. The ship would be "hatchless" type which could additionally decrease both capital and operational costs (Figure 6).

![Figure 6: Cellular vessel for trainer cassette carriage](image)

It must be pointed out that the future vessels in the shortsea trade will have higher speed, and a slimmer hull shape for good fuel economy requirements and better propulsion performance in adverse weather conditions. Cargo handling production rates of lift-on/lift-off mode are generally higher, in comparison to roll-on/roll-off systems, and it would improve efficiency of the ship by reduction of port time.

4.5 FUTURE DEVELOPMENT

The development of a new cargo handling system is a long process but it must be realised that the deficiencies of the conventional systems will be not acceptable in the future especially with introduction of high speed vessels of above 40 knots.
An Alternative System for Shortsea Shipment of Road Vehicles

The proposed trailer cassette system requires further studies and development work of:

a) Trailer securing system;
   b) Coupling and uncoupling of towing vehicle;
   c) Structural design to minimise own weight;
   d) Adaptability to intermodal transport systems;
   e) Adaptation to different port terminal handling techniques;
   f) Lifting arrangement for grip arm or container spreader;
   g) Empty stacking;
   h) Adaptation of cassette system for roll-on/roll-off deck.

The cassettes might be developed in the following phases:

1) Basic model with fittings for detachable axle/wheel arrangement and gooseneck channel for tractor attachment;

2) Frame with fittings as in a) and with a fixed single bogie allowing movement in the longitudinal direction;

3) Frame with fittings as in a) and with gooseneck channels and revolvable bogies at both ends allowing movements of the cassette in any direction. Gooseneck channels will be also fitted with coupling for bogie steering, tandem and parallel trailer train coupling, special fittings for securing to roll-on/roll-off deck with actuator system, if required;

4) Automated Guided Trailer Cassette (AGTC) - advanced model with fully automated cargo unit handling system (shore-to-ship and vice versa), thristor electronic control system governed by the programmable logic controllers connected to industrial PCs.

4.6 TRAILER CASSETTE SYSTEM FOR ROLL-ON/ROLL-OFF VESSELS

Using one more piece of cargo carrying equipment for road vehicle transport on roll-on/roll-off ships seems to be a not quite logical solution. But this must be considered an unavoidable phase-in period of a new system and there are certainly some advantages as listed below:

* Securing of trailers to cassettes is carried out in terminal;
* Trailer cassettes are block stowed on board and no manual lashing is required;
* Better utilisation of deck area;
* Cassette blocks can be built up in the terminal and moved by one terminal tractor;
Section II - Multimodal and Modal Split

* Road hauliers can depart directly after trailer stowage on cassettes;
* Higher safety during sea voyages.

The existing roll-on/roll-off ships require some adaptation for trailer cassette stowage on board but the modifications are in a reasonable range, and might comprise:

* Fittings in roll-on/roll-off decks for securing of block stowed cassettes;
* Side port and ramp for alternative cargo handling over ship side.

5 COMPARISON OF THE CONVENTIONAL AND THE NEW CONCEPT VESSELS

5.1 MAIN PARTICULARS OF THE VESSELS

Table I briefly summarises the differences between the main particulars of conventional and the new type of vessels which have the same cargo carrying capacity of 135 trailers.

<table>
<thead>
<tr>
<th>Vessel type</th>
<th>A1</th>
<th>A2</th>
<th>B1</th>
<th>B2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vessel type</td>
<td>Conventional - Ro-Ro</td>
<td>New concept low speed</td>
<td>High speed Ro-Ro</td>
<td>New concept high speed</td>
</tr>
<tr>
<td>Length O.A. (m)</td>
<td>145.00</td>
<td></td>
<td>181.30</td>
<td></td>
</tr>
<tr>
<td>Length B.P. (m)</td>
<td>135.00</td>
<td>122.00</td>
<td>170.00</td>
<td>135.00</td>
</tr>
<tr>
<td>Breadth (m)</td>
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<td>20.70</td>
<td>22.00</td>
<td>20.70</td>
</tr>
<tr>
<td>Depth (m)</td>
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<td>19.00</td>
<td>13.70</td>
<td>19.00</td>
</tr>
<tr>
<td>Draught (m)</td>
<td>6.60</td>
<td>6.80</td>
<td>6.00</td>
<td>7.00</td>
</tr>
<tr>
<td>Trailer number</td>
<td>135</td>
<td>135</td>
<td>135</td>
<td>135</td>
</tr>
<tr>
<td>Service speed (kn)</td>
<td>17.5</td>
<td>17.5</td>
<td>27.5</td>
<td>27.5</td>
</tr>
</tbody>
</table>

Table I

The A1 roll-on/roll-off vessel is a typical conventional design and belongs to a large group of the trailer ships, employed in shortsea trade. Vessel B1 has been designed by one of the Scandinavian shipyards to meet requirements on speed for future North Sea operations. The main particulars for the new concept ships A2 and B2 have been preliminarily evaluated based on the hull geometrical restrictions and weight estimation. The A1 ship can be compared with A2 ship and B1 with B2. It should be noted that the cellular ships A2 and B2 are shorter.
An Alternative System for Shortsea Shipment of Road Vehicles

than roll-on/roll-off ships A1 and B1. Breadth of a cellular vessel is better utilised, as transversal space between cassettes would be limited (100-150 mm), to assure free access for the crane spreader only. A comparable roll-on/roll-off ship has three fixed decks, lower depth, but cargo on the weather deck is more exposed to sea and weather conditions. The proposed design of a cellular trailer ship is an open type vessel, where hatch covers are not fitted. Trailers are stowed four or five high and increased hull depth protects the cargo. A fifth layer will be stowed above the weather deck safely secured in the guide system against movement in severe sea states. The roll-on/roll-off vessel with her strong fixed decks is a heavy ship while a cellular vessel is generally much lighter. Even if lift-on/lift-off ship weights of cassettes are added (approximately 5 tonnes per cassette), the total weight (light ship plus cassettes) will be lower than a roll-on/roll-off ship. It must also be mentioned that the structure of a fixed roll-on/roll-off deck weights 0.28 - 0.40 tonnes/sq.m, and a cassette can be constructed with uniform weight of about 0.15 tonnes/sq.m.

5.2 CARGO HANDLING

Cargo handling costs for roll-on/roll-off vessels are a heavy burden for every operator and are one of their main costs. However, cargo handling costs vary considerably, depending on terminals, the stevedoring company as well as the agreement between the operator and the stevedoring company. Generally handling costs consist of:

* Loading and discharging tariffs which are fixed for each type of cargo units i.e. container, trailer, car, other towing vehicle or volume and/or weight of break bulk cargo;
* Lashing and securing procedures;
* Lashing material costs, including capital costs, repairs and maintenance;
* Cargo carrying equipment costs (container, trailer, cassette, bolster, etc.);
* Tracking equipment costs.

It is very difficult to gather reliable and comprehensive statistics on cargo handling costs and their components for comparable liner operators. Competition between the operators does not allow them to disclose their cost scenarios. Every operator also has his own cost subdivision and statistics. Generally, cargo handling costs for roll-on/roll-off ship are in range of 40 % or more of the total costs. All operators complain about high expenses and try to rationalise their terminal work by application of bigger cargo units, for instance paper rolls stowed on cassettes of total weight 60-80 tonnes, better stowage (side by side) on roll-on/roll-off deck in order to partly avoid manual securing of cargo, etc.

Cargo handling costs bound directly to the port terminal (excluding equipment capital and tracking costs) can be broken down as follows:

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* Loading and discharging  83 %
* Lashing materials and securing of cargo  17 %

Many stevedoring workers are involved in cargo securing work on roll-on/roll-off decks, often during expensive night shifts. Loose lashing equipment is a problem for any operator, as it has to be steadily replaced, maintained and repaired.

Cargo handling for the proposed system is aimed at simplification and automatization of lashing and securing procedure of cargo, and at moving this work to another time sequence in terminals, i.e. prior to a ship’s arrival in port.

The design of the cassette incorporates wheel protectors against lateral movement of the vehicle, and attachable securing devices are minimized. It is obvious that stevedoring work should be remarkably reduced in such systems. The guide system fitted on the cellular vessel will totally eliminate manual securing of cargo units on board the ship.

Assuming that 3 sets of cassettes are needed for one ship, extra capital cost should be added for 2 sets only, as one set replaces the roll-on/roll-off deck:

\[
2 \times 135 \text{ cassettes} \times 5 \text{ t/unit} \times 2.5 \text{ USD/kg} = 3,375,000 \text{ USD}
\]

Therefore, the capital cost for a cellular carrier system is assumed to be about 7% higher than for a roll-on/roll-off ship.

The cost comparison for the conventional system and the new concept has been related to a single trailer move over the sea. The ship’s operational costs are calculated for 80% utilisation of ship capacity.

<table>
<thead>
<tr>
<th>Vessel</th>
<th>A1 Conventional Ro-Ro</th>
<th>A2 New concept low speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bareboat charter</td>
<td>39%</td>
<td>41.7%</td>
</tr>
<tr>
<td>Bunker</td>
<td>5.5%</td>
<td>5.5%</td>
</tr>
<tr>
<td>Stevedoring</td>
<td>36%</td>
<td>18%</td>
</tr>
<tr>
<td>Port dues and charges</td>
<td>8%</td>
<td>10%</td>
</tr>
<tr>
<td>Crew</td>
<td>8%</td>
<td>8%</td>
</tr>
<tr>
<td>Other</td>
<td>3.5%</td>
<td>3.5%</td>
</tr>
<tr>
<td>Total costs</td>
<td>100%</td>
<td>86.7%</td>
</tr>
</tbody>
</table>

Table II
An Alternative System for Shortsea Shipment of Road Vehicles

Generally, cargo handling efficiency is higher for lift-on/lift-off mode than roll-on/roll-off and it is supposed that the logistics of the new system will be superior to the conventional one. Assuming that following productivity:

- Roll-on/roll-off system 15 moves/hour
- Lift-on/lift-off system 20 moves/hour

The cargo handling time for a round trip for 100% ship capacity utilisation will be:

- Roll-on/roll-off system 135 trailers x 2 / 15 moves/hr = 18 hours
- Lift-on/lift-off system 135 trailers x 2 / 20 moves/hr = 13.5 hours

The 4.5 hour difference can be considered in various scenarios:

- Adding a port to round voyage schedule;
- Saving bunker consumption owing to decreased vessel speed;
- Better adaptation of vessel arrival/departure time at some terminals avoiding expensive handling shifts;
- Other rationalisations in logistics.

6 CONCLUSIONS

The new ship concept for European trade described here is aimed at increasing competitiveness with road and rail transport systems. In order to win this battle it is necessary to study the whole transportation chain of cargo from manufacturer to consumer before any decision is taken regarding investment in new vessels. The type of vessel will depend on cargo units transported. The roll-on/roll-off ship type, developed in the 60s and 70s turned out to have high cargo handling costs and deficiencies in safety. During the last two - three years a new trend towards high speed ships of 30 to 50 knots has been observed (even considered for North Atlantic trade), with the aim of substantial reductions in transit time. Capital and operating costs (especially high fuel consumption) should be compared with decreased vessel sea times. There is doubtful benefit if no improvements are made in port operation and cargo handling and securing. Port times should be limited as far as possible by shifting all required cargo handling work from ship to quay side, before vessel arrival. Furthermore, cargo carrying equipment should fit sea road and rail transport systems.

The purpose of the trailer cassette system is to improve port logistics performance.

Organisational improvement in trailer flows in and out of ports by direct loading and discharging of cassettes and simultaneously building cassette blocks will lead to shorter handling times. Automated lashing of trailers to cassettes will limit stevedore work. Higher efficiency of lift-on/lift-off handling systems in
comparison with roll-on/roll-off mode and complete lack of manual cargo securing on board should be the decisive factors in the proposed system. Full automatization of port operations and integration of the ship with quayside handling, supplemented by high speeds at sea should be the aim of the future sea transport system.
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MODAL SPLIT ANALYSIS IN GREEK SHORTSEA PASSENGER/CAR TRANSPORT


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Modal Split Analysis in Greek Shortsea Passenger/Car Transport

MODAL SPLIT ANALYSIS IN GREEK SHORTSEA PASSENGER/CAR TRANSPORT

ABSTRACT

The purpose of this paper is to investigate the problem of modal split for passengers and vehicles in a specific context, that of the Greek coastal shipping system. The transport modes considered are conventional passenger/car ferries (P/C vessels), fast (30-50 knot) vessels, and air transport. For a variety of reasons, monumental changes are about to take place within this system over the next decade. These center primarily on the deregulation of the market that is a result of the European Union integration, and on the introduction of vessels capable of carrying passengers and cars at high speeds. By EU directive, the Greek coastal market shall be fully deregulated by the year 2004. This means that owners would be able to set up routes with minimal governmental interference. The question is of course how passenger demand will evolve within such a new environment, and how the various competing modes of transport will fare. This paper is an attempt to systematically analyze scenarios that might be the possible outcomes of these changes.

1 INTRODUCTION

The purpose of this paper is to investigate the problem of modal split for passengers and vehicles in a specific context, that of the Greek coastal shipping system. The transport modes considered are conventional passenger/car ferries (P/C vessels), fast (30-50 knot) vessels, and air transport. For a variety of reasons, monumental changes are about to take place within this system over the next decade. These center primarily on the deregulation of the market that is a result of the European Union integration, and on the introduction of vessels capable of carrying passengers and cars at high speeds. This paper is an attempt to systematically analyze scenarios that will be the possible outcomes of these changes.

By EU directive, the Greek coastal market shall be fully deregulated by the year 2004. This means that owners would be able to set up routes with minimal governmental interference. In addition, air transport will also become increasingly deregulated in the years ahead. The question is of course how passenger demand will evolve within such a new environment, and how the various competing modes of transport will fare.
This paper attempts to answer this question by examining various scenarios for the following modes of transport: conventional ferries (passenger/car), hydrofoils, other fast vessels (passenger only), other fast vessels (passenger/car), and air transport. The methodology used is applied to an illustrative subset of the entire network and is based on the "logit" model and the "generalized cost" concept. The cost components used are the fares and the time value of the trip. The time values have been derived from a "revealed preference" dataset. The paper describes the various assumptions made in data collection and model formulation, and discusses the results of the analysis and the additional research needed in this field. Policy recommendations are finally offered for an improved operation of the system in view of the monumental changes that are about to occur.

This paper is one of the products of a large project on Greek Coastal shipping, carried out by NTUA on behalf of the Hellenic Industrial Development Bank (ETBA) during 1993, and in the context of the SPA programme of the EU (Regional Development Plan). The project, heretofore referred to as the ETBA project, carried out a comprehensive investigation of all major aspects of the system, including the topic covered here. Complete details can be found in Psaraftis (1993).

This paper is structured as follows. Section 2 gives an update on the status quo of the system, vis-a-vis the description in a paper that was presented at the previous Roundtable Conference. Section 3 performs the modal split analysis. Section 4 provides some information on the economic viability of fast ships. Finally Section 5 makes some concluding remarks and offers some policy recommendations.

2 STATUS QUO UPDATE.

The basic characteristics of the Greek coastal shipping system were presented in the previous Roundtable Conference in Delft (November 1992), and were published in the Proceedings of that conference (paper by Psaraftis and Papanikolaou (1992)). However, as that paper was written both before the ETBA project had started, and, before the passing of the EU Regulation on maritime cabotage (7 December 1992), some of the data and hypotheses presented in that paper are now obsolete. Thus, before we proceed with our analysis, we deem necessary to give a brief update on the status of the system, with a focus on these elements that are more relevant for our analysis. The basic reference for this material is the ETBA final report (Psaraftis, 1993), which describes all this in more detail:

1) Lines and routes. The Ministry of Merchant Marine (MMM) classifies the 102 official lines of the network in 5 classes: (a) 16 main passenger/car
Modal Split Analysis in Greek Shortsea Passenger/Car Transport

ferry (P/C) lines, (b) 30 secondary P/C lines, (c) 11 local P/C lines of the Argosaronikos bay, (d) 39 other local P/C lines, and (e) 3 main and 3 secondary freight (ro-ro) lines. Within this "line" system, the number of individual routes and schedules that are traveled is on the order of several hundreds.

Some of these lines extend to ports in Italy (Brindisi, Bari, Ancona, and Trieste), although from a legal standpoint the services to Italy are not subject to internal cabotage legislation (e.g., ships can fly foreign flags, even if Greek-owned).

2) Fares. With the exception of First Class fares, which are in principle free (with a theoretical maximum of 4 times but in practice 2.8 - 3 times the level of the corresponding Third Class fare), all other fares are uniform for all ships and established every year by the MMM for all pairs of ports. Fares include Second Class, Third Class, Tourist Class, and fares for vehicles (cars, buses, trucks, and motorcycles). Hydrofoils and catamarans have special fares for the routes on which they operate, all (still) regulated by the MMM. There are services in which the official fare with or without a cabin is exactly the same, cabins being allotted to passengers on a first-come first-served basis, many times onboard the ship (in which case the tip to the steward plays the role of the fare supplement).

At first glance, the fare structure seems reasonable in terms of levels. A more careful examination however reveals that fare levels are largely arbitrary, depending more on what they were the year before, and less on the result of a transparent cost analysis. As an example, the fare to distant Kastellorizo is 8,639 GRD (2nd class), while that to Sitia (Crete) is 8,750 GRD, even though the latter destination is much closer to Piraeus. Such a difference could be explained by socioeconomic criteria, but such criteria are not explicitly defined.

In other examples, the direct 2nd class fare to Hydra is 2,665 GRD, less than the 2,499 GRD fare if one goes to Hydra via Aegina (999 GRD from Piraeus to Aegina and 1,500 GRD from Aegina to Hydra). The fare from Sifnos to Paros is 1,469 GRD if one travels on a small wooden boat, and only 748 GRD if one travels on ferry (2nd class). The catamaran fare to Mykonos is 6,709 GRD, higher than the 2nd class conventional fare (4,470 GRD), but lower than the equivalent 1st class fare (7,988 GRD), and much lower than the airfare to Mykonos, which is 15,900 GRD for an economy class ticket.

The rule of thumb that the triangle inequality (Fare (A-S) ≤ Fare (A-C) + Fare (C-B)) holds for most of the network seems to be true, but in general
there seems to be no consistent logic in the fare structure, nor there exists a well-defined algorithm or procedure for fare determination.

3) Fleet. The Psaraftis and Papanikolaou (1992) paper referred to 1988 fleet data. Having now fleet data that go at least to 1992, we can make some brief observations. The first is that the mean age of large (1,000 GRT or more) P/C vessels increased by 4 years (to 25) in the 4 years from 1988 to 1992. The second is that the situation is worse for the smaller conventional P/C vessels (between 100 and 999 GRT), with a mean age of 28 years, and even worse for the small (100 to 500 GRT) general cargo (feeder) ships, with a mean age of 35 years (in 1992). There is a mandatory withdrawal age of 35 years for P/C ships (which, interestingly enough, does not apply to ships on the Italian service routes). Thus, at 2004, many ships that operate today within the system will have been withdrawn from service.

In 1992, hydrofoils had a mean age of about 15 years, while the three catamarans in the system (one of which was seriously damaged in 1993 and may never again engage in service) were virtually new. Although hydrofoils have been traditionally restricted to protected waters, 1993 saw the deployment of hydrofoils to several new lines, including many of the Central Aegean islands where the sea is sometimes rough during the summer.

4) Passenger and vehicle traffic. With about 12 million passenger movements in 1990 (see Section 3 for estimates in subsequent years), Greek coastal shipping is one of the biggest in Europe. With few exceptions (short periods of temporary decline), passenger traffic has steadily grown every year over the last 30 years, from approximately 3 million movements in 1964, to about 5 million in 1970, 8 million in 1980, and 8.5 million in 1985. There was a period of decline from 1981 to 1983, with a local minimum of 7.5 million.

The heaviest traffic is generated within the short-distance routes of the Argosaronikos system, with traffic that is more than double in passenger movements than that of the long-haul Piraeus- Crete lines. The biggest growth in recent years has been experienced in the Volos-Euvoia-North Sporades lines, mainly due to the massive influx of hydrofoils in that area, and in spite of the decline in conventional vessel passenger traffic that resulted because of this entry.

Vehicle traffic has also grown, in many cases more steeply than passenger traffic. The Piraeus - Crete line is the leader for both cars and trucks, with car movements experiencing a 48% growth between 1981 and 1990, more than double the equivalent passenger growth rate.
Modal Split Analysis in Greek Shortsea Passenger/Car Transport

introduction of large P/C vessels has been the main reason for the generation of such a demand.

Competing with sea transport of passengers in many mainland and island destinations is air transport, provided by Olympic Airways and its "commuter" subsidiary, Olympic Aviation. Growth between 1980 and 1992 has been mixed, with the peak of about 5.3 million annual trips in 1985, and a lowest level of about 3.2 million trips in 1991 (the year of the Gulf war). A few of these destinations are also served directly by foreign airlines (charter or regular flights).

5) Legal regime. The most significant recent development in the legal arena has been the passing by the Council of the EU of Regulation No. 3577/92 (7 December 1992), regarding the freedom of service in maritime cabotage trades. Such regulation (heretofore referred to as "the Regulation") stipulates, among other things, that Greece’s coastal shipping market becomes fully deregulated and open to other EU-flag ships by Jan. 1, 2004. The 11 year waiting period (already reduced to less than 10 years) was intended to provide Greece with the necessary time to prepare for the opening of the market to competition.

Describing the Regulation vis-a-vis the national legal regime, or the probable impacts of the removal of cabotage privileges, or finally what should be done to prepare for 2004, is beyond the scope of this paper. The ETBA final report (Psaraftis, 1993, Section 3) and a companion paper to the present paper (Sturmey et al., 1994) deal with these issues in more detail. However, as the adoption of the Regulation is the actual reason behind the analyses reported in our paper, we shall be referring to it and to some of its provisions whenever this is necessary during the course of this paper.

With these preliminary considerations, we now proceed with our analyses.

3 MODAL SPLIT ANALYSIS

In the summer of 1993, the Italian company Tirrenia Navigazione introduced the fast monohull GUIZZO in the line between Civitavecchia (mainland Italy) and Olbia (island of Sardinia). The GUIZZO, built by Rodriguez Aquastrada, is a state-of-the-art fast ship, capable of carrying 450 passengers and 126 cars at speeds up to 43 knots. The trip (124 nautical miles) is traveled in 3.5 hours, of which 3 hours are at the maximum speed. Two daily trips were planned for the summer high season, dropping to one at lower traffic seasons. The GUIZZO was
scheduled to operate only 11 weeks per year (July-October), and charged for cars a fare only 15% over the equivalent conventional fare.

Such a low high-speed supplement is also charged by the wave-piercer catamarans (such as the HOVERSPEED GREAT BRITAIN) that cross the Channel. Both cases, although completely different in terms of vessel design, enjoy remarkable capacity utilization rates, being generally preferred by the public over the conventional, slower ferries.

In view of the EU Regulation, the appearance of such ships in Greece is considered only a matter of time. Note that as today in Greece there are no fast vessels that can also carry vehicles, conventional P/C ships have a real monopoly on those passengers who travel with their cars (captive demand). The rest of the fast ships operating today are hydrofoils and catamarans, neither of which can carry cars. And although hydrofoils have carved their own special niche in the market, catamarans have been less successful. Technical factors such as sea worthiness have probably little to do with this state of affairs (other than a catamaran collision with a pier in 1993). Their meager presence is mostly attributed to the existing system of route licensing, which, in one case, granted a license to a catamaran on the condition that it serves a 10-port route. It is obvious that such a condition anihilates any speed advantage of these ships over conventional ships and makes their operation uneconomic.

Since the EU Regulation presumably will make route licensing more rational, a natural question to ask is what portion of passenger demand will shift to fast ships (including fast ferries), when these, in fact, are permitted to operate within the system. Given that the passengers would be able to choose among several competing modes, what will be the modal split? It is the purpose of this section to try to answer this question. Note that by "mode" here we mean not only the general distinction between sea and air, but also the finer grain distinction among the various types of vessels (more on this later).

Another (albeit related) question is what is the economic viability of these fast vessels. This question is addressed in Section 4.

Performing the modal split analysis is by no means an easy task, for a number of reasons. First, the coastal shipping network in Greece is huge (138 ports, 34 airports, thousands of inter-port links). Second, one has little or no idea of what will actually happen during the 10 years to 2004 in terms of the fleet, introduction of new technologies, port expansion, and development of legislation, to mention just a few of the crucial factors. Third, it is not immediately clear how the Greek traveler values his or her time, which is perhaps the most critical parameter that one needs to know in order to assess how much more the traveler is willing to pay in order to travel faster.
Modal Split Analysis in Greek Shortsea Passenger/Car Transport

Some additional difficulties exist (for instance, lack of origin-destination (O-D) flow data). These difficulties will be described in the course of the exposition that follows. Last, but not least, we are aware of no similar analyses in other coastal shipping problems that involve such difficulties. Most of the analyses involve freight (for which the issue of fast transport is different), and/or much simpler network configurations (for instance, the analysis for the Channel Tunnel).

In the face of this complex situation, the approach that we adopted consists of the following steps:

**STEP 1:** Choose a workable (but hopefully relevant) subset of the entire network for the analysis;

**STEP 2:** Make aggregate demand projections on this network up to 2004;

**STEP 3:** Make some assumptions on what kinds of transport modes provide service on this network, and for each evaluate the transit times for the relevant links of the network;

**STEP 4:** Make some assumptions on the fares charged by each mode;

**STEP 5:** Calculate the monetary value of the time of the passengers;

**STEP 6:** Run the logit model to determine the modal split on each branch of the network;

**STEP 7:** Interpret results and perform sensitivity analysis.

The main advantage of such an approach is that it bypasses the problem of trying to predict inherently unpredictable scenarios, and produces a flexible tool, by which "what if" assessment of scenarios can be performed. Such a tool can readily be applied to larger networks and alternative scenarios (not only for Greece) once the appropriate data have been assembled.

We now describe the work involved in each of these steps, bearing in mind that the complete detailed analysis is reported in Psaraftis (1993).

**STEP 1:** Choose a workable (but hopefully relevant) subset of the entire network for the analysis

In making such a choice, the following conditions must be satisfied:

- a) There should be a correspondence between ports and airports, so that a comparison between sea and air transport is meaningful;
Section II - Multimodal and Modal Split

b) The range of distances between network nodes should be relatively broad;

c) The selected sub-network should represent a non-trivial part of the entire network in terms of traffic volume.

In this vein, we have decided to examine a 9-port, 6-airport network, distributed in 6 geographical "zones" as follows:

<table>
<thead>
<tr>
<th>Zone</th>
<th>Region</th>
<th>Ports</th>
<th>Airports</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>Attiki</td>
<td>Piraeus, Rafina</td>
<td>Elliniko</td>
</tr>
<tr>
<td>21</td>
<td>Mykonos</td>
<td>Mykonos</td>
<td>Mykonos</td>
</tr>
<tr>
<td>31</td>
<td>Santorini</td>
<td>Thira</td>
<td>Thira</td>
</tr>
<tr>
<td>41</td>
<td>West Crete</td>
<td>Souda, Rathymno</td>
<td>Hania</td>
</tr>
<tr>
<td>42</td>
<td>Iraklio</td>
<td>Iraklio</td>
<td>Iraklio</td>
</tr>
<tr>
<td>43</td>
<td>Lasithi</td>
<td>Ag. Nikolaos, Sitia</td>
<td>Sitia</td>
</tr>
</tbody>
</table>

Notice first that each zone has at least one port (and sometimes two), and one airport. So condition (a) above is satisfied. Also, inter-zone distances for this network range from 69 nautical miles (nm) (between zones 31-42) to 221 nm (between zones 11-43). So the range of distances is indeed broad.

In terms of size, and even though 9 ports is only a small fraction of the 138 ports in the system, in 1990 total passenger traffic among the 9 selected ports was 19.2% of total Greek coastal traffic. Also in 1990, total traffic among the 6 selected airports was 27.3% of total Greek domestic air traffic. So from this perspective the selected sub-network is certainly non-trivial.

STEP 2: Make aggregate demand projections on this network up to 2004.

By "aggregate demand" we mean that at this stage we shall not break down demand by mode, ie how many passengers will go by fast ships, how many by air, etc. This will be done later (Step 6). On the other hand, we want to take full advantage of existing data regarding flows of passengers in the network, including the choice of mode made by these passengers.

Before we proceed, and as an aside to our analysis, we state that in Psaraftis (1993), a projection of total passenger demand for sea transport on the entire network and up to year 2010 was made. After several regression analyses, it was determined that the best fit to historical data (1964-1989) is the one described by the following equation:

\[
TOTAL-PAX = \exp(1.271 + 0.0414 \times (Y-1963))
\]
Modal Split Analysis in Greek Shortsea Passenger/Car Transport

where TOTAL-PAX is the total passenger trips by sea in year Y. The R^2 of this equation is 0.95, and the t-statistic on the coefficient of 0.0414 is 21.06, both acceptable.

The above equation projects about 16.5 million trips in year 2000, about 19.5 million trips in 2004, and about 25.5 million trips in 2010.

Returning now to Step 2, this step involves two sub-steps. First, create origin-destination (O-D) tables for this network for a number of years in the past, and second, use these to forecast origin-to-destination demand on the network up to 2004.

Creating the O-D tables for the sub-network was a rather tricky task. The first difficulty was that no such data was directly available in the databases of MMM's Statistical Service or anywhere else (as much as a lot of other data was available). To circumvent this problem, the direct assistance of this service was requested, and after a series of estimates on how flows at each port split among different routes, an "expert estimate" of the O-D table of passenger trips by sea in the sub-network for 1990 was finally made (see Table I). Psaraftis (1993) provides more details on how this table was produced.

<table>
<thead>
<tr>
<th>From/To</th>
<th>11</th>
<th>21</th>
<th>31</th>
<th>41</th>
<th>42</th>
<th>43</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td></td>
<td>145,879</td>
<td>201,373</td>
<td>357,060</td>
<td>372,855</td>
<td>9,538</td>
<td>1,086,705</td>
</tr>
<tr>
<td>21</td>
<td>140,459</td>
<td></td>
<td>28,603</td>
<td></td>
<td></td>
<td></td>
<td>169,062</td>
</tr>
<tr>
<td>31</td>
<td>203,281</td>
<td>27,757</td>
<td></td>
<td>14,712</td>
<td></td>
<td></td>
<td>245,750</td>
</tr>
<tr>
<td>41</td>
<td>349,526</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>349,526</td>
</tr>
<tr>
<td>42</td>
<td>387,970</td>
<td>11,332</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>399,302</td>
</tr>
<tr>
<td>43</td>
<td>10,890</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10,890</td>
</tr>
<tr>
<td>Total</td>
<td>1,092,126</td>
<td>173,636</td>
<td>241,308</td>
<td>357,060</td>
<td>387,567</td>
<td>9,538</td>
<td>2,261,235</td>
</tr>
</tbody>
</table>

Table I: O-D table for passengers traveling by ship, 1990

Doing the same for passenger trips by air in 1990 was far easier, for this data was directly available from Olympic Airways (see Table II).

In addition to passengers, O-D tables for vehicles are necessary, for a portion of the total passengers (those who travel with a vehicle) do not have the choice
Section II - Multimodal and Modal Split

Table II: O-D table for passengers traveling by air, 1990

<table>
<thead>
<tr>
<th>From/To</th>
<th>11</th>
<th>21</th>
<th>31</th>
<th>41</th>
<th>42</th>
<th>43</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td></td>
<td></td>
<td></td>
<td>148,572</td>
<td>260,554</td>
<td>830</td>
<td>537,119</td>
</tr>
<tr>
<td>21</td>
<td>66,231</td>
<td></td>
<td>4,592</td>
<td>1,664</td>
<td></td>
<td></td>
<td>72,847</td>
</tr>
<tr>
<td>31</td>
<td>65,466</td>
<td>4,358</td>
<td></td>
<td>2,067</td>
<td></td>
<td></td>
<td>71,891</td>
</tr>
<tr>
<td>41</td>
<td>140,226</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>140,226</td>
</tr>
<tr>
<td>42</td>
<td>249,578</td>
<td>1,784</td>
<td>1,940</td>
<td></td>
<td></td>
<td></td>
<td>253,302</td>
</tr>
<tr>
<td>43</td>
<td>816</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>816</td>
</tr>
<tr>
<td>Total</td>
<td>522,317</td>
<td>70,000</td>
<td>70,197</td>
<td>148,572</td>
<td>264,285</td>
<td>830</td>
<td>1,076,201</td>
</tr>
</tbody>
</table>

between sea and air transport (captive demand), and these passengers must be identified. Here we assume that a person traveling with a vehicle has already made the decision to do so and thus does not have the choice of taking the airplane (this assumption is true for a truck driver, but may not necessarily be true for a motorcycle driver, a car driver, or a bus passenger, all of whom conceivably can take the plane and use another vehicle at their destination).

Using a similar methodology to the one described for passengers, O-D tables were produced for trucks, buses, cars, and motorcycles traveling in the sub-network in 1990 (these tables are not reproduced here but are available in Psaraftis (1993)).

To estimate now the passengers traveling with these vehicles, an estimate of how many passengers are carried by each vehicle is necessary. We used the estimate made by Martedec S.A. of Piraeus (in the context of a NATO project on Greek coastal shipping) that each truck carries one passenger, each bus 40 passengers, each car 2.5 passengers, and each motorcycle one passenger. On this basis, Table III shows the O-D table of passengers traveling with a vehicle in the sub-network in 1990.

On the basis of Tables I, II, and III, the O-D table of total passengers traveling without a vehicle in the sub-network in 1990 can be constructed. This is Table IV, and consists of all passengers traveling by air, plus those sea passengers who travel without a vehicle. It is clear that if a(i) is a specific inter-zone entry in Table i (i = 1 to 4), then a(4) = a(1) + a(2) - a(3).
Modal Split Analysis in Greek Shortsea Passenger/Car Transport

<table>
<thead>
<tr>
<th>From/To</th>
<th>11</th>
<th>21</th>
<th>31</th>
<th>41</th>
<th>42</th>
<th>43</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td></td>
<td>37,685</td>
<td>35,173</td>
<td>159,265</td>
<td>206,644</td>
<td>4,703</td>
<td>443,470</td>
</tr>
<tr>
<td>21</td>
<td>33,892</td>
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<td>876</td>
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<td></td>
<td></td>
<td>34,768</td>
</tr>
<tr>
<td>31</td>
<td>35,116</td>
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<td>36,412</td>
</tr>
<tr>
<td>41</td>
<td>145,806</td>
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</tr>
<tr>
<td>42</td>
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<td>201,345</td>
</tr>
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<td>43</td>
<td>3,989</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Total</td>
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<td>38,420</td>
<td>36,590</td>
<td>159,265</td>
<td>207,205</td>
<td>4,703</td>
<td>865,790</td>
</tr>
</tbody>
</table>

Table III: O-D table for passengers traveling with a vehicle, 1990

<table>
<thead>
<tr>
<th>From/To</th>
<th>11</th>
<th>21</th>
<th>31</th>
<th>41</th>
<th>42</th>
<th>43</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td></td>
<td>172,052</td>
<td>229,505</td>
<td>346,367</td>
<td>426,765</td>
<td>5,665</td>
<td>1,180,354</td>
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<tr>
<td>21</td>
<td>172,798</td>
<td></td>
<td>32,679</td>
<td></td>
<td>1,664</td>
<td></td>
<td>207,141</td>
</tr>
<tr>
<td>31</td>
<td>233,631</td>
<td>31,380</td>
<td></td>
<td>16,218</td>
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<td></td>
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<td>41</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>343,946</td>
</tr>
<tr>
<td>42</td>
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<td>1,784</td>
<td>12,731</td>
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<td></td>
<td></td>
<td>451,259</td>
</tr>
<tr>
<td>43</td>
<td>7,717</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7,717</td>
</tr>
<tr>
<td>Total</td>
<td>1,194,836</td>
<td>205,216</td>
<td>274,915</td>
<td>346,367</td>
<td>444,647</td>
<td>5,665</td>
<td>2,471,646</td>
</tr>
</tbody>
</table>

Table IV: O-D table for passengers traveling without a vehicle, 1990

From Tables I to IV it can be seen that from all passengers who traveled without a vehicle in the sub-network in 1990, 43% used the airplane and the rest (57%) took the ship. Overall, 68% of the passengers went by ship, and 32% went by plane.

Of course, making a projection to 2004 just from 1990 data is impossible, so in principle we need to repeat this procedure for several years prior to 1990. Published coastal shipping data in Greece exists from 1964 on. Unfortunately however, individual route data is not available in a uniform way, and MMM's
Section II - Multimodal and Modal Split

Statistical Service was unable to provide such information for prior years, as it did for 1990. To circumvent this new obstacle, it was decided to produce some coefficients, which express the data in the 1990 O-D tables as functions of passenger and vehicle flows into the ports of the sub-network. Then we would use these same coefficients to produce the O-D tables from port passenger and vehicle flows in prior years.

Of course, the assumption that these coefficients stay the same is a debatable assumption. However, given that no major changes in the network have occurred in the past, we feel that it is an assumption that can be justified (lacking a better way to proceed).

No similar problem existed for the air transport O-D data, as this was readily available from Olympic Airways for the period of interest.

Having all these O-D tables for the period 1964-1990, the next substep is to project these into the future. A critical assumption here is that the possible introduction of new technology ships within the network in the future will not generate new demand (other than what would be generated anyway, i.e., even if these ships are not introduced).

This is also a debatable assumption, and one that can be patently false, as demonstrated by several cases in the past (see effect of hydrofoils in the Volos-Euvoia-North Sporades trade, as mentioned earlier). However, counterexamples also exist. In Psaraftis (1993), an analysis of the Argosaronikos system (the heaviest in hydrofoil traffic) in the period 1977-1990 showed that the effect of hydrofoil entry into that market in the mid-seventies was only a shift of demand from conventional ships to hydrofoils, with no documentable generation of new demand. In fact, growth in the above period was only 18% for the Argosaronikos system, as opposed to 111% for the entire network, a clear sign of demand saturation. So in this case hydrofoils did not generate new demand.

Being unable to say whether or not this will be the case for our sub-network, we chose to be conservative and assumed zero generation of new demand because of the possible introduction of fast ships. Of course, our methodology can still be applied if an alternative assumption is used.

Based on this, regression analyses were conducted individually for all inter-zone links of the sub-network, so as to project demand on those links. The results (see Psaraftis (1993) for details) can be summarized in the following two tables: Table V is the equivalent of Table III, and shows the O-D flows of passengers accompanying a vehicle in 2004. Table VI is the equivalent of Table IV, and shows the O-D flows of passengers without a vehicle in 2004.
Modal Split Analysis in Greek Shortsea Passenger/Car Transport

<table>
<thead>
<tr>
<th>From/To</th>
<th>11</th>
<th>21</th>
<th>31</th>
<th>41</th>
<th>42</th>
<th>43</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
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<td></td>
<td></td>
<td>70,762</td>
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<td></td>
<td>727,668</td>
</tr>
<tr>
<td>21</td>
<td>69,948</td>
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<td>1,871</td>
<td></td>
<td></td>
<td></td>
<td>71,819</td>
</tr>
<tr>
<td>31</td>
<td></td>
<td>85,571</td>
<td>1,442</td>
<td></td>
<td>1,147</td>
<td></td>
<td>88,160</td>
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<tr>
<td>41</td>
<td>238,525</td>
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<td></td>
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<td>238,525</td>
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<tr>
<td>42</td>
<td>296,953</td>
<td></td>
<td>935</td>
<td></td>
<td></td>
<td></td>
<td>297,888</td>
</tr>
<tr>
<td>43</td>
<td></td>
<td>13,671</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>13,671</td>
</tr>
<tr>
<td>Total</td>
<td>704,668</td>
<td>72,204</td>
<td>81,112</td>
<td>251,449</td>
<td>314,914</td>
<td>13,384</td>
<td>1,437,731</td>
</tr>
</tbody>
</table>

Table V: O-D table for passengers traveling with a vehicle, 2004

<table>
<thead>
<tr>
<th>From/To</th>
<th>11</th>
<th>21</th>
<th>31</th>
<th>41</th>
<th>42</th>
<th>43</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>275,338</td>
<td>372,470</td>
<td>703,576</td>
<td>787,292</td>
<td>33,697</td>
<td></td>
<td>2,172,373</td>
</tr>
<tr>
<td>21</td>
<td>282,204</td>
<td>64,254</td>
<td></td>
<td>4,544</td>
<td></td>
<td></td>
<td>351,002</td>
</tr>
<tr>
<td>31</td>
<td>377,819</td>
<td>64,757</td>
<td></td>
<td>25,590</td>
<td></td>
<td></td>
<td>468,166</td>
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<td>41</td>
<td>680,042</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>680,042</td>
</tr>
<tr>
<td>42</td>
<td>771,730</td>
<td>5,238</td>
<td>22,030</td>
<td></td>
<td></td>
<td></td>
<td>798,998</td>
</tr>
<tr>
<td>43</td>
<td></td>
<td>34,418</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>34,418</td>
</tr>
<tr>
<td>Total</td>
<td>2,146,213</td>
<td>345,333</td>
<td>458,754</td>
<td>703,576</td>
<td>817,426</td>
<td>33,697</td>
<td>4,504,999</td>
</tr>
</tbody>
</table>

Table VI: O-D table for passengers traveling without a vehicle, 2004

One immediate observation is that projected flows to 2004 are by no means simple multiples of those flows in 1990, as flows in distinct links are projected to grow in a different way.

In 1990, only two modes of transport were present on the sub-network, conventional P/C vessels (capturing the entire demand of passengers with vehicles (Table III) and also receiving a share of the demand of passengers without vehicles, Table IV) and air transport (receiving the rest of the demand of passengers without vehicles, Table IV).
Having produced the O-D tables for 2004, we are now ready to make some assumptions on the modes of transport that will be available on the sub-network at that time.

STEP 3: Make some assumptions on what kinds of transport modes provide service on this network, and for each evaluate the transit times for the relevant links of the network.

We assume that a total of five (5) modes of transport will be available in this network in 2004:

- Mode 1: Air transport;
- Mode 2: Conventional P/C vessels;
- Mode 3: Hydrofoils;
- Mode 4: Surface effect ships (passenger only);
- Mode 5: Fast P/C vessels.

Note first that whereas all modes potentially cater to passengers traveling without a vehicle (those of Table VI), modes 2 and 5 cater only to passengers traveling with a vehicle (those of Table V).

The second remark is that not all modes are assumed to provide service to every inter-zone link of the network. For instance, it would be unreasonable to assume direct hydrofoil service between Piraeus and Crete, or any type of service between Hania and Iraklio in Crete.

The modes that are assumed to be operational for each link of the sub-network are as follows:

- Link 11-21: All modes;
- Link 11-31: All modes except mode 3;
- Link 11-41: All modes except mode 3;
- Link 11-42: Modes 1, 2, and 5;
- Link 11-43: Modes 1, 2, and 5;
- Link 21-31: All modes;
- Link 21-42: Mode 1;
- Link 31-42: All modes.

No modes are assumed to operate (at least directly) on other links of the sub-network.

The following additional assumptions have been made:

1) A passenger’s trip starts from the time he or she leaves home to the time he or she reaches the trip’s ultimate destination;
2) A 30-minute waiting time is uniformly assumed for all modes at both ends of the trip for embarkation and disembarkation;

3) Times from a traveler's home to the port (or airport) of origin and from the port (or airport) of destination to the traveler's ultimate destination have been estimated for each case separately, by making some assumptions on the "centroid" of the location of either end of the trip. The centroid is assumed to be close to the center of the corresponding metropolitan area, and trip times between the centroid and the corresponding port or airport have been calculated separately for each case;

4) To calculate ship transit times, the following average speeds have been assumed: Conventional P/C, 14 knots. Hydrofoil, 30 knots. SES and fast ferry, 40 knots.

Notice that the assumed speed for conventional P/C ship is rather low. This is to reflect the fact that in the existing network of lines, these ships make several stops from zone 11 to zones 21 and 31, and the fact that the trips from zone 11 to zones 41, 42, and 43 are usually made overnight, with an average speed that is very close to the assumed. Overall, the sailing times implied by this speed are very close to the actual ones.

For the fast ships, non-stop services among zones were assumed, and this reflects the speed values assumed.

Inter-zone flight times are given in Table VII below, and inter-zone sailing distances are given in Table VIII below. Based on these assumptions, it is straightforward to calculate the trip times for all relevant combinations of modes and inter-zone links.

STEP 4: Make some assumptions on the fares charged by each mode.

Full information exists on the fares charged by the two modes that were operational in 1990, for all links of the network served by each. Table VII shows that in 1990 Olympic Airways had two fare increases (trip times are also shown in that table). Our analysis uses as airfare the average of the three fares that prevailed.

Table VIII shows the 2nd-class and passenger car fares charged by conventional P/C ships for the various links of the network. All fares are in GRD (1990) and include all relevant taxes and supplements. The last column in Table VII shows inter-port distances in nautical miles.

Notice that no fares are given between Ag. Nikolaos and Sitia in Crete. This is so because no traffic between these two ports is examined, Sitia's traffic from other ports going through Ag. Nikolaos.
### Table VII: Airfares for three periods in 1990 (GRD) and trip times in minutes

<table>
<thead>
<tr>
<th>Link</th>
<th>1/1-7/5</th>
<th>8/5-24/9</th>
<th>25/9-31/12</th>
<th>minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td>11--42</td>
<td>8,700</td>
<td>11,200</td>
<td>12,200</td>
<td>45</td>
</tr>
<tr>
<td>11--41</td>
<td>7,400</td>
<td>9,500</td>
<td>10,400</td>
<td>45</td>
</tr>
<tr>
<td>11--21</td>
<td>6,000</td>
<td>7,700</td>
<td>8,400</td>
<td>45</td>
</tr>
<tr>
<td>11--31</td>
<td>7,600</td>
<td>9,700</td>
<td>10,700</td>
<td>55</td>
</tr>
<tr>
<td>11--43</td>
<td>11,800</td>
<td>15,100</td>
<td>16,600</td>
<td>85</td>
</tr>
<tr>
<td>42--31</td>
<td>5,500</td>
<td>7,100</td>
<td>7,700</td>
<td>40</td>
</tr>
</tbody>
</table>

### Table VIII: Second class and passenger car conventional P/C fares in 1990 (GRD)

For fares that will be charged in 2004, the following baseline assumptions are made:

1) All mode 1 and mode 2 fares remain constant in 1990 GRD prices;
2) All mode 3, 4, and 5 fares are 15% higher than the equivalent mode 2 fare.
Modal Split Analysis in Greek Shortsea Passenger/Car Transport

Of course, both sets of assumptions are debatable. In particular, the second assumption may be characterized as not very strong (15% is too low). However, 15% was the increase used by both the GUZZO and the HOVERSPEED GREAT BRITAIN, so it would be reasonable to want to see what would happen if this were applied to Greece as well. In addition, in Step 7 we shall examine alternative increases and see what happens then.

The assumption of fare constancy (in 1990 terms) in modes 1 and 2 is also debatable, as either of these two modes may decide to adopt a different pricing policy as 2004 approaches. We shall discuss these alternative scenarios and their implications later on.

STEP 5: Calculate the monetary value of the time of the passengers.

How much a passenger values his or her time is a critical factor in the analysis, for this would ultimately determine the traveler’s willingness to pay in order to make the trip faster. The relevant question for our problem is whether we can say anything for the value of time of passengers using this particular network.

There are two ways to ascertain somebody’s value of time. The first, and generally the best, is the “stated preference” method, in which the traveler answers a detailed questionnaire in order to explicitly define his or her utility function of time versus money. Unfortunately, this method is very expensive and time consuming, and, as such, was not used here.

The second method is the “revealed preference” method, and consists of using historical data on travelers’ modal choices in order to draw conclusions on how much the traveler values time.

In Greece, Lioukas (1982, 1993) used a logit model for travelers using rail transport. In his latest study, conducted in the context of the Athens-Piraeus subway system, he derived a value of about 800 GRD per hour (1993 prices).

Of course, it is far from clear whether such a value is applicable for the case of coastal shipping in Greece. In Japan, Akagi (1991) showed a value of time on the order of 3,000 Yen per hour on the average. Obviously, it would be inappropriate to use such a value for our analysis.

The only alternative left was to see if we could derive an appropriate value of time using existing data on the Greek coastal shipping system. As such, we decided to use the 1990 data on the sub-network (Tables I to IV), in which there is a clearly revealed preference of those passengers traveling without a vehicle, between air transport and conventional P/C ship.

To use this data, we assume that for a specific trip the travelers’ preferences are according to the following multinomial logit model: (1)
Section II - Multimodal and Modal Split

\[ f_i = \exp\left(\frac{a_i p_i + c t_i}{\sum_k \exp\left(\frac{a_k p_k + c t_k}{L}\right)}\right) \]

where \( f_i \) is the fraction of travelers using mode \( i \), \( p_i \) is the fare charged by mode \( i \), \( t_i \) is the trip time using mode \( i \), and \( a_i \) is the "preference constant" of mode \( i \), reflecting possible natural biases in favor of or against that mode. \( b \) and \( c \) are the same for all modes, and are both negative.

For two modes \( i \) and \( k \), we can see that:

\[ \ln\left(\frac{f_i}{f_k}\right) = \Delta a_{ik} + b \Delta p_{ik} + c \Delta t_{ik} \]

where:

\[ \Delta a_{ik} = a_i - a_k, \Delta p_{ik} = p_i - p_k, \Delta t_{ik} = t_i - t_k. \]

This expression means that an increase of the fare by one unit can be offset by a reduction of the trip time by \( \frac{b}{c} \). Alternatively, the ratio \( c/b \) is the amount the traveler is willing to pay in order to reduce trip time by one unit. Therefore, the value of time we want is the ratio \( c/b \).

A linear regression analysis of (2) with the 1990 data (looking only at passengers traveling without vehicles- Table IV), and with the additional assumption that \( \Delta a = 0 \) (there is no initial documented bias in favor of either mode) produces the value of \( c/b = 415 \text{ GRO/hr} \).

It should be noted that the \( R^2 \) for this analysis was not that spectacular (0.54), implying that there are probably more factors affecting traveler preference and behavior than those examined by this model (fare and trip time). For instance, it is certainly true that different classes of passengers have different values of time (a businessman who travels by plane has a different value of time from a tourist who enjoys being on the deck of a ship during the entire morning, or from a traveler who enjoys an overnight journey in a cabin). Having no way to measure such differences, we had to settle with the "average" value of time calculated above. We shall use such a value with caution, knowing that it is only an average, and one that probably overestimates the value of time of some travelers (those traveling by ship) and underestimates the value of time of other travelers (those taking the plane).

To validate this model, we applied the value of 415 GRO/hr to the O-D data shown in Table IV (passengers without vehicles, 1990) to produce what the logit model gives for total passengers traveling without a vehicle and who prefer sea transport for 1990. We then added the passengers captive to sea transport (those of Table III), and produced Table IX. A comparison with Table I shows generally acceptable results.
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<table>
<thead>
<tr>
<th>From/To</th>
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<th>21</th>
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<th>41</th>
<th>42</th>
<th>43</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1,087,042</td>
</tr>
<tr>
<td>21</td>
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<td>182,363</td>
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<td>166,433</td>
</tr>
<tr>
<td>31</td>
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<td></td>
<td>22,784</td>
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<td></td>
<td></td>
<td>218,634</td>
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<td>331,072</td>
<td></td>
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<td>331,072</td>
</tr>
<tr>
<td>42</td>
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<td></td>
<td></td>
<td></td>
<td>412,494</td>
<td>9,224</td>
<td>421,718</td>
</tr>
<tr>
<td>43</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>8,229</td>
<td>8,229</td>
</tr>
<tr>
<td>Total</td>
<td>1,080,611</td>
<td>167,573</td>
<td>214,371</td>
<td>341,807</td>
<td>421,477</td>
<td>7,289</td>
<td>2,233,129</td>
</tr>
</tbody>
</table>

Table IX: Validation of modal split: "predicted passengers traveling by ship, 1990 (compare with Table I)

We finally note that comparing the 415 GRD/hr value with the value of Lioukas (1993), 415 GRD/hr of 1990 are equivalent to about 625 GRD/hr in 1993, which is lower than (although same order of magnitude with) the 800 GRD/hr produced by him.

**STEP 6: Run the logit model to determine the modal split on each branch of the network**

Having calibrated the logit model by calculating an appropriate value of time, and having validated it by comparing Table IX with Table I, we now run it for 2004 as follows.

First, as to what the value of time will be in 2004, we assume that this will grow (in constant 1990 prices) as the rate of annual growth of Greek gross domestic product. Assuming a 1.5% average growth (in real terms), this value becomes about 510.6 GRD/hr in 1990 prices (unless otherwise noted, all our analysis is expressed in 1990 GRD). This assumption is plausible, for a person will probably value time more if he or she makes more money.

So we examine modal split in 2004 with a value of time equal to 510.6 GRD/hr (1990 prices). Note however that in 2004 the number of possible modal choices in our sub-network is 5 and not 2, as in 1990. Since the value of 510.6 was derived assuming two modes, a question is whether we can use it for the 3 additional modes assumed in 2004. Another question is whether we can use this value for those passengers traveling with a vehicle. Such passengers,
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having no choice but to use the conventional P/C ship in 1990, have the fast P/C ship as an alternative in 2004.

There is no foolproof way to address either of these two questions. In fact, in a strict sense, the correct answer to both questions is "no," particularly to the second one (somebody traveling with his car will generally have a different value of time from somebody traveling without it). However, the average value of 510.4 GRD/hr is about the only piece of information on travelers preferences we got, and short of scrapping this analysis altogether, we decided to use it in our analysis as best we could. "As best we could" means a number of additional assumptions concerning the way the modal split calculations are made. These are as follows.

a) In 2004 there will be no capacity constraints on the number of available ships or aircraft to meet projected demand on each link of the subnetwork;

b) The value of time for all passengers in the system (traveling with or without vehicles) is 510.6 GRD/hr (1990 prices);

c) The fare assumed to be paid by each passenger traveling with a vehicle (those of Table V) is the second class fare, plus 1/2.5 the corresponding private car fare. This assumption is reasonable for passengers traveling with their private cars (since on the average each car carries 2.5 persons), but neglects possible fare differentiations for bus, truck or motorcycle travelers. These are estimated to be minor. For these passengers, modal split is made between 2 modes, 2 and 5 (binomial logit model) and is shown in Tables X and XI below;

d) The most important assumption concerns how the modal split should be made for passengers traveling without a vehicle. All 5 modes are present here, and a straightforward way to run the model would be to apply the multinomial logit formula with all 5 modes present, and let the results fall where they may. The initial set of runs were in fact made this way, and showed fast ships and air transport combined capturing from 70% to 88% of total passenger traffic without vehicles if the value of time is 510.6 GRD/hr and if the fast fare surcharge goes from 15% to 100%. If the fast fare surcharge is kept constant at 15%, this combined percentage ranges from 88% to a striking 99.7% of the passenger traffic without vehicles, the latter case (in which conventional ships receiving almost zero passengers without cars) happening if the value of time is tripled. Judging these results as unrealistic, we decided to adopt a different philosophy on how the modal split is made, as follows.

Instead of a multinominal model (split among 5 modes), we used a binomial model in a pairwise sequential fashion. The first split was between air and all
Modal Split Analysis in Greek Shortsea Passenger/Car Transport

ships combined. The second split was between conventional P/C ships and and all fast ships combined. The third split was between hydrofoils and other fast ships combined (SES and fast P/C ships). The fourth split was between SES and fast P/C ships. Notice that each split (except the fourth) is between a distinct single mode and a set of other modes combined. The time and fare parameters of the combined modes were assumed to be those of the one among these modes for which the "generalized fare" (fare plus trip time multiplied by value of time) was the lowest. This is tantamount to assuming that the traveler makes his choice in a sequential fashion, and at each step he or she always compares a mode with the best (in terms of generalized fare) among all other modes still under consideration.

There is no a priori way of telling what selection biases are introduced by this scheme, or whether these biases are systematic. This is so because there is no systematic ranking of the modes according to their generalized fares (as much as there is one according to their trip times and another one according to their fares). However, from the results (and from a comparison with the multinomial logit runs) we speculate that the biases are primarily against the fast ships. In that sense, we consider these runs (coupled with the assumption that the fast ships generate no new additional demand) to be on the conservative side with respect to the future of these ships.

Tables X to XVI summarize the results of these runs as follows.

1 Passengers traveling with vehicles (modal split of Table V passengers)

<table>
<thead>
<tr>
<th>From/To</th>
<th>11</th>
<th>21</th>
<th>31</th>
<th>41</th>
<th>42</th>
<th>43</th>
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</tr>
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<tbody>
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<td>436,961</td>
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<td>83,225</td>
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<td>54,865</td>
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<tr>
<td>41</td>
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<td></td>
<td></td>
<td>143,115</td>
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<tr>
<td>42</td>
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<td></td>
<td></td>
<td>175,792</td>
</tr>
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<td>7,998</td>
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<td></td>
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<td></td>
<td></td>
<td>7,998</td>
</tr>
<tr>
<td>Total</td>
<td>423,397</td>
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<td>150,869</td>
<td>185,867</td>
<td>7,830</td>
<td>863,776</td>
</tr>
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</table>

Table X: Passengers who will travel by conventional P/C (mode 2)
## Section II - Multimodal and Modal Split

<table>
<thead>
<tr>
<th>From/To</th>
<th>11</th>
<th>21</th>
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<th>42</th>
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</thead>
<tbody>
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<td>100,580</td>
<td>128,624</td>
<td>5,554</td>
<td>290,707</td>
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<tr>
<td>21</td>
<td>26,091</td>
<td>683</td>
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<td></td>
<td></td>
<td>26,774</td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>32,346</td>
<td>526</td>
<td></td>
<td>423</td>
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<td>33,295</td>
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<tr>
<td>41</td>
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<td></td>
<td>95,410</td>
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<td>5,673</td>
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<td>Total</td>
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<td>30,628</td>
<td>100,580</td>
<td>129,047</td>
<td>5,554</td>
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### Table XI: Passengers who will travel with fast P/C (mode 5)

## 2 Passengers traveling without vehicles (modal split of Table VI passengers)

<table>
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<th>From/To</th>
<th>11</th>
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</thead>
<tbody>
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<td>5,911</td>
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<tr>
<td>21</td>
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<td>19,463</td>
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<td></td>
<td>89,170</td>
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</tr>
<tr>
<td>31</td>
<td>86,213</td>
<td>19,754</td>
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<td>7,015</td>
<td></td>
<td>112,982</td>
<td></td>
</tr>
<tr>
<td>41</td>
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<td>149,233</td>
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<tr>
<td>42</td>
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<td></td>
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</tr>
<tr>
<td>43</td>
<td>6,037</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6,037</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>457,150</td>
<td>87,797</td>
<td>112,295</td>
<td>152,819</td>
<td>161,666</td>
<td>5,911</td>
<td>977,638</td>
</tr>
</tbody>
</table>

### Table XII: Passengers who will travel by air (mode 1)

---

*European Shortsea Shipping* 177
## Modal Split Analysis in Greek Shortsea Passenger/Car Transport

<table>
<thead>
<tr>
<th>From/To</th>
<th>11</th>
<th>21</th>
<th>31</th>
<th>41</th>
<th>42</th>
<th>43</th>
<th>Total</th>
</tr>
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<tbody>
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<td>122,772</td>
<td>177,190</td>
<td>184,671</td>
<td>8,195</td>
<td>578,741</td>
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</tr>
<tr>
<td>21</td>
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<td>26,524</td>
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<td></td>
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<td>115,663</td>
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</tr>
<tr>
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<td>26,921</td>
<td>10,892</td>
<td></td>
<td></td>
<td>159,786</td>
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</tr>
<tr>
<td>41</td>
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<td></td>
<td></td>
<td>173,032</td>
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<td>185,160</td>
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</tr>
<tr>
<td>43</td>
<td>8,370</td>
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<td></td>
<td></td>
<td></td>
<td>8,370</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>577,674</td>
<td>112,834</td>
<td>158,696</td>
<td>177,190</td>
<td>195,563</td>
<td>8,195</td>
<td>1,230,152</td>
</tr>
</tbody>
</table>

### Table XIII: Passengers who will travel by conventional P/C (mode 2)

<table>
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<td></td>
<td></td>
<td>35,470</td>
</tr>
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<td>47,212</td>
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<tr>
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<td>14,717</td>
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</tr>
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</tr>
<tr>
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<td>3,582</td>
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<tr>
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<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Total</td>
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<td>13,993</td>
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<td>4,150</td>
<td>0</td>
<td>100,981</td>
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</table>

### Table XIV: Passengers who will travel by hydrofoil (mode 3)
### Section II - Multimodal and Modal Split

<table>
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<tr>
<th>From/To</th>
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<th>42</th>
<th>43</th>
<th>Total</th>
</tr>
</thead>
<tbody>
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<td>11</td>
<td>10,194</td>
<td>42,307</td>
<td>52,501</td>
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<td></td>
<td></td>
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<tr>
<td>21</td>
<td>10,577</td>
<td>2,992</td>
<td>13,569</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>42,301</td>
<td>3,037</td>
<td>1,193</td>
<td>46,531</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>41</td>
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<td></td>
</tr>
<tr>
<td>42</td>
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<td></td>
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</tr>
<tr>
<td>43</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>Total</td>
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<td>46,328</td>
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<td>1,193</td>
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</tbody>
</table>

**Table XV:** Passengers who will travel by SES (mode 4)

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<th>31</th>
<th>41</th>
<th>42</th>
<th>43</th>
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</thead>
<tbody>
<tr>
<td>11</td>
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<td>42,307</td>
<td>122,118</td>
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<td></td>
<td></td>
<td>13,569</td>
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</tr>
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<td>3,037</td>
<td>1,193</td>
<td>46,261</td>
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<td></td>
<td>119,252</td>
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<td></td>
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<tr>
<td>42</td>
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<td>1,029</td>
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<td>6,340</td>
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<td></td>
<td></td>
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<tr>
<td>Total</td>
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<td>13,231</td>
<td>46,328</td>
<td>122,118</td>
<td>139,939</td>
<td>6,207</td>
<td>645,136</td>
</tr>
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</table>

**Table XVI:** Passengers who will travel by fast P/C (mode 5)
Modal Split Analysis in Greek Shortsea Passenger/Car Transport

To get the total picture for modes 2 and 5 (which are the only modes catering to both categories of passengers), we also have:

Table XVII: Total passengers who will travel by conventional P/C (mode 2), sum of Tables X and XIII

<table>
<thead>
<tr>
<th>From/To</th>
<th>11</th>
<th>21</th>
<th>31</th>
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<th>42</th>
<th>43</th>
<th>Total</th>
</tr>
</thead>
<tbody>
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<td>11,616</td>
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<td>214,651</td>
<td></td>
</tr>
<tr>
<td>41</td>
<td>316,147</td>
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<td></td>
<td></td>
<td></td>
<td>316,147</td>
<td></td>
</tr>
<tr>
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<tr>
<td>43</td>
<td>16,368</td>
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<td></td>
<td></td>
<td></td>
<td>16,368</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1,001,071</td>
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<td>381,430</td>
<td>16,025</td>
<td>2,093,928</td>
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</tbody>
</table>

Table XVIII: Total passengers who will travel by fast P/C (mode 5), sum of Tables XI and XVI

<table>
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<tr>
<th>From/To</th>
<th>11</th>
<th>21</th>
<th>31</th>
<th>41</th>
<th>42</th>
<th>43</th>
<th>Total</th>
</tr>
</thead>
<tbody>
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<td>71,907</td>
<td>222,698</td>
<td>267,370</td>
<td>11,761</td>
<td>610,279</td>
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<tr>
<td>21</td>
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<td>40,343</td>
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<td>1,616</td>
<td>79,556</td>
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<tr>
<td>41</td>
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<td></td>
<td></td>
<td></td>
<td>214,662</td>
<td></td>
</tr>
<tr>
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<td></td>
<td></td>
<td></td>
<td>12,013</td>
<td></td>
</tr>
<tr>
<td>Total</td>
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<td>40,106</td>
<td>76,956</td>
<td>222,698</td>
<td>268,986</td>
<td>11,761</td>
<td>1,219,091</td>
</tr>
</tbody>
</table>

Table XVIII: Total passengers who will travel by fast P/C (mode 5), sum of Tables XI and XVI
STEP 7: Interpret results and perform sensitivity analysis.

As these results concern only a limited application of modal split (sub-network and not entire network), they should be interpreted with caution. For instance, the percentages of each mode depend not only on passenger preferences, but also on our very assumption on what links of the subnetwork are served by each mode. So these results should only be considered an output of a "what if" analysis, and not as predictions of what will actually happen in 2004. At the same time, we consider useful to perform a sensitivity analysis on some of the parameters so as to obtain some additional insights. Sensitivity analysis concerns two main parameters: The fare differential between conventional and fast ships (assumed in the baseline scenario at 15%), and the value of time (assumed in the baseline scenario equal to 510.6 1990 GRD/hr).

In 1990, of those passengers who traveled in the sub-network without a vehicle, 43% traveled by air, and the rest (57%) by conventional P/C ship. In total, 68% took the ship, and 32% used the plane.

In 2004, for those who will travel without a vehicle, 32% will take the plane, 40% will go by conventional P/C ship, 3.3% will take the hydrofoil, 3.7% will use SES, and 21% will go by fast P/C ship. For those who will travel with a vehicle, 60% will go by conventional P/C, while 40% will go by fast P/C.

These percentages, if interpreted narrowly, may be misleading. For instance, for passengers who travel without vehicles, the small hydrofoil and SES percentages (as compared to that of the fast ferries) are mostly due to our assumption on what links of the subnetwork are served by these modes and less on actual preferences. In fact, SES and fast P/C have the same speed and charge the same fare, so on one should expect a tie of these modes on the links served by both. This happens indeed (Compare Tables XV and XVI). However, not all links are served by both modes, by our own assumption, and that is why the overall shares of mode 5 are higher than those of mode 4.

In addition, these percentages do not differentiate between short and long-haul routes. If we are more careful, we can see that hydrofoils raise their percentage on short-haul routes and other new technology ships do so for longer-haul routes.

The general observation from these runs is that the overall percentage of traffic that goes to the new technology ships (modes 3, 4 and 5) can be significant. This is mainly against the airplane for passengers without cars and against conventional ferries for passengers with cars. One possible reason for this is the small (15%) fast fare surcharge assumed. Irrespective of whether these ships can survive on such a small fare (this will be examined in Section 4), one natural question is what happens to modal split if the fast fares become higher.
Modal Split Analysis in Greek Shortsea Passenger/Car Transport

To investigate this, we examine what happens if the fast ship fare is 30%, and 50% over the conventional one (ceteris paribus). The results are again differentiated between passengers without vehicles, and passengers with vehicles:

For the former passenger category, if the fast fare surcharge is 30% (50%) the shares of each mode become: Air, increase to 34% (36%); conventional ferry, slight increase to 41% (41%); hydrofoil, decrease to 2% (1.9%); SES, decrease to 3.1% (2.8%), and fast ferry, decrease to 19.9% (18.3%). For passengers traveling with a vehicle, the share of the conventional ferry increases to 64% (68%), while that of the fast ferry goes down to 36% (32%). In other words, the main beneficiary of a more expensive fast ship fare is the airplane for passengers traveling without a car and the conventional ship for passengers traveling with a car.

We next examine what happens if the value of time is twice or three times what was originally assumed (with a 15% fast fare surcharge).

For passengers without cars, if the value of time is doubled (tripled), the new shares are: Air, increased to 35% (37%); conventional ships, decreased to 36% (31%); hydrofoil, decreased to 2.4% (2.6%); SES, decreased to 3.6% (3.4%); and fast ferry, increased to 23% (25.4%). For passengers with cars, the shares are: Conventional ferries, dropped to 55% (49%), while fast ferries increase their share to 45% (51%).

We see that if the value of time increases, for both passenger classes the main loser is the conventional ferry, while the main beneficiary is the fast ferry and the airplane. Interestingly enough, the other two fast ship modes see their shares slightly decrease.

4 ECONOMIC FEASIBILITY ANALYSIS

In view of the promising results of the previous section with respect to the possible share of passenger demand that new technology ships might be able to attract in 2004, a pertinent question is what is the economic potential of these vessels. Clearly, a modal split analysis would be incomplete if the economic viability of these vessels is not also assessed. Although such an analysis is not the central focus of this paper (see Psaraftis (1993) for complete details), we provide here a summary of its main results.

The project team collected (and/or estimated) technical and economic data (not reproduced here) for the following categories of new technology vessels:
1) The fast monohull GUIZZO (mainland Italy - Sardinia);
2) The swath AEGEAN QUEEN (under design at NTUA - see Papanikolaou et al (1991));
3) The wave-piercer catamaran HOVERSPEED GREAT BRITAIN (Channel service);
4) The swath PATRIA (Tenerife service);
5) The SES CORSAIR 900 (under construction in Germany);
6) The hydrofoil KOMETA (in service in Greece).

Of these, vessels 1, 2, 3, and 5 can carry cars, while vessels 4 and 6 can only carry passengers.

A parametric analysis was performed on two important parameters: The vessel’s capacity utilization (ranging from 30% to 70%, with 60% assumed as the baseline value), and the company’s required return on investment (ranging from 0 to 40%, with 20% assumed as the baseline value).

The vessel’s economic performance depends not only on the above parameters, but also on the route it serves, as well as the operating scenario for that route. For instance, if the MMM imposes a mandatory requirement of provision of year-round service, the ship would have to collect higher fares to stay viable than if no such requirement were imposed. So we formulated seven possible scenarios, the following:

**Scenario a:** Route Piraeus - Mykonos (94 nm), 2 roundtrips per day for the 3 summer months, 1 roundtrip per day for 8 months, 1 month out of service;

**Scenario b:** Same as scenario a, but 2 roundtrips per day for 11 months, and 1 month out of service;

**Scenario c:** Same as scenario a, but route is Piraeus - Santorini (126 nm);

**Scenario d:** Same as scenario b, but route is Piraeus - Santorini;

**Scenario e:** Same as scenario a, but route is Piraeus - Iraklio (175 nm);

**Scenario f:** Same as scenario b, but route is Piraeus - Iraklio;

**Scenario g:** Same as scenario e, but 1 daily roundtrip for 11 months and 1 month out of service.

The purpose of scenarios b, d, and f is not so much to examine the performance of these vessels if the two daily roundtrips of the summer are extended during the rest of the year, but to simulate a scenario in which the shipowner can remove his ship from service during the 8 months of the off-season, and employ
Modal Split Analysis in Greek Shortsea Passenger/Car Transport

the ship outside the Greek system. The assumption is that this alternative employment is equivalent in terms of revenue.

We also note that some of these scenarios do not match some of the vessels. For instance, the AEGEAN QUEEN cannot make the two roundtrips to Crete (scenarios e and f), due to lower speed. Similarly, the PATRIA and KOMETA (that do not carry cars) are not examined at all on this route.

There are 34 vessel-scenario combinations. All are shown in Table XIX. The table shows two fares for each vessel-scenario combination:

(i) The (minimum) required passenger fare to break even (on a net present value sense) over the ship's lifetime (codenamed RFR, and expressed in 1990 GRD);

(ii) The passenger fare that maximizes revenue, assuming a binomial logit modal split between the vessel and a conventional ferry charging the conventional fare (codenamed MAX, and also expressed in 1990 GRD).

Psaraftis (1993) provides more detail on how both fares are calculated. MAX is obtained by taking the derivative of the logit equation and then iteratively solving a set of non-linear equations. No retaliation is assumed from conventional vessels.

Also shown in the table are the 2nd class conventional vessel fare, and the airfare for each route.

Several remarks can be made from this table. First, and with the possible exception of the PATRIA and the KOMETA, all other vessels require fares considerably higher than both the conventional fare and their own revenue maximizing fare. These fares become prohibitive (compare for instance with airfares) for scenarios a, c, and e, which require the maintenance of a year-round service.

By contrast, if the year-round service requirement is lifted (scenarios b, d, and f), the RFR's drop considerably.

The above scenario assume a 60% utilization and a 20% required return on investment. If the utilization is increased and/or the rate of return is decreased, the RFR's drop somewhat (see Psaraftis (1993 for the full sensibility analysis).

The above results certainly do not paint a particularly rosy picture for the future of fast ships in Greece, and neutralize, to a significant extent, the promising results of the previous section. They boil down to the realization that although fast ships can attract a significant share of passenger traffic if the fares they charge are modest (15% to 50% over the conventional fares), the economic
### Table XIX: Economic performance of vessels for each scenario

<table>
<thead>
<tr>
<th>Scenario</th>
<th>a</th>
<th>b</th>
<th>c</th>
<th>d</th>
<th>e</th>
<th>f</th>
<th>g</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ship</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GUIZZO</td>
<td>10,453</td>
<td>7,477</td>
<td>11,226</td>
<td>8,250</td>
<td>12,408</td>
<td>9,432</td>
<td>14,640</td>
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<tr>
<td>MAX</td>
<td>2,825</td>
<td>2,825</td>
<td>3,403</td>
<td>3,403</td>
<td>4,668</td>
<td>4,668</td>
<td>4,668</td>
</tr>
<tr>
<td>AEGERAN QUEEN</td>
<td>5,757</td>
<td>3,936</td>
<td>6,011</td>
<td>4,191</td>
<td>7,123</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAX</td>
<td>2,686</td>
<td>2,686</td>
<td>3,194</td>
<td>3,194</td>
<td>4,316</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HOVERSPEED</td>
<td>8,092</td>
<td>5,521</td>
<td>8,439</td>
<td>5,869</td>
<td>8,973</td>
<td>6,402</td>
<td>10,901</td>
</tr>
<tr>
<td>MAX</td>
<td>2,732</td>
<td>2,732</td>
<td>3,254</td>
<td>3,254</td>
<td>4,449</td>
<td>4,449</td>
<td>4,449</td>
</tr>
<tr>
<td>PATRIA</td>
<td>5,339</td>
<td>3,566</td>
<td>5,497</td>
<td>3,724</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>MAX</td>
<td>2,693</td>
<td>2,693</td>
<td>3,230</td>
<td>3,230</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CORSAIR</td>
<td>9,723</td>
<td>6,682</td>
<td>10,246</td>
<td>7,145</td>
<td>10,896</td>
<td>7,854</td>
<td>13,177</td>
</tr>
<tr>
<td>MAX</td>
<td>2,825</td>
<td>2,825</td>
<td>3,403</td>
<td>3,403</td>
<td>4,668</td>
<td>4,668</td>
<td>4,668</td>
</tr>
<tr>
<td>KOMETA</td>
<td>5,158</td>
<td>3,575</td>
<td>5,432</td>
<td>3,849</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAX</td>
<td>2,590</td>
<td>2,590</td>
<td>3,054</td>
<td>3,054</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2nd class fare</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Airfare</td>
<td>10,558</td>
<td>10,558</td>
<td>11,620</td>
<td>11,620</td>
<td>12,550</td>
<td>12,550</td>
<td>12,550</td>
</tr>
</tbody>
</table>

Viability of such vessels is likely to be problematic because they need much higher fares to break even. As these fares are often close to the level of air transport fares, very few people would accept them, rendering the overall operation problematic.

Several factors contribute to this outlook, and to the extent that some or all of these factors change, the outlook itself can change for the better. These are the following:

- **a) Low level of conventional fares.** If those were higher, the prospects would be better. In fact, MAX is not a linear function of the conventional fare. As conventional fares are under the strict control of the MMM, the prospect of deregulation of these fares by 2004 could relieve some of the pressure from new technology vessels. See also b below.
b) High relative cost of fast ships. By "relative" we mean per unit passenger capacity, as compared to conventional ships. As conventional ships in Greece are mostly conversions and not new designs, this relative cost of fast ships is even higher. Of course, the strict control of the fares by the MMM is one of the reasons for this state of affairs, for keeping fares at low levels provides little incentive for a shipowner to buy a new ship. This situation seems to be changing lately, as several shipowners have ordered newbuildings for their fleet. Even though most of these new ships will go to the Italy- Greece services (which are not governed by the same fare structure as the internal cabotage services), this will eventually bring pressure to the MMM to deregulate fares sooner rather than later.

c) Low value of time in Greece. It is interesting to report that the income maximizing fare for the GUIZZO in Italy is at about the same level as the actual fare charged (Psaraftis (1993)). This is assuming a value of time for Italy about 3 times the Greek level. So the GUIZZO, although probably subsidized in her early runs, is more profitable in Italy than it would be in Greece, for the traffic could bear the higher rates more easily. Of course, a higher value of time in Greece can be associated with (and be the result of) a substantially higher income per capita.

d) Operating scenario controlled by the MMM. Above we saw that if these vessels are required to provide a year-round service, their economic viability is much lower. The same would happen if the MMM sets unreasonable conditions as prerequisites for granting licences to such ships (for instance, calling at 10 ports, as we noted earlier). It is our view that come 2004 the MMM will have no right to impose such conditions on fast ships, even though it will (as per the EU Regulation on cabotage) retain such authority for a select subset of the network, on which "public services" will be imposed and provided. Psaraftis (1993) and Sturmey, et al (1994) provide more details on this issue.

At the same time, the outlook can get more complicated if the other modes (1 and 2) cease to adopt a "do-nothing" fare policy (as we assumed) but formulate a fare structure that is explicitly designed to make life even more difficult for new technology ships. The analysis of the implications of such policies (which may contain elements of gaming and oligopolistic price equilibrium theory) are left for a future phase of this research.

5 CONCLUDING REMARKS

This paper presented some modal split scenarios for the Greek coastal shipping system, in view of the lifting of cabotage privileges by 2004. All of these
scenarios are hypothetical, but we feel they have a substantial degree of realism so as to be able to perform a "what if" analysis of what is likely to happen.

Our analysis would be stronger if a "stated preference" data set were available instead of the "revealed preference" one, for the latter was seen to exhibit some limitations. Also, a broader analysis for a larger part of the network could provide some additional insights.

In terms of policy recommendations, a lot of work needs to be done in the 10 years to 2004, both by the MMM and by private industry, in order to be able to best adapt to the new game that will be played. Many of such recommendations are listed elsewhere (see Psaraftis (1993) and Sturmey et al (1994)). Within the scope of this paper, we feel that the analysis presented supports the following policy recommendations.

1) Put an end to the tightly controlled fare structure, well before the end of 2003, at least for some types of service;

2) For those routes and services that do not belong to the "public service" sector, allow competition and freedom to set routes and fares;

3) The MMM should set up criteria for the determination of which will be the "public service" routes, and on how licenses will be granted for those;

4) Market surveys should be carried out to determine the "stated preference" of travelers. These are essential so as to be able to predict modal split with an acceptable degree of confidence.
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SHORT-SEA SHIPPING: VIA OPTIMA?

By R.J. Martens

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ABSTRACT

Various positive elements of maritime transport, such as environmentally friendly and under-utilised infrastructure capacity, have been recognised and have resulted in the integration of maritime coastal transport in the European transport policy.

The objective of this paper is to function as a catalyst for thought and action on the topic of intermodal services by sea, with a focus on short-term practical solutions. Shortsea shipping is defined in this paper as proximity intermodal shipping by sea, without taking into account the size of the vessel.

Research indicates that, based on the current competitive position, around 5% of the current international road transport (more than 4 million tonnes out of a total of 86 million tonnes in 1986) of The Netherlands could be transported by sea from a transport cost perspective. However, shippers and consignees still select road transport. It appears that costs are important, though the quality of the services (frequency, schedule, reliability, safety of cargo) have to meet a certain threshold level before shippers and consignees are interested in another transport option.

This paper focuses on these elements from the perspective of a new, private, organisation stepping into the intermodal shortsea market.

The main conclusion of this paper is that an intermodal shortsea operation has a better commercial future if it is developed as an integral part of a total corridor system approach - an organisation offering the market all possible transport modes.

This corridor organisation "Via Optima" uses a pro-active approach, applying the principle of dedicating account managers to clients. The transport providers, including port terminals, reserve a minimum part of their equipment for this corridor organisation, all under the same name.

Support can be given to a commercial successful implementation of such a corridor organisation by supporting the establishment of a "Geographical Transport Information System (GTIS)" - which provides detailed market information, supporting the establishment of a "Bureau Shortsea Shipping" - focused on improving the perception of the shortsea sector, and giving policy attention to
matters concerning customs, pilotage, port licenses and duties, as well as supporting technical improvements on the longer term.

1 INTRODUCTION

In 1991 the Directorate-General Shipping and Maritime Affairs (DGSM) from The Netherlands commissioned the Maritime Economic Research Centre and NEA to carry out a study in order to identify a number of trade-routes, using Dutch ports, where shortsea shipping is in a better competitive position vis-à-vis road transport.

The report stated that the international road transport to and from The Netherlands totalled 86 million tonnes in 1986. Of this total around 32 million tonnes was identified to be:

a. Related to coastal regions;
b. Characterised as cargo that could be transported by sea; and
c. Significant in transport volumes.

On the basis of this volume the study carried on with a detailed analysis of the cargoes involved, with respect to parcel sizes, transport prices, perishability and other cargo characteristics.

The analysis resulted in a total amount of 4.3 million tonnes (5% of total Netherlands international road traffic) of cargo as being transferable to sea. This 'transferable' cargo is subdivided in NSTR-cargo groups:

* 0 and 1 (agricultural products);
* 8 (chemicals); and
* 9 (other products).

Of this 4.3 million tonnes, 3.1 million tonnes is transported on five trade-routes. These five trade-routes are:

1. Netherlands - St. Petersburg 44,000 tonnes
2. Netherlands - Finland 444,000 tonnes
3. Netherlands - Spain/Portugal 1,378,000 tonnes
4. Netherlands - Middle & South Italy 799,000 tonnes
5. Netherlands - Eastern part Mediterranean 606,000 tonnes

Using this as a basis, DGSM prepared in 1992 the policy paper "Filevrij over zee". This paper provides a framework for the shortsea shipping strategy of the

\[1\text{Mariniseerbare Ladingen, MERC/NEA, 1991, Rotterdam.}\]
Short Sea Shipping: Via Optima?

Dutch government. The first element identified as necessary was a further investigation into the thresholds confronted by the shortsea shipping sector to become more competitive as an intermodal transport supplier and the formulation of recommendations improving this competitive position, as well as the identification of the trade-route potentially to be used in a pilot project.

This study was commissioned to Frederic R. Harris, the Maritime Economic Research Centre and Maritime Systems Technology late 1992. The study concluded in June 1993 with the report Groene Golf" (green wave).

This paper is largely based on this report, and it uses preliminary results of a Frederic R. Harris “Research Paper”, prepared by two students (Peter Postema and Wouter Kesseler) of the Transport College from the Erasmus University in Rotterdam. Their research focuses on the organisation of intermodal transport in general and to what extent shortsea shipping can learn from the development of land-based intermodal transport.

This paper is further divided in three sections:

In Section 2 a broad outline of the market environment, with regard to changing logistic structures, is presented. This outline provides the market framework within which the new intermodal operator has to operate.

In Section 3 the most prominent thresholds for shippers and consignees to use shortsea shipping as an alternative to road transport are presented, as identified in the Groene Golf study.

In Section 4 concept solutions are proposed for a hypothetical introduction of a pilot project on a transport-route. The concepts are presented for further investigation but also to be assessed and potentially to be implemented if such a pilot project would be regarded an efficient learning path for the further development of intermodal services by sea and to increase the cohesion of economies in the European Union.

2 THE MARKET ENVIRONMENT

2.1 CAPTIVE MARKET

The objective of The Netherlands is to enhance the competitive position of The Netherlands as the European Distribution Land (EDL). To achieve this objective it is a necessity to maintain and expand the role of all the transport modes.
However, also in The Netherlands, the land transport modes will most likely not be in a position to encompass the forecasted intra-European transport demand. Furthermore, the (land) access to the port, especially the mainport Rotterdam, runs the risk to become suboptimal, which could well result in a decrease of the use of the port for im(ex)port of commodities.

The (existing) familiarity with the maritime sector in The Netherlands, the existing port infrastructure and access to the sea could result in a significant development of intermodal maritime services in The Netherlands. This could then maintain/increase the position of The Netherlands in the intra-European trade.

So there is a policy support for a improvement of the competitive position of intermodal maritime services vis-à-vis road transport.

A number of studies so far have resulted in merely an estimate of traffic flows. Shipowners, also, have very little precise and comprehensive information at their disposal regarding captive traffic flows. The lack of this kind of information has led several major shipowners to set up their own information service (B.A.I. Company\(^2\)), enabling the shipowners to monitor the traffics and their fluctuations.

When focusing on The Netherlands, analyses of the international trade relations indicate that, based on transport costs, currently between 1.5 and 4.5 million tonnes of road cargo could be transported by sea\(^3\). That seems not to be significant in relation to the current volumes. But one consideration should be added.

Sea transport currently does not grow as fast as road transport. The road transport sector is increasing its competitive position continuously. More cargo, today transported by sea, could very well be transported by road tomorrow. Assessments indicate that potentially 10 to 18 million tonnes of sea cargo could move to the road\(^4\).

This, however, does not include the competitive position of rail. The statement that the maritime sector could very well lose cargo to the road sector might be, in a sense, not the whole truth. The increasing market share of intermodal rail services in Europe certainly is a result of attracting cargo from the road to rail. The question, however, if rail has also gained from sea has to be raised.

\(^2\)B.A.I. Company: Bretagne, Angleterre, Irlande company

\(^3\)Report Groene Golf, Frederic R. Harris, MERC, MST, 1993

\(^4\)Report Mariniseerbare Ladingen, MERC/NEA, 1991
Short Sea Shipping: Via Optima?

As an example we can mention Haulmark European Transport, a major UK container intermodal operator. Haulmark\(^5\) has launched new, long-haul container intermodal door-to-door services between the UK and France, Spain and Italy. The concept behind the services is that of using the shortest possible sea-routes combined with longer overland rail hauls, or exactly the opposite of what the discussions in Europe with regard to the future of shortsea sector entail until now.

Keeping this in mind, it still can be concluded that the result of increasing the competitive position of shortsea shipping is a market hovering between 10 and 20 million tonnes annually for The Netherlands. In view of the expected growth of intra-European transport this can only grow.

2.2 LOGISTIC CONCEPT CHANGES

The environment in which transport has to operate has changed significantly and will change further and will therefore continuously change the 'product' requirements of transport.

Various developments led to the transport of smaller parcel sizes with a higher frequency, resulting in more sophisticated transport requirements.

* Shorter life-spans of products and shorter delivery times resulted in a change of logistical concepts, e.g. resulting in central distribution and value added logistics;

* The globalisation of production processes - global sourcing - leaded to an increase of international containerised transport, resulting in an increase of logistic coordination requirements, e.g. electronic parts production and assembly;

* The trend of "glokalisation" - shifting part of production capacity to other trade blocks - results in significant changes of transport volumes and structures, e.g. passenger car transport to Europe.

Also a number of other developments resulted in changing logistical solutions.

* The increasing power of shippers and consignees, due to economic concentration;

* The internationalisation of the marketplace;

\(^5\)Containerisation International, October 1993
Section II - Multimodal and Modal Split

* The increasing international competition not only results in lower prices but also in higher customer service levels.

Through the availability of fast communication methods has become technically (though not always commercially) possible to fully organise, coordinate, and control the logistic process.

Until now these developments have led to more 'individualised' transport. As road hauliers were among the first actors to recognise this individualisation (through their direct contact to the client), they have been successful in increasing their market share vis-à-vis other transport modes.

As a result of this attention to logistics within companies, it is interesting to note that there are some changes in sight in the client's organisation.

The market can be differentiated broadly into two categories of customers. On the one side there are the industrial customers and on the other side the consumer market customers.

In the first - industrial customers - it is still shipping/traffic managers who handle the seafreight function, and who decide which forwarders and/or shipping lines to use. Senior management in industrial manufacturers often regard shipping as a necessary evil, and consequently they are not interested in it. Even shipping costs may be deemed to be not very important, since they are passed onto customers as components of CIF prices.

In contrast, in manufacturers, or importers of consumer products, the approach to transport and distribution is different. The reasons are that the distribution/logistics requirements are higher (just-in-time) and that a difference in transport costs may have a significant influence on the profit margin.

Consequently, in the latter group a trend can be identified showing that transport is becoming more important. Shipping/traffic departments are replaced by logistics departments, usually headed by more senior people than traditional shipping managers. Such people are reputed to be more sophisticated, and often have specialised backgrounds.

This trend can only expand as transport costs is recognised as a significant element of the total product.

Within this business environment intermodal sea transport has to find its market niche.
3  THRESHOLDS

In Section 2 we saw that there is around 4 million tonnes of road cargo transferable to the sea. What are the current threshold for shippers and consignees then not to select shortsea shipping?  

First, an important element with which prospective intermodal operators are confronted is the lack of precise and comprehensive transport market information. To ensure commercial success, it is necessary to formulate very clear marketing plans. These plans should include market segmentation, a clear product and pricing strategy and a clear sales strategy covering channel, coverage and promotional activities.

Segmentation could mean: identifying distinct groups of shippers sharing similar characteristics (geographic location, traffic corridors, traffic density - potato exporters from The Netherlands to Italy) and cargo safety requirements. Key questions in segmentation are: Is the revenue potential adequate to justify market entry? What service and product attributes are most highly valued? Is the market concentrated among a few leaders? Who is deciding on the transport mode?

This analytical step is an important prelude to positioning the new intermodal product for longterm commercial success. In addition this should be a continuous effort in order to ensure market responsiveness. To answer these crucial questions solid supporting data is needed to develop a detailed understanding of the market segments - "know your client". This data is usually not available (clearly put forward by shipowners and line operators to Frederic R. Harris during the "Groene Golf" study).

Second, it is the demand side’s (shippers and consignees) current negative perception of the maritime sector. When specifically asking for it, the shortsea sector does offer multi-modal or even intermodal services. Albeit, they do not actively market these capabilities. Therefore, the shortsea sector can be characterised as re-active. However, shortsea is in competition with more pro-active sectors: the road haulier and rail sector.

Third, the quality of service factors - frequency, timing of departures and arrivals, and reliability - are decisive factors, more important then rate charges, in

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6This section is based on findings of the "Groene Golf" study. The methodology used was geared to find, short-term, answers why shippers and consignees are not selecting transport by sea, from the point of view that answers and solutions had to be practical in order to influence the decision process of the shipper/consignee on the short term.
the decision whether or not to use intermodal transport. Within this context, the issues of customs (not in many countries applied as seamless to the transport flow as in The Netherlands), and pilotage (is there a need for obligatory pilotage for liner vessel captains) form also part of the quality of service provided.

A fourth important aspect forms the question who the responsible party in the door-to-door transport is; each party involved in a part of the transport process is only responsible for his particular part of the transport process. One aspect of this responsibility issue is formed by the port terminals with respect to the 'control' of the cargo. When the cargo is underway, be it on the truck or on the vessel, there is a form of inactive control: the parties have been informed that the cargo is underway. However, at the terminal, only active control ensures the interested parties that the cargo is 'safe'. Another aspect of this responsibility issue are insurance rates, more often than not higher when a number of parties is responsible for the cargo in the door-to-door transport process. Finally, relatively more documentation is often required in the situation that multiple parties are responsible.

Fifth, another important element in the selection of the transport mode and transport company is the effect of habituation. In any circumstance, clients will be affected by this element. However, solutions can not be found on the short term. The shortsea sector has to develop the same kind of longterm relations with clients as the other transport modes.

Sixth, the 'problem' of transfer of cargo from one mode to another requires handling. Since most handling equipment is geared to deep-sea vessels, a relative high handling rate is charged to shortsea shipping. This can form an important bottleneck for the selection of shortsea shipping. However, the example of the Dutch container terminal operators in the ports, where the handling rates were differentiated according to the transport mode involved (deep-sea or inland water vessel) shows potential for the shortsea sector.

These problem areas can be considered as more general problem areas, independent of the transport route and markets.

Other elements, though some of them are already mentioned, such as total transport costs, total transport time, customs documentation (differing between land and sea transport modes), reliability, cargo safety, requirements of the client, and availability of transport services are more related to a specific trade route and, more importantly, related to the 'to be transported commodity'.

\[^{7}\text{Report \textit{Towards a really combined transport}, INRO-TNO/NEA, 1990, Delft.}\]

European Shortsea Shipping
4 CONCEPT SOLUTIONS

4.1 INTRODUCTION

In Section 3 the most important bottlenecks from a market perspective to grow intermodal shortsea services were presented. In summary these are:

* Lack of precise and comprehensive commercial market information;
* Shippers' and consignees' current perception of the maritime sector;
* The maritime sector's re-active policy;
* The decentralized responsibility for the transported cargo;
* High handling costs;
* Habituation effects; and
* Documentation.

In this section I will discuss each of these problem areas and propose concept solutions for a hypothetical introduction of a pilot project on the transport-route Spain/Portugal to and from The Netherlands/Belgium. This route is selected on the basis of the potential level of so-called 'transfer' cargo and on the basis of being a parallel route to the land-based routes. I will call this service "Via Optima". These concepts are presented for further investigation but also to be assessed and potentially to be implemented if such a pilot project would be regarded an efficient learning path for the further development of intermodal services by sea and increase the cohesion of economies in the European Union.

4.2 MAKING THE RIGHT START

This is, probably, the most important element of all actions to be taken in establishing "Via Optima".

In Section 2 the conclusion was that there is a trend towards 'individualised' transport solutions. The other conclusion was that the recognition of logistics/transport as an important element in the positioning of a product has resulted in an ongoing trend of the introduction of more senior people than the traditional shipping managers. In the design of a successful intermodal transport service it will therefore be important to determine who among the transport providers is in the best position to package, price sell, and service the product for each targeted segment.

Detailed market research is therefore required - "Know Your Client". However, two remarks have to be made. First, the 'individualisation' of the client requirements will lead to higher costs for the transport provider to understand and
offer the client the right transport solution. Second, it appears that the transport providers are competing for the same clients.

Because of these remarks it is regarded that an international strategic alliance, or another form of cooperation, could be an option to deal with these matters in a commercially viable way. As such, the hereunder proposed corridor organisation forms the backbone of pursuing an improved competitive position of the shortsea shipping sector.

**Concept Solution I: Corridor Organisation**

The proposed corridor organisation consist of sales personnel (account managers) only, with offices on both sides of the transport corridor "Via Optima", assuming responsibility for the total door-to-door transport process. It offers all transport modes (road, rail, sea and IWT). Importantly, it also provides terminal capacity on both sides of the corridor.

Each (existing) transport/terminal provider has an arrangement with the corridor organisation. Based on the market research a captive market is determined. A minimum level of transport and terminal capacity is reserved (all under the same name: Via Optima) for use by the corridor organisation. Transport and/or terminal capacity above the reserve capacity can either be hired from members of the 'corridor alliance' or from outside, depending on availability and price.

![Diagram of Via Optima organisation](image)

*Figure 1: Via optima organigram*

All actors in the transport link are connected to the sales office by EDI links. Each client has a connection to the system for tracking and tracing purposes, but no ability to change items in the system. Also service organisations, like customs on both ends, are connected.
A client’s JIT procurement strategy requires the timely arrival of ordered components. In case the modal scheduling is inaccurate, alternative routings need to be available so as to ensure the arrival of the parts. The corridor concept creates in this context a win-win situation. Also, as each client tends to require different logistical concepts for its commodities, different transport solutions should be available. This concept provides these different transport solutions as well as the ability to offer ‘confection’ and ‘tailor-made’ transport.

Another positive element of the concept is the use of account managers (or client manager). As a result, the client has only one person to deal with in the total transport process. Furthermore, this account manager can offer the client all types and forms of transport solutions, creating the perception of a ‘client dedicated’, or even ‘commodity dedicated’ approach of the transport provider. He or she is also high educated and as such on par with the educational/cultural level of the client.

Furthermore, carrier selection determines the use of a mode. The amount of cargo is of influence on negotiation power (small is beautiful but big is powerful). Also other positives can be reached, e.g. priority use of transport capacity, less administrative requirements. However, it all leads to a pressure on the transport rates. Developing the corridor concept could well counteract this pressure by offering these clients value-added through the provision of multiple transport solutions.

Of course, multiple, organisational solutions within this corridor concept are possible, and the one presented only is of relevance as an example.

However, overall, this concept concentrates the responsibility, facilitates transport providers to acquaint their existing clients with shortsea shipping. Moreover, it also contributes positively to the ‘habituation’ issue, since examples of successfully using shortsea shipping can be found in-house (within the corridor organisation) and client’s experiences can be used for promotional/marketing activities towards other clients, and last but not least, this corridor organisation has a pro-active character, and as such contributes to changing the perception of the maritime sector from a re-active sector towards a pro-active sector.

4.3 SUPPORTIVE CONCEPT SOLUTIONS

In order to increase the commercial viability of the corridor organisation concept, or in a broader perspective to improve the competitive position of inter-modal maritime services, a number of supportive concept solutions are presented hereunder based on the findings of section 2 and 3.
Section II - Multimodal and Modal Split

Concept Solution II: Geographical Transport Information System

Above it was mentioned that market information is essential for the development of a successful transport organisation.

In my opinion, those beneficiaries of the development of shortsea shipping, such as governments and ports (as they benefit from increased volumes shipped by the shortsea sector), should support shipowners, line operators and the corridor organisation with providing access to detailed information. It can be considered a necessity for these companies to apply a pro-active commercial policy and for example to plan fleet renewal. The development of a "Geographical Transport Information System" (derived from the commonly known GIS datasystems) could well provide the private operators/organisations with the required information.

Concept Solution III: Framework Issues

1. "Bureau Shortsea Shipping"

In any event, the perception of the shortsea sector can be improved. The message that the shortsea sector meets the transport (service) requirements has to be conveyed to the clients. Concentration of this type of efforts has proven to be a useful method\(^8\). A "Bureau Shortsea Shipping could play an active role in conveying the right messages, on the one hand to influence the governmental policies, and on the other hand to positively influence the perception of the shortsea shipping sector.

2. Combined Terminals

It has to be stated that one of the prime targets for decreasing the total transport cost is decreasing the handling costs at the terminal for shortsea shipping use. However, usually shortsea shipping uses the same terminal, and thus the same equipment, as the fourth generation container vessel. This result in high unit rates.

Already a high number of specialised container terminals for Inland Water Transport are established, in development or planned. These terminals, within seaports located almost adjacent to the deep-sea terminal, have a far lower financial break-even point due to smaller gantry cranes at a quay with a lower water level.

\(^8\) The Dutch government has openly requested the inland water transport sector to reach consensus on issues relevant to potential government support, thereby giving proof of the fact that the sector is viewed as one party. Combining forces therefore seems to be beneficial to achieve results in favour of the sector.
Short Sea Shipping: Via Optima?

Although a number of these, already built, terminals can not be used by shortsea shipping, it is recommended to include an analysis if a new terminal is planned whether a 'Combined IWT and Shortsea' terminal is feasible, rather than a dedicated IWT terminal.

Within this context, not only locations in seaports come to mind, though also terminals located more inland.

Furthermore, technical innovations, geared to lowering handling costs and/or geared to increase handling speed, are continuously in the limelight, and rightfully so.

3. Policy Support

The objective of the European Community is to increase the market share of environmentally friendly modes of transport vis-à-vis road transport.

However, from a economic transport point of view this objective should not be pursued by creating bottlenecks for the road transport but through supporting the other modes of transport to become more competitive.

Changing the perception of shortsea shipping as being coastal shipping into intermodal services by sea can therefore be considered not only a task of the sector itself, but also a task for the national governments and the European Commission in view of the adopted European transport policy. The establishment of the "Bureau Shortsea Shipping" could therefore be supported both by national governments and by the European Commission.

Aspects of influence on the pricelevel and commercial viability of shortsea shipping are:

a. Port Licenses,

Shortsea operators often have to acquire port licenses, backed up by a financial guarantee. This situation has an adverse effect on their cash-flow situation, especially for a small, just starting, company. Port Authorities and/or Governments could, potentially, be helpful in this respect.

b. Port Duties,

Although port duty structures differ from port to port, it is still unusual to base port duties only on the cargo transferred in the port, but is more frequently based on vessel size. For developing a shortsea supportive policy it is felt that defining port duties on the basis of cargo transferred
in the port is more in line with the intention to develop cost structures based on the actual use of infrastructure and energy.

c. Other Port related Costs,

As mentioned in Section 3, pilots are often obligatory, though from a safety point of view not required if an experienced captain is in charge of the vessel. In view of this, special licenses should be given to those captains, without any costs.

d. Other Issues,

The customs have to perform their tasks. However, if possible, their task should be performed in a way that the transport process is seamless in character – don’t stop the cargo. In this respect, it is recommended that customs become an integral part of the transport organisation. The proposed corridor organisation should therefore establish close ties to the customs on both sides of the corridor. Also, exchange of customs procedures know-how between the two involved customs organisations could well improve the total system.

Documentation is another issue, and should be standardised between modes of transport. Also related to this aspect is the issue of passing international waters when using the sea mode versus the situation using land modes. Within the context of the corridor organisation concept it is felt necessary that a fully standardised documentation system, independent of the transport mode (and if legally possible also independent of using land or sea modes) is developed and implemented.

4.4 CONCLUSION

In conclusion it can be said that, with the right support, there is a window of opportunities for the shortsea sector when they develop a clear intermodal product. The best commercial approach is considered to establish a corridor transport organisation, like "Via Optima", combining all possible modes of transport inclusive of the terminals.

Policy support is required both with respect to the short term, geared to organisational type of thresholds, and with respect to the longer term, geared to technical improvements of the cargo transfer, and the transport modes.

It is felt that the ‘corridor concept’ contributes to cohesion of the European economies as one of the elements would be the transfer of know-how in the corridor organisation.
WATER-BASED MULTIMODAL TERMINALS:
AN ECLECTIC SITE EVALUATION MODEL

By L. Clinkers, E. Declercq, C. Peeters and A. Verbeke

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WATER-BASED MULTIMODAL TERMINALS: AN ECLECTIC SITE EVALUATION MODEL

ABSTRACT

Traditional solution models on optimal location focus on mathematical modelling with a high degree of accuracy, resulting either in an optimal point or in a region, having an acceptable deviation from the optimal location. Dominant decision factors in these models are related to distances and transportation costs. But in the case of multimodal terminals for shortsea shipping or inland navigation, other factors might prevail in the decision.

In this paper, an integrated decision model for strategic site selection will be discussed. The selection of optimal locations for inland navigation in Flanders will be used to demonstrate the usefulness of the decision model.

Traditional solution models on optimal location focus on mathematical modelling with a high degree of accuracy, resulting either in an optimal point or in a region, having an acceptable deviation from the optimal location. Dominant decision factors in these models are related to distances and transportation costs. But in the case of multimodal terminals for shortsea shipping or inland navigation, other factors might prevail in the decision.

In this paper, an integrated decision model for strategic site selection will be discussed. The selection of optimal locations for inland navigation in Flanders will be used to demonstrate the usefulness of the decision model.

1 INTRODUCTION

A general policy framework concerning the transport of goods and passengers has been made explicit by the Commission in various publications during the last few years. These publications include, among others:

* COM(90) 218 final, June 27, 1990: Green Paper on the Urban Environment;
* COM(92) 231 final, Brussels June 11, 1992: Guidelines for the development of a European Transport Network;
Water-Based Multimodal Terminals


The development of *Trans-European-Networks* (TENs) which include the different modes of transport perform an important role in the implementation of the Commission’s program.

The terms and principles of the TENs are expressed in the Treaty of Maastricht (Title XII and Article 129 b-d and Title XIV and Article 130 a-e) and the Presidency of the European Council in Edinburgh on 11/12 December 1992 (Conclusion, part C, Annex 3). In general, the main principles include:

* The increase of cohesion among Member States;
* The improvement of mobility;
* The facilitation of trade.

As a first step, individual working groups were set up within DGVII (the Union’s Directorate General for Transport of the European Commission) in order to develop Trans-European-Networks for the different modes, i.e., road haulage, trains, shortsea shipping, inland waterways or air transport.

The Commission also installed other working groups related to ports and the creation of networks for energy transmission and telecommunications. The Commission’s objective was to coordinate the efforts of Member States in making more efficient the movement of goods and passengers throughout the Union.

The different networks for the transport of passengers and commodities should be integrated in a future phase into one single, multimodal transport network. The network should cover the entire European Union and link the different modes of transport.

A transport network covering the entire Union, requires the equal treatment of all transport modes. Policy makers should also take into consideration all modern standards of business logistics. This overall strategy should be imple-
Section II - Multimodal and Modal Split

mented by the individual Member States according to the principle of subsidiarity.\(^1\)

Policy concerns regarding the protection of the environment will lead to both a reduction of road haulage and by the promotion of environment friendly transport modes to absorb the expected increase of commercial transport in the union. Environment friendly modes of transport such as short sea shipping (SSS) and inland navigation (IN) have only recently been fully recognized as a useful alternative for commercial transport given a number of logistical constraints related to time, efficiency and transportation costs.

The integration of SSS and IN in existing transportation chains is a very important condition for their further development. This integration is required to fully exploit the potential of both modes as regards "just-in-time" (JIT) and "in-time" (IT) concepts.

However, this urgently needed integration requires more than the mere introduction of innovative ship designs or techniques for transhipment.\(^2\) The location of the terminal for the transshipment of goods also plays a major role in the development of an integrated "water-based" transportation network that is competitive with road haulage.\(^3\)

The identification of optimal locations for the development of multimodal terminals requires a new approach to site selection. Conventional principles such as the minimization of distances and/or transportation costs need to be replaced by a more eclectic approach whereby these determinants will be included as two determinants in a set.

\(^1\)The principle of subsidiarity was expressed in Article 3b of the Treaty of Maastricht. The Member States have the responsibility to identify the precise detail of their individual contribution and to propose projects of interest to the European Union which contribute to the objectives of the European Union.


\(^3\)The stimulation of Multimodal Inland Port Terminals was also advocated in an in depth study on the competitive position of SSS in Europe. See Policy Research Corporation N.V. *Analysis of the Competitive Position of Short Sea Shipping: Development of Policy Measures*, study co-financed by: Directorate-General for Transport (DG/VII), Commission of the European Union and Department of the Environment and Infrastructure, Ministry of the Flemish Community, August 1993.
Water-Based Multimodal Terminals

In 1993, Policy research Corporation N.V. conducted a study on the optimal location(s) for multimodal terminals. This study was commissioned by the Flemish Community, Department of the Environment and Infrastructure, Administration for Water Infrastructure and Maritime Transport. The main purpose of the study was to provide information to public policy makers on the optimal location of multimodal terminals. It also aimed to develop an integrated decision model to evaluate these potential locations. This paper discusses some results of the study and the foundations of an eclectic site selection model.

2 AN ECLECTIC APPROACH TO STRATEGIC SITE SELECTION

The study on the optimal location for multimodal terminals for IN included three core elements:

* The identification of attractive areas for the establishment of multimodal terminals, through the use of a new, advanced software package;
* A SWOT-analysis (Strengths - Weaknesses - Opportunities - Threats) for each possible location, including information on both internal and external criteria;
* The design of a manual for project evaluation, which should be used by public policy makers whenever specific new projects need to be assessed (eclectic approach).

The assessment of various possible locations, suggested by the Department, was performed through the use of a number of criteria, both external and internal ones, see Figure 1. These parameters constituted the basis for respectively the OT and SW analysis of potential locations. The analysis of internal parameters resulted in an assessment of various possible areas in terms of their strengths and weaknesses as regards the physical transportation of goods. The analysis of the external parameters led to insight regarding the opportunities and threats characterizing specific sites and is thus of equal importance for site selection. It should be emphasized that the classification of criteria as "internal" or "external" in Figure 1, may sometimes be ambiguous. The main determinant for this classification was the answer to the question: "should terminal operators be able to influence the impact of this criterion on the viability of his terminal operations at the time when this criterion becomes relevant the decision process (i.e. either before or after the investment decision)?" The

overall evaluation of each location required the integration of the different components mentioned above, and resulted in decision profile charts with a presentation of relevant data on all sites, in this case both the ones suggested by the Department and a number of alternative ones. The positioning of the different sites was performed using an integrated decision model.

This integrated approach consists of three steps, resulting in an overall assessment of every potential location. The first step is the single parameter approach whereby every location is ranked according to a single parameter. This provides the possibility to develop partial comparisons of different locations on the basis of single parameters considered crucial, such as "centrality" (see Section 3).

The second step is the location approach whereby every location is assessed according to the different parameters simultaneously. A detailed profile chart is developed at this stage for every potential location. In this stage, the performance of the location to every parameter is measured and ranked according to a scale, varying from ++ (excellent) to -- (unacceptable). If a parameter has no relevance for a particular location, a neutral value (N) is given.

The third and final step is the integrated approach, whereby an overall evaluation is performed of each potential location. An adapted version of the SWOT-model (Strengths, Weaknesses, Opportunities and Treats) is used to visualize the results, see Figure 2.

This integrated model includes a dual evaluation:

- **Horizontal evaluation (internal factors):**
  Internal parameters are decision factors that can be influenced directly by the terminal operator. These parameters are related to logistical and operational management. Thus, these parameters can be considered as internal and can therefore be positioned on the horizontal axis:
  - **strong:** positioning of locations that are characterized by a weighted overall score on internal parameters that is higher than the average for all locations;
  - **weak:** positioning of locations that are characterized by a weighted overall score on internal parameters that is lower than the average for all locations.

- **Vertical evaluation (external factors):**
  External parameters cannot be influenced by the terminal operator and are positioned on the vertical axis:
  - **High opportunity:** positioning of locations that are characterized by a weighted average overall score of external parameters that is higher than the average of all locations;
Integrated evaluation of potential locations

External decision parameters (opportunities & threats)
- Property rights
- Multimodal integration
- Physical characteristics of site
- Quality and capacity of site
- Possibilities for expansion
- Environmental impact

Internal decision parameters (strengths & weaknesses)

Technical determinants
- Transport costs
- Centrality
- Inland navigation access

Site specific determinants
- Public infrastructural facilities
- Waste disposal

Market specific determinants
- Customer base
- Potential demand growth
Section II - Multimodal and Modal Split

Figure 2: Integrated evaluation model

- Low opportunity: positioning of locations that are characterized by a weighted average overall score of external parameters that is lower than the average of all locations.

The integrated approach results in the positioning of every potential location in the matrix. A practical selection can then be made amongst the locations which are situated in quadrant 1 because these locations received an above average score for both the internal and external parameters.

However, as will be demonstrated in Section 4, specific project-related criteria, such as its financial viability are obviously also important, therefore requiring a model for eclectic site evaluation that goes beyond the integrated model, presented in this section.
3 THE INTEGRATED ANALYSIS OF POTENTIAL LOCATIONS FOR IN TERMINALS IN FLANDERS

3.1 SINGLE PARAMETER APPROACH: CENTRALITY

The use of centrality indices is important from a geographic perspective. These indices provide information on the geographic positioning of each potential terminal vis-a-vis the markets to be served. The centrality of the different locations was assessed in three steps. In the first step, the centrality was calculated from a national perspective, using the performance of the Belgian main- and IN-ports in the numerator of the index. As a result, the Centrality Index (Cl) of a potential location $i$ can be expressed as:

$$CI_i = \sum_{j=1}^{n} \frac{P_j}{t_{ij}}$$

where:
- $n$ = the number of destinations
- $P$ = the port performance of port $j$
- $t_{ij}$ = the transportation cost.

In the second step, the same procedure was followed, but using an international perspective, that included French, Dutch and German ports. In the third step, a "weighted" CI was calculated according to both the international and national CIs.

The importance of the Antwerp and Ghent seaport areas as core distribution areas was confirmed by this analysis. All areas located in the proximity of one of these ports were characterized by a favorable index. The areas located near the 'Bovenschelde', the 'Albertkanaal' and the 'Zeekanaal' to Brussels also obtained positive scores, which demonstrated their potential for the location of a multimodal terminal.

However, the centrality indices for the various areas did not diverge very much, which indicated the central position of the Flemish region from a European perspective. It also confirmed that the Flemish region could perform a key function in an integrated European "water-based" system for the transport of goods.

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5Port performance, both from a national and an international perspective is measured by the quantities transported to every port, as published in the statistics of the National Institute for Statistics (NIS).
Section II - Multimodal and Modal Split

Additional information as regards geographic locations can only be generated through the use of specialized mathematical models.

In the second stage of the single parameter analysis, a software package was used that included three sequential steps:

1. **Step 1**: the optimal location is determined for the construction of a multimodal terminal(s) in the Flemish region;
2. **Step 2**: the boundaries are determined of a geographical area within which a sufficient approximation is obtained of the results characterizing the optimal location;
3. **Step 3**: each actual location under consideration is assessed in terms of the results obtained in the first two steps.

The designation 'optimal location' implies a minimization of transport costs associated with the movement of goods from this location to various destinations. In the model, the distance was taken into account between each alternative location and various selected destinations, both in Belgium and abroad. A substantial number of Belgian and foreign ports were selected as destinations, in function of their relevance for inland navigation and according to inland navigation statistics. The calculations also took into account the relative significance of the various destinations under consideration. The 'weight' of each destination was determined in accordance with the individual share of each port in the total traffic of all ports in a specific year.

The basis of the simulation model, was the branch and bound technique with space partitioning. The method included location-constraints, defined as 'regions of any shape defined by closed non-self-intersecting contour lines'. The program calculated the optimal solution up to an accepted deviance $\varepsilon$. However, in real-world applications, the identification of one single location is useless. Economic decision makers prefer the identification of a region of near-optimality was identified with a range of possible solutions up to an approximation $\delta$. This was done in step 2 of the algorithm, where a region of near-optimality was calculated, given a pre-defined acceptable deviation.

In the third and final step of the simulation model, each potential discrete location was evaluated according to its position relative to the region of near-optimality. The analysis was twofold. First, its (linear) deviation from the optimal location was calculated and all locations were ranked accordingly. Second, the geographic position of every location was determined. This position could be

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Water-Based Multimodal Terminals

outside the region of near-optimality, an outer - or inner approximation of the region of near optimality, the latter being the optimal result.

Mathematically, the algorithm could be defined as a finite set of points in the plane $\mathbb{R}^2$. All points $a \in A$ are destinations interacting with a central facility, located at some unknown location $x \in \mathbb{R}^2$ and to be determined. For every destination, the distance was calculated through the use of a norm $N_a$ as $d(x,a) = N_a(x-a)$. As a result, a corresponding vector of distances could be identified for every point $x$:

$$D(x) \in \mathbb{R}^A, \text{i.e. } D(x) = (N_a(x-a))_{a \in A}.$$  

This vector of distance was transformed into an objective value by way of a globalizing function $G : \mathbb{R}^A \to \mathbb{R}$, which is continuous and boxwise optimizable. The latter is possible by determining a minimal and maximal value of $G$ for every box through calculating the Upper and Lower bounds of the variables. If $l$ and $u$ are considered vectors in $\mathbb{R}^A$ so that $l_a \leq u_a$ for any $a \in A$, then both

$$LG(l,u) = \min \{ G(x) | x \in \mathbb{R}^A, s.t. \ l_a \leq x_a \leq u_a \}$$

$$UF(l,u) = \max \{ G(x) | x \in \mathbb{R}^A, s.t. \ l_a \leq x_a \leq u_a \}$$

could be calculated. The feasible region is then the set of potential location sites for the central facility (to be located), denoted by $S$, and a subset of $\mathbb{R}^2$. The feasible region can be defined as $S = H \cap P$, where $H$ is the initial region (taken large enough to contain all relevant parts) and $P$ is the union of closed bounded polygonal regions $P_i$, which in turn can be defined as the points within a closed non-self-intersecting piecewise linear boundary curve. The $P_i$ finally, represent the different regions of interest (geographical constraints). If no such region(s) exist, $P$ equals the whole plane. The problem can therefore be reformulated as:

$$\min_{x \in S} G(D(x))$$

Several simulation exercises were performed, both for national and international transportation. In addition, a number of areas were selected for further analysis in function of their significance for inland navigation. These areas are concentrated around the two main inland navigation routes in the Flemish region, namely the 'Albertkanaal' and the 'Schelde'. The different simulations demonstrated that the main geographic areas with acceptable locations largely correspond with the access routes to the main Flemish ports, see Figure 3. These access channels include:
The 'Zeekanaal Ghent-Terneuzen';
- The 'Schelde-Rijn'-link;
- The 'Albertkanaal' as an access channel to Antwerp;
- The link Ghent-Antwerp;
- The 'Zeekanaal Brussels-Rupel'.

The area that stretches from 'Niel-Willebroek' to 'Lier-Duffel' was identified during the computer-simulation as the most attractive location for a multimodal terminal in the Flemish region, see Figure 4.
The identified area includes the channel linked with the river ‘Rupel’ (accessible for vessels of 2000 tons) and the ‘Nete’-channel. The latter is already accessible for vessels of 1350 tons. The present strategic plan of the Department (‘Programme for the Infrastructural improvement of the Flemish inland navigation system’) foresees that this channel will also be made accessible for vessels of 2000 tons.

A ranking of the four areas was performed to allow for an optimal sequence of establishing the various terminals. The area between the ‘Nete’-channel and the river ‘Rupel’ (and ‘Zeekanaal’ Brussels) unambiguously constituted the most favorable location, see Figure 4. The seaport area of Antwerp was ranked second. The area around ‘Meerhout’ and the seaport area of Ghent, which appeared to be equally attractive, were positioned as third in the ranking.

The area ‘Rupel-Nete’ is very attractive for establishing a multimodal terminal, from a logistics perspective. The port of Antwerp is centrally located for most inland navigation-traffic flows, whereas the port of Ghent can be viewed as a
major nodal point between the north-south axis ('Bovenschelde') and the east-west axis ('Albertkanaal'). 'Meerhout' should also be considered as a potentially valuable logistical center, given that a number of multinational companies have established their European distribution headquarters in this area. The areas around Brussels, 'Genk' and the southern part of the 'Schelde' (where a terminal has already been established, namely 'Avelgem') constitute additional locations, where a terminal could be built. However, it should be recognized that these areas are somewhat peripheral and do not benefit from a central position to the same extent as the four most attractive areas. The establishment of multimodal terminals in these areas could be considered in terms of attracting specific traffic flows or pursuing regional policy goals.

3.2 SWOT-ANALYSIS

Each of the different areas discussed in the previous section contained various appropriate sites, which were assessed in terms of a wide variety of selection criteria. Profile charts were developed for each individual site, based upon in-depth information on these criteria. This information allowed to assess a variety of sites within a single area.

3.3 THE INTEGRATED ANALYSIS

The last stage of the empirical research consisted of integrating the results of the analysis on internal and external factors in a dynamic SWOT-matrix. Each potential site was positioned in the matrix, according to its 'performance' in both the strength-weakness part of the assessment (horizontal axis) and the high-low opportunities part (vertical axis), see Figure 5.

The sites positioned in the top left quadrant of the matrix should be considered as the most attractive ones for establishing a multimodal terminal. The most attractive locations are: 'Rupel-Nete' (24), the ports of Antwerp (8) and Ghent (23) and 'Meerhout II' (14), on the leftbank of the 'Albertkanaal'.

Public policy makers will be able to use these results, when formulating strategies for the integration of inland navigation in the overall transportation system and the selection of sites for multimodal terminals.

However, the analysis above does not taken into account project-specific elements, given the choice of a specific location. Therefore, an eclectic site evaluation model is needed to assist public policy makers in the assessment of potential projects.

The integrated evaluation of all potential locations as described above presents a ranking of potential sites according to a variety of internal and external ele-
Figure 5: Integrated evaluation of potential locations

1: Krulbeke
2: Kerkhove
3: Hoboken
4: Ghent (Zw.
5: Zutendaal (1.5)
6: Genk
7: Dendermonde
8: Antwerp
9: Oudenaarde (n)
10: Oudenaarde (z)
11: Menen
12: Lommel
13: Meerhout I
14: Meerhout II
15: Zandvliet
16: Etteren
17: Roesselare 1
18: Roesselare 2
19: Roesselare 3
20: Vlvoorde
21: Ostend
22: Diksmuiden
23: Ghent (port area)
24: Rupel-Nete

Internal parameters

Strengths

Weaknesses

Opportunities

Threats

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ments. However, a project-specific appreciation of the different locations is required to come to a final decision on whether or not to develop a "water-based" multimodal terminal in a particular location. The eclectic site evaluation model which is presented next, could be a useful tool for public decision makers to rank and evaluate all additional project specific factors.

4 ECLECTIC SITE SELECTION MODEL

4.1 THE IMPACT OF PROJECT-SPECIFIC CRITERIA

Whether the final selection is made by public or private decision makers, the results of the integrated selection model should be complemented by an assessment of project-specific operational criteria which are considered relevant. These criteria may include:

* The financial viability of the project;
* The expected additional project-related traffic;
* The impact of this traffic on mobility (mobility impact study);
* The environmental impact;
* The direct and indirect return of public investments, if applicable.

Given the most attractive sites, identified in the integrated analysis (i.e. the solutions located in quadrant 1 of Figure 5), the eclectic site evaluation model compares the different projects according to a standardized information processing model. If a decision is to be made by public authorities, the required information as described above, should be provided by the investors demanding financial support. In this paper, the eclectic site evaluation model will be discussed from the perspective of public authorities. This is the case when public (financial support is demanded by private investors).

4.2 FINANCIAL EVALUATION

The financial viability of investments should be evaluated on the basis of the business plan used by investors for major projects. In accordance with conditional financial appraisal, methods as Net Present Value (NPV), Profitability Index (PI) and Internal Rate of Return (IRR) should be preferred over other methods such as the Pay Back Period.\(^7\)


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The financial impact of projects should be evaluated after eliminating all subsidies and the use of shadow prices should be avoided. If the financial results are not satisfactory under these stringent conditions, the economic viability of the project could be assessed taking into account additional benefits, such as:

- Time savings and increased efficiency of transhipment activities;
- The reduction of operational costs of transport as a consequence of modal shifts from the road towards IN or SSS;
- The creation of economies of scale.

4.3 TRAFFIC FORECASTS

A detailed traffic-analysis should include an assessment of:

- The generation of additional traffic (increase of volume);
- The creation of new, environment friendly traffic;
- Transfers from road haulage to environmental friendly traffic modes (modal shifts);
- A combination of the different options, mentioned above.

As regards the development of multimodal terminals, the detailed analysis also requires:

- The identification of the potential hinterland;
- The evaluation of the market potential;
- The identification of the modal split for the terminal;
- The evaluation of the minimum required capacity as compared to the required degree of service, given an expected traffic potential for the terminal.

4.4 ENVIRONMENTAL IMPACT ASSESSMENT

Particular attention should be paid to the potential impact of projects on the environment. Given that one of the principal objectives of "water-based" multimodal terminals is to promote environment friendly transportation (and thus, a reduction of road haulage), it would be unacceptable to invest in projects with a (considerable) negative impact on the environment.

Such impact could be e.g. an unacceptable increase of road traffic in densely populated areas or on heavily congested roads. Hence, it should always be
taken into account that increased road traffic could be an unexpected spin-off due to the additional cargo flows, generated by the terminal.

4.5 CONTRIBUTION TO ECONOMIC DEVELOPMENT

The contribution of projects to economic development is one of the main determinants for public decision makers to allocate subsidies. Hence, the value of projects can be determined by considering the following elements: the initial investment (subsidies), the creation of value added, the backflow to government and the creation of new employment. It is important to identify the number of times the value added which is causally linked to the project exceeds the initial public investment. This value added includes gross wages and salaries, social contributions by the employer, cash flows and taxes on the production\(^8\). The contribution of a project to economic development can be measured through the use of Economic Impact Studies (EIS).

4.6 MOBILITY IMPACT STUDY

A criterion that is becoming increasingly important for public authorities is the impact of projects on mobility. This impact could be measured through so-called "Mobility Impact Studies" (MIS). As regards mobility, the objectives of private investors could diverge substantially from objectives of public decision makers. Private investors are mostly interested in mobility impact only to the extent that these have an impact on their own logistical chain. An important objective of public authorities, however, may be to improve overall mobility in the region. In other words, they are more interested in the so-called "socio-economic mobility" (SEM)\(^9\).

The use of Mobility Impact Studies to evaluate the potential impact of projects on SEM includes the following elements:

* The demand for operational capacity of the terminal;
* The possibility to use existing (infrastructural) capacity;
* An evaluation of congestion, created by the project and the consequences on travel time, both for commuters as commercial traffic;
* The identification of potential effects on public networks;
* The assessment of external costs.

\(^8\)This can also be expressed as: actual production MINUS intermediate input EQUALS gross value added at market prices.

\(^9\)The concept of "Socio-Economic Mobility" was proposed by Policy Research Corporation N.V. in the manual for project evaluation, presented to the Department of Infrastructure and Environment of the Flemish Community in October 1993. The manual includes a detailed discussion of the concept of MIS and suggests how several important aspects could be assessed.
4.7 STANDARDIZED INFORMATION PROCESSING

All information collected for every individual project requires finally a careful evaluation. This can be done using nXn-matrices to link the analytical results with the initial objectives. The increase of environment friendly traffic, related to the use of existing road infrastructure is e.g. one of the important matrices, see Figure 6. It is clear that projects which generate substantial environment friendly traffic and have only a limited (negative) impact on the existing infrastructure should be preferred over those with a high negative impact on the road infrastructure and only a limited increase of environment friendly traffic.

The results of the different matrix evaluations leads to insights as to the value of all project-related decision factors. All these values can be integrated it in a project related profile chart.

The method is similar for all matrices. The matrix, presented in Figure 6 can be used to illustrate the different steps of the procedure. The use of information presented by the investor(s) such as traffic data and the assessment of possible effects on mobility, allows public authorities to position the project in one of the nine quadrants. The translation of the project’s performance in the 3x3 matrix into a score in the profile chart could be done as follows:

+ + quadrant 1 and 2;
+ quadrant 4 and 7;
N quadrant 5;
- quadrant 8;
- - quadrant 3, 6 and 9.

Although this positioning appears to have some face-validity, it should be emphasized that other classifications are also valid depending upon the situation.

This "translation" should be done for every parameter and the entire process repeated for every potential location. This approach will finally result in the creation of profile charts for every potential location.

The weighing of these various outcome for every individual project can be done in a final step, using multi-criteria analysis. Although sophisticated methods exist\(^\text{10}\), a more user-friendly method could be applied, based on the results of

the different profile charts from which the position of every project can be calculated and the project positioned in a final (eclectic) decision matrix ("matrix-positioning").

The profile chart (Figure 7) consists of different sections, each of which is divided into sub-sections. Once all information is translated in several nXn matrices, these matrices should be translated into scores for each criterion in the profile chart, by giving one of the five possible scores (+ + to --) a '1', the other four options consequently being '0'. This is the parameter evaluation (horizontal oriented evaluation).

In the next step, all values are considered for each of the five colons in the profile chart. The final value at the bottom is the sum of the individual values in that colon, each of which thus equals either '1' or '0'. In the extreme case, that bottom-value could be 19 if all 1-scores are in the same colon, or 0 if none of the scores is in that particular colon.

The final step in the whole process is the "matrix-positioning", where every project is positioned in a 2x2-matrix, based upon its performance both for the

Figure 6: Impact of project on environment
**Figure 7: Profile chart of the Investment**

<table>
<thead>
<tr>
<th>CRITERIA</th>
<th>TARGETS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>WEIGHTING</strong></td>
</tr>
<tr>
<td>2</td>
<td><strong>OBJECTIVES</strong></td>
</tr>
<tr>
<td>3</td>
<td>Creation of new IN traffic</td>
</tr>
<tr>
<td>4</td>
<td>Contribution to an increased integration of IN</td>
</tr>
<tr>
<td>5</td>
<td>Impact on general mobility</td>
</tr>
<tr>
<td>6</td>
<td>Consistency of the information</td>
</tr>
<tr>
<td>7</td>
<td>Quality of the information</td>
</tr>
<tr>
<td>8</td>
<td>Financial revenue</td>
</tr>
<tr>
<td>9</td>
<td>Financial revenues</td>
</tr>
<tr>
<td>10</td>
<td>Quality of the socio-economic revues</td>
</tr>
<tr>
<td>11</td>
<td>Potential of the terminal</td>
</tr>
<tr>
<td>12</td>
<td>Jobs creation from supplying industries</td>
</tr>
<tr>
<td>13</td>
<td>Capital release after closure</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>POTENTIAL LOCATIONS</th>
<th>TRAFFIC ANALYSIS</th>
</tr>
</thead>
<tbody>
<tr>
<td>IMPACT ON ENVIRONMENT AND MOBILITY</td>
<td>MACRO-ECONOMIC ANALYSIS</td>
</tr>
<tr>
<td>QUALITY OF THE INSTALLATION</td>
<td>RESULTS OF THE ENVIRONMENTAL IMPACT STUDY</td>
</tr>
<tr>
<td>QUALITY OF THE INTEGRATION</td>
<td>IMPACT ON GENERAL MOBILITY</td>
</tr>
<tr>
<td>QUALITY OF THE INFORMATION</td>
<td>CONSISTENCY OF THE INFORMATION</td>
</tr>
<tr>
<td>QUALITY OF THE FINANCIAL REVENUE</td>
<td>FINANCIAL REVENUE</td>
</tr>
</tbody>
</table>

The criteria in the table have only been included for purposes of illustration and do not necessarily reflect the actual list of criteria used in a specific analysis.
private investor and the public authority\textsuperscript{11}, see Figure 8. At this stage, the positioning of the projects is no longer qualitative, but a metric scale is introduced on the vertical and horizontal axes of the matrix which enables a "diagonal" appreciation of the different projects.

\begin{figure}[h]
\centering
\includegraphics[width=0.5\textwidth]{matrix.png}
\caption{Eclectic site evaluation matrix}
\end{figure}

This "diagonal" appreciation is from bottom-right to top-left and the closer the project approaches the top-left corner, the better the project scores on the two axes. In other words, the projects are ranked in order of descending preference, starting at the top-left of the matrix.

The final evaluation of the project is performed at two levels, the project-specific level of the private business operator and the macro-oriented perspective of the public authority. Given that the assessment in the profile charts are characterized by values that are either positive or negative (exclude the neutral value which has no influence on this particular problem), making a sum of the positive values is the opposite of making a sum of the negative values. Thus the

\textsuperscript{11}It should be noted that the relation private - public authority could be replaced by an other combination, depending the situation and the criteria that were used in the profile charts.

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weight of "++" should be equal to the weight of "--". The same should be applied to the opposite values "+" and ".-". Given that a neutral value (N) is obtained in case the criterion is not really relevant to a particular project, it is preferable that the weight of this value remains limited in the overall appreciation.

The sum of the contributed weights should equal 1.

A possible weighing of the values of a hypothetical profile chart could be:

<table>
<thead>
<tr>
<th>Value</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>++</td>
<td>0.35</td>
</tr>
<tr>
<td>+</td>
<td>0.13</td>
</tr>
<tr>
<td>N</td>
<td>0.04</td>
</tr>
<tr>
<td>-</td>
<td>0.13</td>
</tr>
<tr>
<td>--</td>
<td>0.35</td>
</tr>
</tbody>
</table>

The colon-value is then:

\[ V_c = W_c \sum_{i=1}^{n} w_i x_i \]

where:
- \( W_c \) = the weight of the colon
- \( n \) = the number of criteria, included in the profile charts
- \( x_i \) = the value of criterion \( i \)
- \( w_i \) = the weight of criterion \( i \)
- \( V_c \) = the total value of the colon under the constraints \( x_i = 0.1 \) and \( c \in [1, \ldots, 5] \).

The total value of the project is then:

\[ \sum_{i=1}^{3} V_{ci} - \sum_{i=4}^{5} V_{ci} \]

Hence, the neutral value is put on the positive side of the equation. However, an alternative approach could be to shift this neutral value to the negative side, thus emphasizing the requirement that the project should have positive results. A third alternative could be to give an 0-weight to the neutral value, hence, eliminating the colon in the final evaluation.

The approach described above, can be used for both a public and a private evaluation. However, differences in appreciation can be made explicit via different weights, given to the various criteria included in the project-profile chart. Here again, the sum of all weights should be equal to 1.
Private investors may pay more attention to logistical factors whereas public authorities may emphasize e.g. the effects on the socio-economic mobility or the environment. In any case, the approach leads to an eclectic site evaluation matrix where the individual projects are ranked according to their overall scores, both from a public and a private perspective.

5 CONCLUSIONS

If the process described above is repeated for all potential locations, they can all be positioned in Figure 8. It then becomes possible to re-evaluate specific projects in function of changes in specific parameters without having to repeat all evaluations. For example, if private investors want to reduce any potential opposition of public authorities to a particular project, they may choose to alter a number of project-specific characteristics.

However, this eclectic evaluation also gives public decision makers the possibility to make a balanced judgment regarding a particular project. If a project obtains a "negative" score from a public point of view, but a high "positive" score from the point of view of the private investor, the authorities could still grant permission for the project conditional upon, e.g. improved environmental protection or less road haulage.

Finally the use of the step-by-step approach, whereby every analysis leads to a particular result and the final result is one single profile chart, facilitates simulation-analysis with weights given to all criteria. By changing particular weights in the profile chart, elements in the eclectic evaluation can be emphasized.
# Growth Prospects of High-speed Car-ferries Utilization

## GROWTH PROSPECTS OF HIGH-SPEED CAR-FERRIES UTILIZATION ON EUROPEAN SHORT-SEA ROUTES

By J.P. Dobler

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INTRODUCTION

The conventional type of large open-sea passenger/car-ferry was developed during the fifties on the West-European short-sea routes most of which previously were served by many passenger "mail boats" and some train-ferries connecting the British and Scandinavian railway networks with the continental ones. Of course, this development was primarily answering the seasonal requirement of a fast-growing number of tourists wanting to bring their cars for their holidays abroad.

However, from the late fifties onwards, the explosion of road haulage in Europe added a brisk, and more regular demand for crossings by lorries and trailers, thus providing the large car-ferries with a year-long employment. Consequently, from being mainly complementary to rail transportation, the ferry services became, more and more, an integrative part of the road one, despite the fact that most terminals are benefiting from a direct rail link and that an important number of "walking" passengers still are using such rail/sea/rail connections.

In southern Europe, apart the cases of Messina Straits and Bosphorus, the dedication of the passengers routes to the links between railways networks has never been as obvious than in North-west Europe as such networks were not much developed in the big Mediterranean islands nor in North Africa. Also, the passengers sea-routes generally being longer than in the Channel or the Baltic, they occasion a greater proportion of overnight crossings and entail the provision of berths and cabins in the ships plying on them.

Therefore, the passenger ships used before and after the second world war on the longest of these open sea Mediterranean routes- or some of the North Sea ones- were, as far as type of accommodations and service speed were concerned, more akin the bigger liners plying the oceans than of the typical cross Channel mail boats.

The generalizing of the large night car-ferry type on these Mediterranean routes came later than in the North-West European waters and was achieved during the sixties and early seventies. The growth of the road haulage was also a bit delayed in south Europe as compared with the north but was very fast and resulted in the recent appearance on certain routes, such as the Corsican ones,
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of a "combi" type of ro/ro cargo vessel with berths accommodations primarily for drivers but extended to cater for other night passengers. This trend was observed earlier in the Scandinavian peninsula and British Isles/ Continent trade.

The leading of the north European short-sea passengers routes over the south ones can also be observed in the field of the development of high-speed open sea car-ferries, the subject matter of the present lecture. In this field, we need at first to define the above concept: by "high-speed" we will consider thirty knots and over, by "open sea" we will includes crossings in the 50 to 200 miles range, and, of course, a "car-ferry" is a passenger vessel having an important garage area, mainly designed for private cars, with at least one direct roll-on/roll-off access.

In the first part of the present lecture, recent developments in the whole field of high-speed vessels will be presented and, in the second, safety and operational constraints, peculiar to fast-ferries, will be reviewed. Finally, the rational and economics of the use of high-speed car-ferries on European short- but open- sea routes shall be discussed in the third part.
1 RECENT DEVELOPMENT IN THE FIELD OF HIGH-SPEED CRAFT (HSC)

1.1 STATE OF THE ART IN THE VARIOUS CATEGORIES OF HSC

1.1.1 Some preliminary remarks on HSC concept.

The feeling of "high speed" presents an evolutive and relative character: its perception has evolved in the course of time since the Marathon runner in 490 BC; also it varies according the specific drag encountered by a mobile on the land, on the sea or on the air. When a supersonic plane is required to move at more than 1,000 Km/h to be so qualified, a train exceeding 250 Km/h is a high-speed one. For a ship the requirement appears again five time less severe as the usual limit, set at 30 knots, correspond to 55 Km/h.

Indeed, water is the element in which the drag is the strongest for a vehicle, all the more when its surface become choppy under the influence of the wind. The immersed hull drag is the main constraint to take into consideration in estimating the requested power to impel a ship at a relatively high speed in calm sea conditions; yet the brake effect of the waves has also a great influence on the actual service performances. This last remark has its importance within the framework of our subject matter as it explains why a fast ferry encounters more difficulties to reach and maintain an high speed in the open-sea conditions than in rivers, protected estuaries, fjords and coastal waters.

Therefore, the sea/atmosphere interface offers the less favourable environment for reaching high speeds and one may wonder why HSC are developed when it is obvious that, in this element, they would never compete seriously with the air plane. In this respect, it is interesting to recall the international race for high speed at sea, started a century ago, for passenger liners and warships. It shows that the HSC concept has a long history and some bright past achievements.

Before the second world war, this race has resulted, for passenger liners on the north Atlantic run, in "Blue ribbon" records exceeding 30 knots for the French "NORMANDIE" and the British "QUEEN MARY" and "QUEEN ELIZABETH". At the same period, the French escort vessel "LE TERRIBLE" sustained a trial speed of 45 knots during several hours. After the war, despite the building of the dual purpose "UNITED STATES", this race was not started anew since the economical or military interest of high speed over the Oceans, were dwarfed by the advent of the jet plane.
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However, in the intercontinental mass cargo carrying activities, the sea transportation remained practically unchallenged and the relative advantage of speed was again taken into consideration during the sixties with the advent of the container cargo vessel. By the end of this decade, the US ship owning company SEALAND developed a class of container ships, fitted with gas turbines as prime mover and reaching a service speed of 30 knots. Here again, this development was stopped, this time by an economical event, the first oil shock, the direct impact of which on bunker prices rendered unprofitable the operation of such highly powered units.

Also in the sixties, within the naval framework, the speed tactical advantage was again considered for very fast patrol craft, equipped with "sea to sea" or "sea to land" missiles and used to launch a quick raid against an enemy fleet or along a hostile coast. Indeed, the same advantage remains true for nuclear submarines, whilst in the surface air-sea theatre of operation the turn of the balance again appears with the plane.

In the merchant fleet field, despite the severe competition of the plane for the passenger transportation at the turn of the seventies, it become obvious that, in front of the continuous growth of mass tourism, the passenger ship in the guise of the large car-ferry was irreplaceable for short and medium distance sea crossings, in North-West and South Europe, all the more because more and more tourists wanted to bring their car with them. However, with the bunker prices becoming very expensive during most of the decade, the speed of these large car ferries was seldom exceeding 22/23 knots even on the longest routes.

Once again the economic conditions have modified the technological scene and, during the eighties, the oil barrel price, computed in constant US $, has returned to the level experienced before the first oil shock and even below. Therefore, high speed looks again as a profitable proposition. The recent and current technical developments in the fields of HSC have to be appreciated within the changing framework of the economic and strategic constraints prevailing upon the world maritime and naval activities.

1.1.2 The various HSC categories.

1.1.2.1 A long and complicated history

The "non conventional" HSC designs currently in operation or under development, derives from researches undertaken since a long time at the crossing of aeronautic and hydrodynamic sciences and technologies. The "hydrogliders", developed by French and Italian engineers, between the two world wars can be considered as a first step in this R&D efforts. The later developments took place after the war and resulted of further cross fertilisation between air and naval
Section III - Ships, Ports and Safety Issues

architecture and propulsion. The enclosed Figure 1 presents a (simplified but nevertheless intricate) technological lineage tree of the recent and current HSC designs. We will not follow in detail this multifarious line network of evolution but it is worth to recall before this audience what, at present, are the main categories of HSC in operation from which are, or can be, derived fast carferries.

1.1.2.2 Dynamically supported HSC: the AIR-CUSHION VEHICLE and the HYDROFOIL

The prototypes of these two first categories of operational HSC have been developed during the fifties and units of the two types have been in operation from the sixties until now. The two concepts are very different but permit very high speed up to 50 knots. Both have borrowed to the aeronautics their dynamic lifting appliances: engine for the Air-cushion vehicle and wing for the hydrofoil. The aircraft influence is also felt in the light alloy material employed for the construction and in the design of the passengers accommodations and crew cockpit.

The AIR-CUSHION VEHICLE, very often referred to as "HOVERCRAFT", according its first and most known British design trade mark, is sailing on an air cushion contained by flexible rubber skirts and fitted with aircraft type gas turbo-prop engines both for propulsion and lift. It presents an amphibious character, flying just over the sea surface, but taking off and landing on concrete aprons specially built on the beaches. therefore the AIR-CUSHION VEHICLE is a kind of low flying aircraft that avoids the harbour time consuming constraints.

The HYDROFOIL directly borrows to the sea-plane its hull form and its wings but these ones are placed below the craft and permit to lift and stabilize it during its progress on the sea. The drag of the craft is very much reduced by the lifting of the hull but the immersed part of the wings are applying a braking effect. The propulsion is of a marine type, and comprises generally two variable pitch propellers coupled with high-speed diesel engines. Contrarily to the AIR-CUSHION VEHICLE, the HYDROFOIL remains a ship and as such has to deal with harbour constraints that can be troublesome due to the great draft of such a craft when it is stopped. The first generation HYDROFOILS, built in Italy and USSR, were fitted with fixed wings crossing the surface. A more recent US design offers fully immersed wings the incidence of which is permanently and automatically adjusted by a remote control system in order to provide the craft with the requested dynamic stability.
Figure 1: HSC technical lineage tree
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1.1.2.3 Multi-hulls displacement HSC

This category of HSC was pioneered in Norway during the early seventies. Originally, twin-hulls catamarans were developed and this type is still by far the more frequent despite the fact that treble-hulls trimarans have also been developed but mainly as race sailing boats. The hulls of these HSC remain immersed in calm sea conditions; thus they are full displacement vessels. Yet, the distribution of this displacement between two or more hulls enables the naval architect to optimise the design of their respective waterplane areas in order to minimise their drag, whilst offering a wide platform for the arrangement of the accommodations in the ship’s superstructure.

A classical catamaran design offers an efficient base for HSC operating in protected waters but its seakeeping ability appears questionable in choppy ones. This drawback is the reason for which was developed in Australia, during the eighties, several types of large “wave-piercing” catamaran, intended to be used in open-sea conditions. The peculiarity of such a design consists in the central Vee-bow placed between the two hulls well forwards and slightly over the water line. When the catamaran is encountering a wave at sea, this device penetrates the water transforming the craft into a trimaran for a while, thus bettering its sea keeping ability at least in a well formed regularly spaced wave system.

Another design derived from the twin-hulls concept is the SWATH (Small Waterplane Area Twin Hulls) of which the seakeeping ability is very much enhanced by immersed floats connected by pillars to the craft main structure. However, to realise HSC according this idea presents some difficulty: the power required to compensate for the pillars drag is very big and the horizontal stability of the immersed floats only can be obtained by fitting on the floats a variable fins system, the operation of which is permanently controlled by a computer program. Another disadvantage of the SWATH is its important draft, a constraint for shallow water and port operations.

1.1.2.4 Surface Effect Ships and other hybrid HSC

As the advantages and disadvantages of the various categories of non-conventional HSC are different, it was logical to try to combine the firsts and avoid the seconds in developing some hybrid designs. The Surface Effect Ship (SES) appears to-day as the most popular hybrid HSC.

A SES is a dynamic supported HSC that results of a cross fertilization between the Air-Cushion Vehicle and the Catamaran. It sails on an air cushion contained on both sides by twin-hulls and, at fore and aft ends, by flexible rubber skirts. Its seakeeping and route keeping abilities are better than the one of both its
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"parents", whilst at a given power and for a same commercial load, its maximum speed capability on a calm sea stays in between: less good than the Air-Cushion vehicle but better than the Catamaran.

The "FOILCAT", a brand name of the Norwegian shipyard WESTAMARIN, offers an other combination, this time between a Catamaran and an Hydrofoil. Each of the two hulls is fitted with immersed wings.

1.1.2.5 A newcomer the MONOHULL HSC

After several decades of research devoted to non-conventional HSC, we are witnessing, since some years, a comeback of the more conventional solution of a displacement monohull vessel. A single hull presents many advantages for the naval architect: a satisfactory route and seakeeping abilities and enough internal space for easily fitting up on board the propulsive and generating sets with all their auxiliaries. It is a lot more easy to arrange two high power propulsive sets, each comprising a gas turbine and a waterjet in a monohull than in a Catamaran or a SES, non to mention the SWATH. Three such sets can also be considered, a proposal impossible within a twin hull arrangement and requiring a Trimaran for a multi-hull solution.

During the seventies, when the bunkers were very expensive, many efforts were carried out to enhance energy savings by optimizing the hull lines and the propeller design in order to reduce the drag of a conventional ship. At a time of low oil prices, the results of these efforts permit to better the propulsive efficiency of high power machinery, thus minimizing the cost of high speed for monohull and reducing the advantage of the non-conventional solutions. Thus, since the mid-eighties, the economics of the ratio power/speed have become favourable for the monohull HSC designs.

Of course cross fertilization between monohull and non conventional designs have also taken place. Several recent Italian and Spanish monohull HSC designs derive from OFFSHORE racing motor boats and their Vee-shaped hulls are semi-dynamically supported at full speed with the bow completely out of the water. A French shipyard proposes a very slender full displacement hull, the stability of which is obtained by mean of two aft side outrigger fins, each supporting a float.
1.2 COMPARATIVE MERITS OF THE VARIOUS HSC CATEGORIES

1.2.1 Main fields of HSC utilization

The development of the various types of HSC was undertaken to answer different requirements of prospective military and civilian users. Fast patrol boats have the favour of many navies but the sophistication of the non-conventional HSC brings their reliability into question. Therefore, neither Air-Cushion Vehicles—despite their amphibious capability—nor the hydrofoils have encountered much success in their respective military careers. S.E.S are looking more promising for mine hunting and off-shore patrol, specially when they are long enough to obtain an improved sea-keeping ability, allowing the carriage and the operation of a light helicopter. For instance, such is the case for the French prototype AGNES 200.

Finally, it is in the passenger transportation field that HSC have found their main uses since the sixties. Most of the existing units are small fast ferries, used for relatively short-trips in protected waters such as the Norwegian fjords, the Russian rivers, some parts of the Greek archipelago or the Pearl River estuary/Macao/Hong-Kong area. These units generally are not exceeding 40 meters and carry up to 250/300 passengers in aircraft-type seats and cabins. Cars are not carried by these small HSC of the Air-cushion, hydrofoil, catamaran, and SES categories.

Fast Passenger and car-ferries have appeared in the late seventies for strait crossing. The biggest (length 55/60 m) Air-cushion vehicles, of the British HOVERCRAFT or the French NAVIPLANE types, operating on the Dover/Calais route were able to carry more than 400 passengers and 50 to 60 cars. In calm sea conditions, their speed reaches the 50/60 knots range but, when the sea is turning rough, they have to slow and the crossing becomes quite uncomfortable.

Recently, these Air-cushion vehicles have been progressively replaced by the Australian designed SEACAT "Wave-piercing" Catamarans on the strait of Dover. The current SEACAT type is longer- 74 m- but slower- 35 knots than the big HOVERCRAFT. Its passenger capacity is lower-350 seats- but its car capacity - 80- is bigger; therefore, its Passengers/car ratio at 4.38 is better, for a car-ferry, than the one of its predecessor at 6.67.

The seakeeping ability of a wave-piercing Catamaran, is certainly better than the one of an Air-cushion vehicle but on a choppy sea the ride is far from being comfortable. It appears that these fast car-ferries compose a first generation the use of which is somewhat restricted to short crossings, such as the Dover strait, during which the exposure to possibly bad open sea condition is limited.
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to a time short enough to limit the sea-sickness phenomenon to a limited number of passengers.

Big HSC catamarans fitted with Motion Dampening system (MDS) such as the ones ordered by the Swedish owner STENA in Finland or the JUMBO CAT proposed by the Norwegian shipbuilding group KVAERNER, or large SES presently at the design stage in Netherlands and Italy, may provide an answer for the longer open sea routes that are the next step forwards in the development of fast car-ferries utilization. Yet, the monohull appears as a very strong contender since the entry in service in the summer 1993, on the route linking Italian mainland and Sardinia, of the "GUIZZO", prototype of the AQUASTRADA brand name HSC designed by the Italian RODRIGUEZ shipyard, a most experienced builder of Hydrofoils.

1.2.2 Pros and cons of the major HSC categories for the design of fast open-sea car-ferries

The subject of the present Round Table being short-sea shipping, this lecture shall focus on this last generation of fast car ferries able to operate, if possible, on a year round basis, along open-sea routes with a length comprised in the 50/200 nautical miles range. This range covers most of the European passengers routes served by large classic car-ferries, when the short crossings over the various straits is excluded.

At present, most of the relevant HSC designs are at the project or prototype trial stage; accordingly, a comparison cannot be carried out on actual experiences and measurements but on empirical approach based upon the information gained during the long years of development of these designs on the performance of much smaller units. Such exercise may look over ambitious and its results have to be considered as preliminary ones.

Despite these reservations, it was considered worth to present such a tentative comparison the scope of which is limited to the HSC categories, already employed or possibly to be employed to carry passengers and cars on the open-sea. The comparative criteria are the following ones:

* **Speed**: capability to reach, in calm sea conditions, a service speed of 40 knots or more;

* **Energy saving**: relative importance of the corresponding power requirement;

* **Minimisation of slowing-down**: expected reduction of the service speed when encountering rough weather (Two cases: force 3 and force 5);
* **Ride quality:** (with the use of stabilizers and/or MDS when available) for the same two cases;

* **Comfort:** infrequency of motion sickness symptoms among the passenger for the same two cases;

* **Capaciouness:** capability to carry about 400 passenger and at least 100 cars;

* **Easiness:** for steering and operation;

* **Reliability:** more or less frequent maintenance and repair operation;

* **Strength:** for the hull structure;

* **Limited draft:** for access to secondary port facilities.

The method of appraisal of these various criteria is essentially qualitative, therefore the notation from 0 (bad) to 5 (very good) is more subjective than objective. Also, such a multicriteria analysis suppose that the weigh of each is equal when for a given service, the peculiar constraints of which are to be taken into consideration, it is probably never the case. The results are presented in Table I.

The result of this comparison conducted among the various HSC categories, give a clear advantage, for their utilization as fast car ferries on open sea routes, to the monohull category. The wave-piercing Catamaran came to the second place and the SES rank third. It should be underlined here that the performances of the Catamaran -wave piercing or not- may be very much bettered, as far as seakeeping ability and passenger comfort are considered, by the fitting of a reliable remote control automated MDS.

For SES it is fair to remark that no unit of the requested size has been built up to now and that the seakeeping ability of such HSC should be better for a car ferry with a length in the 75/90 meter range than for the present navy-oriented prototypes. In this respect, it is to be regretted that the building in an Italian shipyard of a SES fast ferry for 750 passengers and 180 cars has been stopped in 1992 for financial reasons.

The SWATH concept is very interesting for a cruise ship, but its speed/power ratio appears so uneconomic that the operation of a fast ferry, built according such a design, don’t have a chance to become a profitable venture, even at the present low bunker prices. At least for the time being, the Air-cushion vehicle and the Hydrofoil appear, excluded of the competition. Despite their good performance in protected waters or on short strait crossings, the first one cannot comfortably withstand a rough sea for some hours, whilst the use of the second as a car ferry has never been seriously considered.
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Table I: Comparison of various HSC categories pros cons for fast car ferry operation

2 SAFETY AND OPERATIONAL CONSTRAINTS

2.1 SPECIFIC SAFETY PROBLEMS OF PASSENGER HSC.

2.1.1 I.M.O. building and operational rules applied to these craft

At the time of the appearance of first Passenger Air-cushion vehicle in the United-Kingdom waters, the British marine safety authorities considered impossible to apply to such a craft the I.M.O. SOLAS rules in force for passenger ships and decided, instead, to put them under the Civil Aviation safety by-laws but for the navigation lights that were to be of the marine type and located as
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on a ship. Obviously such a craft "flying" on waves crest is more likely to encounter a ship than an aircraft!

The HSC problem was discussed at length during the seventies in the I.M.O. Maritime Safety Committee and resolved in 1977 by the adoption of the rules contained in a resolution numbered A. 373. These rules were drafted having in mind the Dynamically Supported Craft, and accordingly are also known as "DSC Code". Despite being clearly directed to Air-cushion vehicles and Hydrofoils, the two passenger HSC categories that, at the time, were considered as the more likely to operate outside the protected waters zones, these rules also are applied to displacement types HSC, such as Catamaran and Monohull.

Yet, two important restrictions are imposed by these rules: the maximum number of passengers is set at 450 and the craft shall not operate farther than 100 nautical mile from a refuge port. Also limited is the total duration of a trip and these craft are forbidden to sail under too adverse weather conditions. These restrictions are the counterpart of the exceptions offered by the DSC rules as compared with SOLAS ones for passengers ships.

These exceptions are numerous but the main ones concern the possibility to extensively use for the construction light alloys instead of steel, and the limitation of on-board rescue means and fire fighting systems. For passengers rescue, as for fire fighting, it is considered that the safety is insured by the capability to rely on outside salvage and assistance means, whose intervention can be summoned quickly enough by the regional SAR Centres.

Since 1991, a complete revision of the rules applicable to passenger HSC has been undertaken by I.M.O.. This revision has been finalized, at working commission level, in February 1994, but has still to be approved, later in the current year, by the I.M.O. Maritime Safety Committee. The new document will be called "HSC Safety rules Code". Despite the fact that it is not yet in force, its provisions are more or less already applied to the new craft under construction or at the design stage. It is worth mentioning that the minimal speed considered for applying these new rules to a ship has been set at 25 knots, a limit rather low, when considering the state of the art and the fact that some classical carferries are already reaching a service speed in the 23/24 knots range.

The new rules are very comprehensive and complicated. They introduce a "B category HSC" without restrictions as regards the number of passengers and limitation for the distance of the nearest refuge port. For such units, the safety rules are nearing the ones of SOLAS Convention for passenger vessels as regard the prevention and fighting of water ingress or fire by the means of the board. In certain casualty conditions (for instance, fire or collision ) a disabled HSC should have the capability to reach a refuge port. A new set of rules concerns the suitable binding of seats and other furniture in passengers accommodations.

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in order to overcome the stresses resulting of a sudden slowing down of the craft.

Moreover, taking into account the current rapid evolution in the field of fast ferries, the I.M.O. rule makers have decided to proceed with a new revision of the HSC rules as soon as lessons can be learned from the experience in operation of several new units currently in trial, construction or in order. Such revision will probably results on a further reduction of the expections to the SOLAS rules concerning conventional passenger ships

2.1.2 HCS impact on navigation safety.

This experience also shall prove precious for a matter, the importance of which still has fully to be taken into consideration, i.e. the problem of the insertion of a growing flotilla of HSC on an increasing number of open-sea routes. The coexistence, on the same surface, of craft sailing at 40 knots and over, with the current merchant ships, plying mostly between 10 and 20 knots, and the even slower fishing and pleasure boats, is something to be considered carefully.

The example of the Dover Strait area, where these different types of traffic intensively mixe, can be deem reassuring since no major accident, involving an HSC, has been recorded up to now. This has been attributed to the great manoeuvrability of the various types of HSC, for the pilot of which, an ordinary slower vessel appears as an easy to avoid fixed obstacle. Nevertheless, Dover Stait is not only is the area, in which the maximum density of maritime traffic can be found, but also the one where the traffic control from the shore is the more advanced. Dover MRCC, on the British side, and CROSS Gris-Nez, on the French one, are permanently monitoring the longitudinal Vessel Traffic System (VTS) movements and transverse crossings. However, despite their policing influence, near-misses involving HSC have been on the increase recently. This dangerous trend can be explained by the fact that some HSC pilots are becoming overconfident in the manoeuvrability of their craft.

The likely multiplication of HSC on other open-sea routes, not presently covered with VTS, will certainly create navigation safety problems; such is already the case in the Pearl River/Macao/Hong-Kong area. In these much travelled waters, about forty collisions between HSC and other vessels, have been registered during the recent years. Seven of these events have been severe enough to result in human casualties.

Thus, It is obvious th at the current trend towards larger and faster passenger/car HSC and the multiplication of their crossings have to be scrutinized from the viewpoint of navigation safety. Technically speaking, It can be envisaged to create new and longer VTS extending even to high-sea areas by supplementing coastal radars by satellite relays and GMDSS type radio beacons placed on-board ships.

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From a legal and political viewpoint, the things certainly are more complicated. Yet, it would require, in Europe, very few casualties of the MOBY PRINCE magnitude, involving one (or two) fast passengers ferries, for starting a campaign in the media questioning the responsibilities of the national maritime Administration and the EEC "Policy for a safer sea". It may prove difficult, after a collision having resulted in hundreds of human casualties, to explain to the public opinion why a world-wide compulsory routing exists for aircraft and has not been implemented for sea craft even on a regional basis.

Of course, compulsory high-sea VTS cannot be limited to HSC and has to be extended to all vessels passing in the area. The ships - apart the submarines manoeuvring only in a two dimensions space, some kind of virtual "level-crossings" would have to be arranged for other traffic cutting the HSC tracks, specially by night or poor visibility. Yet, to impose to a ship to alter her route or even slow down, is considered by most captains and shipowners as an infringement to the principle of the Liberty of the sea and an unacceptable limitation to their freedom of decision.

In the coastal waters, at the approaches of ports served by a fast ferry service, the riverine State enjoys already all the necessary power to decide that some lanes at some specific hours should be reserved to HSC. Indeed, the enforcement of such prescriptions specially as regards fishermen, boating and yachting people shall certainly prove difficult.

Nevertheless, the coming into service of a quickly growing number of fast passenger/ car ferries ( and at a later stage of fast ro/ro and container cargo ships such as the Japanese Super Techno-Liner Liner) in the European short-sea trade, will certainly requires from the Authorities responsible for navigation safety, a drastic reappraisal of the coastal state role and the development of its interventions. The "laissez-faire" cannot be a long term solution and the choice would be either to impair the profitability of fast ferries in putting restrictions as regards their possibility to run at full speed in certain zones or to restrict, up to a reasonable extend, the freedom of the other users of the sea.

2.2 PORT CALL CONSTRAINTS FOR FAST CAR-FERRIES

2.2.1 Problems deriving from special features of HSC

Most of HSC designs prevent the use of the current conventional car-ferry terminal installations existing in the main ports of call. Of course, such is the case for Air-Cushion vehicles, the landing of which take place in special aprons on the beach, but it is also true for big Catamarans and S.E.S. due to their large breadth and the height of their garage deck. SWATH are adding to these con-
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strains, their very important draft that prevent the use of numerous berths in secondary ports.

Pure Monohull HSC are more likely to be accommodated in existing car-ferries terminals; however, some designs that includes outrigger floats cannot be directly berthed along a quay side and will required special mooring equipment

2.2.2 Time consuming constraints of port operations.

A fast ferry, running full speed for two hours at 40 knots and over, would lose much of its advantage over the classic type, sailing at about half this speed, if its port operations- boarding of passengers and loading of vehicles, sailing from the berth, exit from one port, entry in the other, berthing and mooring, disembarkation of passengers and vehicles - are requesting the same duration than for its slower competitor. Such a ferry is part of an overall system, of which each other component also should be geared for the speediest operation.

Therefore, the location of the fast ferry terminal in the port installations is very important: a berth with a short and direct access from and to the pass presents much advantages, subject however to easy land connections to the highway and sometimes the railway networks. Mooring and release operations can be shortened by introducing automated equipment. Passengers boarding and disembarkation should be arranged as for Jumbo jets in an airport with the fastest- but nevertheless efficient- security control procedure and machinery.

The main difficulty for the shortening of calls is the rolling-on and rolling-off of the vehicles. The exercise can be made easier when a ferry possesses both a fore and aft accesses since the cars are not loosing time in turning. Such an arrangement is not generally possible for most of HSC; however, it can be considered feasible to provide, in certain Monohull designs, a side access in the fore part of the garage deck. To park the vehicles just outside the terminal to prepare a smooth and swift loading of the cars in the garage should not be too much of a problem as long as the number of cars to be loaded will not exceed 200 units. Finally before the departure of a fast ferry, the cars have always to be fastened, even when the weather looks very nice, in order to prevent the consequences of a possible sudden slowing down.

2.2.3 The advantage of dedicated fast ferries terminal.

All the points just discussed demonstrate that it is desirable, as far as possible, to provide a dedicated terminal for the servicing of fast-ferries at a point of vantage both for sea and land accesses. Only in such a dedicated facility, the various above mentioned port operations can be fully streamlined and optimized. A duration of call in a terminal matching the particulars of given type of fast-
ferry can be reduced to 45 minutes or even half an hour. However, in designing such a dedicated terminal, it should be taken into consideration the probability to receive, after some years, bigger HSC than the currently considered units.

Time saved in the process of embarking/disembarking passengers and cars is very precious as it enhances the global performance of the whole system or, alternatively, can secure a margin for reducing the actual speed during the crossing either to improve the comfort of the passengers or to reduce the energy consumption. What it is really important for the client is the total time he spend for the trip, from his arrival to the embarking terminal to his departure from the disembarking one.

3 THE RATIONAL AND ECONOMICS OF THE USE OF FAST CAR-FERRIES ON EUROPEAN SHORT SEA ROUTES

3.1 WHAT IS BEHIND THE DEVELOPMENT OF FAST FERRIES?

3.1.1 General remark.

Apart the mere attraction of speed, a quite irrational feeling which, however, may be a motivation of choice for some sport-minded clients, it is obvious that the development of fast ferries should be based on more solid motives. Both passenger and shipowner motives have to be considered. Of course the driving forces result from the combinasion of the client requirements, on one side, and the shipowners technical and financial constraints on the other.

3.1.2 The ferry passenger requirements.

From the passenger viewpoint, fast ferries main attraction is the time saving. A lecture, presented at CRUISE + FERRY 93 CONFERENCE by MM. O. VEDERHUS and H. HEIJVELD, has discussed the "Market potential for fast ferries between Italy and Greece". The authors mention in their paper the result of a market research, conducted among a sample of 300 passengers travelling on a conventional ferry between Bari and Patras: 96 % of the respondents answered that they would have chosen to travel with a fast ferry if this could reduce the time of crossing by half and if fares would be equal to the ones of the conventional vessel.

However, this very high percentage was falling to 85% when it was precised that the crossing would have to be done mostly indoors without possibility to walk on the deck. Here, it should be underlined that the Bari/Patras is a "long"
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ferry route of 300 nautical miles requiring a crossing duration of seven and half hours at a service speed of 40 knots. The problem of confinement is certainly less severe for shorter crossings with a duration of two to four hours.

The sensitivity to fare prices has also been tested by this market research and the result showed that, among the customers interested by using a fast ferry, a large majority would be willing to pay 10% more for such a crossing and nearly a third would accept a fare increase of 25%.

Of course, time saving attractiveness has two aspects, shortening the total duration of the door to door travel, including the time spend to reach the boarding port and to arrive at the final destination from the disembarking one, and reducing the exposure to the inconveniences the sea crossing itself, specially the sea-sickness. The first motive is more effective for long crossings, whilst the second appears more valid for shorter ones.

The above general remarks have to be put in the perspective of the various segments of the present car-ferry passenger population: the regular commuters and the occasional passengers, both categories being subdivided in walkers, drivers and bus users. The regular commuters are found on the shortest and generally domestic routes not exceeding a range of 20/25 nautical miles, the hubs of which are large coastal cities. This type of commuting ferry service is very frequent in Scandinavia, but exists also in South Europe, for instance in the Naples Bay, in the Athens/ Pireus/ Saronic Gulf area or on the Bosphorus and Marmara sea.

The numerous fast ferries used in these multifarious services are catering only for walking passengers, whilst car drivers and bus users are using conventional small car-ferries, also carrying lorries and trailers. These car-ferries services connecting island and coastal road networks are generally operated in narrows between the nearest possible crossing points. The introduction of fast car-ferries on such very short routes is not required by the clients nor considered by the operators as the time saving would be too small taking into account the incompressibility of the duration of the multiple embarking and disembarking operations.

Indeed, the occasional passengers also exists on board these commuting ferries but they are mainly to be found on longer routes crossing large straits or deserving big Mediterranean islands, namely Balearic ones, Corsica, Sardinia and Crete. The "walking" passenger sub category, travelling for business, pleasure or family reasons is very sensible to the shortening of the crossing time. Often user of fast trains on land, he is also a client of the aircraft for long distance travel and would certainly consider to use it for short sea crossings.

When such crossings are not exceeding 100 nautical miles this passenger will be attracted by a fast ferry service offering a "city centre to city centre"
service. For farther links with the port hinterland a good direct connection between fast trains and fast ferry services also may offer a surface transportation combination more attractive than the flight if the fare is cheaper and the total trip duration not much longer, if the duration of the trips to and from the airports, the waiting time before boarding and frequent flight time schedule delays are taken into account.

Yet, on these routes as on longer ones, car and bus passengers provide the mainstay of the car-ferry clientele, as the air transportation cannot offer a credible alternative for carrying their vehicles. Yet, most of these passengers are tourists and this traffic presents an highly seasonal character. These individual or group tourists, going to or coming from, their holidays resorts, are the most likely to be interested by the time saving offered by the use of fast ferries on the sea portion of their travel. However, these users of large conventional night car-ferry long crossings are accustomed to find on board many amenities such as restaurants, night clubs, free-tax shops that cannot be provided in the much smaller space offered by fast ferries where the passenger, for safety reason should remain seated during the whole trip.

Consequently, the attractiveness of time saving could be progressively reduced for the fast-ferry passenger by a growing feeling of boredom, even of claustrophobia, when the crossing duration largely exceed three hours. Of course, like in long-distance air flights, meals and drinks will be served and films presented.

Yet, on the longer routes, the competition will come from the large conventional night car-ferry, the internal arrangements of which are at present more and more intended to turn the crossing in a overnight mini-cruise. Only the experience shall test the competitiveness of the fast-ferry with its much larger and luxurious, but much slower, predecessor. It appears that the competition will become very severe for the newcomer on routes in the 150/200 nautical miles range and many observers consider that the fast-ferry maximum attractiveness would be found for crossing lengths between 50 and 150 nautical miles.

3.1.3 The shipowners’ growing interest for fast car-ferries.

Until a recent time, the operators of conventional car-ferry have considered, that HSC designs were not likely to offer them a safe and profitable alternative to the various vessel types they were operating on their day crossings and, all the more, on their night ones. The coming into service of the large HOVERCRAFT able to carry 50 cars on the Dover/Calais route, has not changed very much their opinion as they were considering as marginal its possible impact on their enormous market. The things have begun to change with the advent on the cross-Channel routes of the Wave-Piercing Catamarans of the SEACAT and
Growth Prospects of High-speed Car-ferries Utilization

CONDOR types, despite the teething troubles encountered by these Australian designed and built machines.

The domestic Italian car-ferry operator TIRRENIA has shown its interest in HSC solutions by accepting in 1991 to charter, for a trial period, both one SEC 750, a SES prototype proposed by Cantieri Navali S. E. C., and one AQUASTRADA, a Monohull prototype proposed by the shipyard RODRIGUEZ. Both were intended for the Civitavecchia/Olbia 128 miles route, between Italian mainland and Sardinia. The most ambitious project, the SEC 750, intended to carry 750 passengers and 180 cars at 50 knots has not been completed as previously mentioned, but the RODRIGUEZ steel Monohull, named "GUIZZO" after a kind of flying-fish, designed to carry 450 passengers and 114 cars at 42 knots, has entered in service for the summer peak season, in July 1993 and, was considered as a success since three further AQUASTRADAs have been ordered.

For the service between the Balearic Islands and the Spanish mainland, the domestic ferry operator TRANSMEDITERRANEAN has ordered two light alloy Monohull HSC to the shipyard BAZAN. These units, due to enter service for the 1994 summer season will carry 450 passengers, but only 76 cars, at a service speed of 34 knots, somewhat lower that the one provided for their Italian counterpart.

Another fast but smaller light alloy Monohull ferry is presently under completion by the French shipbuilding Group LEROUX & LOTZ. This prototype, dubbed CORSAIRE 6000, ordered by EMERAUDE LINES will accommodate 400 passengers but only 42 cars. This unusually high PAX/CAR ratio is explained by the fact that the vessel is intended for the route between Saint-Malo in Brittany and the Channel Islands, much patronised during the summer season by non-motorist day trippers. The distance is about 50 nautical miles and a service speed of 32 knots was deemed sufficient. It is obtained with a relatively modest power developed by diesel engines coupled with waterjet.

The biggest North European private ferry operator, the STENA group, has placed in the summer 1993 a Wave-Piercing Catamaran on the Holyhead/Dublin service, a 61 miles route. The interest of STENA for fast ferries was soon confirmed by the placing of an order with the Finnish shipbuilding group FINNYARS for two 124 meters length gas turbines and waterjets propelled Catamaran able to carry 1500 passengers and 375 cars at a full power speed of 40 knots. More economical service speeds also can be obtained by other combinations of the four propulsive sets the two power ranges of which are different.

These units, by far the biggest fast car/ferries ever seriously considered are intended for the STENA Irish sea service, however the may also be placed on other medium to long cross-Channel or cross-Baltic routes. If, due to their mere size and probably also to the fitting of some MDS, these "JUMBO CATS" can
ride smoothly the North- West European often choppy seas, their entry in service would herald a new era of high-speed mass sea transport.

3.1.4 The motives behind the Shipowners' interest.

As can be seen by the above mentioned extensive range of fast car-ferries in service or in order, the large ferry operators are at present very interested by the alternative offered by HSC designs. Most of them are waiting to be sure that the experience in service of, at least, some of these various prototypes will become, after some months, favourably conclusive as regards their mechanical reliability, their seakeeping ability, and the navigation safety. Then, if the answer is positive, the economical and financial cost advantages that the fast ferry presents as compared with the conventional one, shall not fail to have an overwhelming influence on the future technological development of the short sea passenger transportation.

The cost advantages of the fast-ferries in both fields of investment and operation derive from the possibility for a much smaller vessel to offer a daily passenger and car transport capacity, more or less comparable to the one of a far bigger one. This capacity is also more flexible as the sailing frequency is increased. As regards the initial investment and despite the requirement for a very powerful propulsive plant, the cost of a much smaller vessel with streamlined and simplified accommodations may be three to four time less than the one of the conventional unit having the same daily carrying capacity.

Of course, this initial cost comparison has to take into account many variables such as the length of the crossing or the respective speeds of the compared units. In this last respect, it is worth to underline that to increase, for instance, the fast ferry service speed from 35 to 45 knots would result in bettering such a comparison, only if this greater speed results in permitting one daily round trip more. Should this be the case the increase in the fast ferry initial cost will be relatively small as compared with the benefit derived from the extra daily transport capacity. Yet, the required supplementary power investment would be worthless if the sea conditions encountered on the route prevent too often the fast ferry to sail at its maximum speed.

Another important factor to consider is the type of conventional car ferry that the fast one may replace. The investment cost differential will be less if it is a day ferry than if it is a night one. In the lower part of the 50/150 nautical miles range of crossings, the displaced unit would certainly be a day tripper when in the highest part of the said range it would be a far more expensive vessels with cabins and more lavish and spacious public spaces.

In the field of operational costs, bunkering ones will be more expensive for the fast ferry but, for the time being, this disadvantage is reduced in a period of low
oil barrel price. Certainly, the crewing costs are the item that offer the greatest saving for a the fast ferry as compared with the conventional one. A 450 passengers HSC can be operated by 15 to 19 people among which only three Officers. this complement is to be compared with 90 to 120 for a conventional vessel, depending of the importance of the catering service. This advantage is particularly important for the shipowners on European short sea routes where it is generally compulsory to employ national crews on ferries service. To this direct cost advantage it should be added a very important indirect one: a fast ferry crew is not staying overnight on board; thus; no cabin, galley, mess or cafeteria has to be provided for them in the ship accommodations. This of course contribute to reduce the initial cost but also the crew catering ones.

3.1.5 The European short-sea routes for fast car-ferries

We have seen that the various presently developed passenger/ car HSC, which can be considered by the their type of aircraft accommodations as day ferries. They operate, for instance, from 6 a.m. to 11 p.m.. Such craft will find their operational "niche" in the crossings the distance of which is situated between 50 and 150 nautical miles. A further condition is, of course that they rank among the most travelled routes for motorists with a marked seasonal peak. The interest of this last condition is the peak-shaving ability offered by the greatest flexibility of the fast car-ferry as compared with the bigger conventional unit. The Table II and Table III present these selected routes.

CONCLUSION

The above review of the car-ferry routes suitable for introducing HSC demonstrates the very large potential offered to this revolutionary mean of sea transport. Indeed, it appears larger in the north of Europe than in its South, a quite obvious consequence of the relative density of population and degree of economic development. However, the routes in the South are longer as an average than in the North and the rough sea conditions are less frequent in the Mediterranean Basin than round Scandinavia and the British Isles. More and more northern tourists are attracted by the Spanish, French, Italian and Greek beaches and many of them can only be reached by private car or busses after one or more ferry crossing. Therefore the potential of the fast ferry looks good all over Europe.
### Section III - Ships, Ports and Safety Issues

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Table II: The more suitable European short-sea routes for passenger/car HSC services, (North Europe)
## Growth Prospects of High-speed Car-ferries Utilization

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**Table III:** The more suitable European short-sea routes for passenger/car HSC services, (South Europe)
FUTURA - A FAST RO-RO SHIP FOR MEDITERRANEAN COASTAL TRADE

By G. Trincas, C. Closca, R. Nabergoj, J.S. Popovici

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FUTURA - A FAST RO-RO SHIP FOR MEDITERRANEAN COASTAL TRADE

ABSTRACT

In order to make ro-ro ships competitive with respect to land-based transport system, it is mandatory to design them faster while assuring global safety and high performance as well as low manning and operating costs. For any progress at average speed of trailer transport it is needed not only to properly develop hull form and propulsors, but also to decrease ship weight and speed losses in waves. The last problem includes all characteristics of seakeeping development. FUTURA monohull configuration is the first response to all these requirements as a result of an international cooperative research program between the University of Trieste and ICEPRONAV. It has been conceived to produce a prototype matching the north-south Italian route given the waterborne transport of trailers required. Economic studies indicate that a service speed of 24 knots in severe weather conditions is the goal to be pursued to candidate ro-ro ships as a real alternative to road transport mode before the latter reaches saturation. Combination of theoretical calculations and experimental analyses reveals capability of the prototype concept to accommodate driver-accompanied freight market, improving economic efficiency as well as superior levels of safety. A sensitivity study making use of TOPSIS procedure for preference order among a set of design alternatives allows evaluation of techno-economic efficiency with respect to different requirements and constraints posed by driver-accompanied freight market.

INTRODUCTION

The importance of shipping as a primary method of trading and communicating has never been recognized completely by Italian politicians, although necessity to develop a rational and efficient coastal trade system has been recognized by the General Transport Plan since 1986. But the shipping industry has never been known for its high profitability. Consequently, the low return on capital invested and the continual rise in the operating costs are more and more stimulating the development of innovative ships. In Italy the way forward is seen as moving into highly specialized vessels, also as a measure to avoid transfer of older tonnage from northern Europe. Although significance of cabotage activities is continuously growing, at EU level coastal trade still remains the less agreed shipping policy, maybe because Mediterranean countries still apply commercial restrictions to foreign flags.
Nevertheless, here it is assumed that a liberalized market as well as modern and highly efficient maritime services are provided. Duty of naval architects is then to conceive and design the most efficient ships possible in terms of performance and cost with very low environmental impact. As regards ro-ro vessels they have grown only slightly in size, limited by the amount of cargo available and the port dimensions. In spite of improving the efficiency and economics of shipping, ro-ro’s have never been really competitive with land-based transport mainly because of inadequate minimization of roundtrip times. Commitment of innovative ro-ro vessels urges to develop more specialized vessels within a fully integrated intermodal transport system. The objective of this study is to develop a commercially viable ro-ro/trailer ship capable of matching the market requirements in terms of safety and port-to-port schedule. Fast speed, reliability in time schedule, major safety with respect to environmental risks, comfortable accommodation, frequent and safe service with reduced operating costs, are targets to be simultaneously achieved in order to persuade drivers and trailer companies to prefer costal transport. First a market survey was performed to determine proper goals in terms of size and speed. A set of alternative designs has been developed, derived from a concept design of a fast monohull concept vessel with high ratio of slenderness, deemed as optimal from a previous study [1]. Notwithstanding a number of limitations, the analysis of economies of size and speed are to be evaluated at the earliest stages of design together with estimate of unit costs, mainly because they provide an internally consistent set of comparisons to work from. On this basis, evaluation of the competitive vessels by means of a techno-economic mathematical model has given information to rank them according to different goals and preference importance given to main selected attributes.

SHORT-SEA SHIPPING INTO MEDITERRANEAN AND BLACK SEA BASINS

Growth in the number of movements of vehicles and pollution as well as increasing congestion of long-distance heavy traffic compels European shipping industry to introduce and apply new strategies for developing intermodal and combined transport using techniques integrating road, rail, inland, and maritime transport. Recent statistics show an unacceptable number of road traffic accidents and the growing negative effects of pollution and energy wasting of land-based transport in the environment. To lead to a better division and integration of traffic flows among the various modes, while minimizing at the same time social diseconomies and in view of the potential it affords to relieve the congestion which threatens the crowded motorways, the Prague declaration on pan-European transport policy (1991) emphasizes the necessity of structural support for less environmentally detrimental transport modes, like inland waterways and coastal shipping, also because speed restrictions at European level for cars, coaches, trailers and
lorries are expected. Reduction of the circulation of vehicles and of the air and noise pollution from too congested traffic veins through a suitable development policy of intermodal traffic is deemed fundamental to develop a transport system efficient in economic, environmental and social terms. The huge maintenance costs of heavily loaded road systems and the relatively small investment planned in the future for cargo-rail transport system indicate that coastal services will become vital to our countries.

Compared with other modes of transport, the waterborne transport presents a number of advantages. The cabotage has minimal impact on the environment, requires a relatively low level of infrastructural facilities required, and consequently needs much less financial support than that required by roads and rails. In spite of recent release of new ships, Italian coastal trade is still marginal with respect to land-based transport although shipping is a topic definitely of major significance to all the countries in the Mediterranean and Black Sea basins. It is of utmost importance to create and provide for an efficient and technically advanced short-sea shipping which has to be encouraged as a particular mode of transport in view of the potential it affords to relieve the congestion which threatens the crowded motorways and to ensure a favourable environmental impact. In this respect goods moved by trailers are of main concerning, thus compelling a reanalysis of ro-ro ships as an alternative means of transport.

Particular attention is here paid to Italian and Romanian situation. Goods are moved in Italy mainly on road base, up to 90 percent of cargo transport from and to Sardinia and transfer of goods towards first processing plants sited in coastal centres are neglected. Their increase is forecast to double at the end of this century with a saturation till paralyse of motorway network. Italy’s geography and orography gives a further clue as to why powering the waterborne transport is the faster, more viable solution. Analyses show that goods are mainly moved in the north-south direction along coastal infrastructures. The demand for high-value products (electronics, cars, etc.) to be delivered on a just-on-time basis, together with fresh fruits, vegetables and flowers because of their perishable nature, plus other sectors, requires fast shipment.

As regards Black Sea coastal trade some information have been collected from shipping company ROMLINE and from a land transport corporation. Because of the war in former Jugoslavija and insecurity of cargo through Bulgaria, the traffic of trailers from northern and western Europe to Turkey is mainly preferred via coastal trade. A ro-ro shipping line is open between Constanta and Istanbul (192nm) sustained by 3500 dwt ro-ro ships flying Turkish flag with a capacity of 35 trailers. Fare is about 350—400 $/trailer. Two or three runs are performed weekly from each side. Another ro-ro line has been recently activated between Turkey and Russia, namely, Samsung/Soci (270 nm) and Samsung-Odessa (300 nm). Also these ships fly Turkish flag with a capacity of 60 trailers/ship. Fare is about 800—1000 $/trailer. All these ships run at a mean speed of 12 kn and have no accommodation for the drivers. Fares per trailer are higher than in Italian coastal trade. However, they can be justified by the fact that the road-transport costs for a trailer from Constanta to Istanbul is about 1550—1750$ including...
all particular costs and taxes through Bulgaria and Turkey. So the road transport seems to be at least three times more expensive than the waterborne transport in the Black Sea area.

The ro-ro trailer traffic across the Black Sea is not covered by Romanian ships. The present imbalance in the use of the different transport modes can be demonstrated by the following figures: almost 50% of the Romanian domestic traffic is carried by road and 50% by rail, with a very low contribution by waterborne transport. The Romanian ro-ro fleet currently consists of the following ship types (Table I), operating in time charter or bareboat charter contracts. But since ship speeds are too low and comfort on board is totally unsatisfactory, a large margin exists for easy improvements. Consequently, here discussion on innovative ro-ro ships will be mainly devoted to Italian situation, assuming that results could be interesting also for Romanian shipping’s needs.

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<td>4700</td>
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Table I: The Romanian ro-ro fleet

THE FUTURE OF FAST TRAILER WATERBORNE TRANSPORT

The future development of trailer waterborne transport system will be dramatically affected by the evolution of the national and international economy. But an ever-increasing traffic demand can be foreseen. Estimation of traffic quota for potentially acquisition by waterborne transport shows that in Italy 750,000 trailers and lorries might leave the road in favour of cabotage [2]. Since traffic flow along the Adriatic roads is quantitatively similar to the one in the Tyrrenian basin, in the next future the possible goal is to move 1000 trailers per day by Adriatic waterborne transport.

Taking advantage of Italian government subsidies, development has continued in the numbers, size and sophistication of ro-ro ships built in Italy. Main characteristics of some vessels are illustrated in Table II.

The competitive nature of the transport industry compels to new faster ships which must carry payload more efficiently, also in severe environment. Worldwide experience indicates that a successful high-tech design presupposes significant upgrades in design strategy [1]. Our basic assumption is that speed
Table II: Some Italian ro-ro ships since 1988

The slow service speed of ro-ro ships would demand more than one day for a one-way trip on the longest routes. The technique of round trip modelling has been used, incorporating the need to operate within a daily rhythm as a basic condition. The idea about trailer transport network presupposes a complex network of multiple itineraries providing wide distribution between the trading hinterlands served. The shipping lines can release the strict confines of the daily rhythm by precise choice of route using intermodal transport to adjust the number of ports in the itinerary and route length. Given the premises, and some assumptions about handling rates, port access time, etc., freedom of choice about speed/size configuration becomes constrained. Comparative studies show that with costs based on services offered by currently available services, only increased distances between ports convey towards seaborne transport. Therefore, the ship is conceived for relatively long voyages parallel to land routes, thus excluding very short shipping, such as Salerno-Palermo. Service frequency has to be daily with departure time selected to guarantee that most part of voyage is undertaken by night.
Since the percentage growth rate of trailer traffic is uncertain, the realization of size economies for individual ships is preferred instead of conceiving a fleet immediately. The preferred policy is envisaged in gradual introduction of modest size increases and increased frequency of sailing obtained by higher sustained speed. Some preliminary economic studies show that it is necessary to reach a sustained speed of 24 knots if times of road- and waterborne transports are wanted to match, for instance in the route Trieste-Bari (Table III). Alternative proposals have been designed specifically for the carriage of wheeled trailers between the north and south of Italy. Investigation of transport demand calls for a flexible and fast ro-ro trailer carrier, improved version of ro-ro ships built in Italy during last years.
FUTURA - A fast Ro-ro Ship for Mediterranean Coastal Trade

<table>
<thead>
<tr>
<th></th>
<th>Trieste (calm weather)</th>
<th>Present ro-ro (calm weather)</th>
<th>Land-based transport</th>
<th>Fast ro-ro (Beaufort 4-5)</th>
<th>Fast ro-ro (calm weather)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance</td>
<td>336 nm</td>
<td>965 km</td>
<td>336 nm</td>
<td>336 nm</td>
<td>336 nm</td>
</tr>
<tr>
<td>Route time</td>
<td>19 h</td>
<td>15 h</td>
<td>14 h</td>
<td>12 h</td>
<td></td>
</tr>
<tr>
<td>Manoeuvres in ports</td>
<td>1 h</td>
<td>-</td>
<td>1 h</td>
<td>1 h</td>
<td></td>
</tr>
<tr>
<td>Loading/unloading time</td>
<td>5 h</td>
<td>-</td>
<td>5 h</td>
<td>5 h</td>
<td></td>
</tr>
<tr>
<td>Fixed stops</td>
<td>-</td>
<td>3 h</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Total time</td>
<td>25 h</td>
<td>18 h</td>
<td>20 h</td>
<td>18 h</td>
<td></td>
</tr>
</tbody>
</table>

Table III: Time comparison among different transport modes

Since on long coastal routes no existing Ro-ro ship is able to guarantee departures every 24 hours, speed at sea has to assure that the fast vessel can handle the same value as two traditional Ro-ro vessels. The concept has been conceived to emerge as a standard design of fast trailer carrier along Italy’s west and east coasts for the mid-1990s. It strictly complies with the rules laid down in international agreements. It does not represent the perfect ship for every owner. As such, it can be modified as needed by a specific operator purchasing the concept design.

Risk associated with fast Ro-ro ships may be high because of their departure from proven designs. Experimental campaigns are necessary also to validate theoretical calculations which basically constitute a means of achieving innovation and controlling risk in Ro-ro design. Design of innovative Ro-ro ships implies coupled analysis and experiments since very early design stages, since only limited information is available on the resistance properties of fast displacement ships.

NAVAL ARCHITECTURE MODEL

The general approach for the project was first to identify the trade route and market requirements, and then to develop the best design possible to meet these specifications. Preliminary analysis of commercial requirements call for a trailer capacity of between 100 to 200 trailers. A service speed of approximately 24 knots in sea state 5 is established, specifying the Adriatic sea as basic area of operation for investigated ships. Further restrictions imposed by the selected service are a maximum overall length of 210 metres and a maximum draft of 6 metres.

The global design goal was to produce ship designs technically feasible, with as low an initial cost as practical while maintaining overall commercial viability. To the purpose, it has been absolutely necessary to yield reasonable estimates of speed loss in weather routing as well as power and fuel consumption cor-
Section III - Ships, Ports and Safety Issues

responding to those speeds on the one hand, and probabilistic estimates of operating time in bad weather conditions, on the other hand. To this purpose the hydrodynamic items of the design model have been tuned up for a new type of fast ro-ro vessel, based on the results of an experimental campaign carried out at ICEPRONAV.

The present model is structured around several basic assumptions:

* Propulsion arrangement is predefined outside the model itself (main engine output 2,490 kW, two shaft axes with controllable-pitch propellers);
* Features of the hull form are transom stern, high slenderness and low block coefficient;
* Hull structure material is partly higher tensile steel.

Principal components of the model comprise ship parameters, attributes, objectives, and constraints, which uniquely define the model itself and whose numerical values are controlled by the designer. Most part of the design model hereinafter outlined concerns the phase of estimating main hydrodynamic characteristics subject to given constraints (longitudinal strength, intact and damage stability, vibrations, manoeuvrability) and reaching prescribed objectives for selected attributes, e.g. trial speed, service speed, operating time in winter under established criteria of pitch, vertical accelerations, slamming and deck wetness, damage stability, first cost, required freight rate.

Development of alternative ships

The first step in developing the naval architecture model concerned the phase of generating a set of design alternatives built up from a mini-series, which can potentially meet the objectives. These alternatives should be developed freely with respect to the anticipated acceptability. Starting from FUTURA prototype baseline hull form developed according pure heuristic decision-making, two parent forms have been derived in the light of realistic design criteria [1] capable to be transformable to two large families of realistic hull forms suitable to foreseen traffic requirements in the Mediterranean and Black Sea basins. Main characteristics of the parent hull forms indicated as ECONOMY and ECOFAST as well as of FUTURA prototype are reported in Table IV, where PL/W is the payload-to-weight ratio. ECONOMY vessel was obtained by putting emphasis on economy while ECOFAST vessel was the result of giving approximately equal preference importance to economy and trial speed. Each design was developed to the concept level. Some technical areas (particularly hydrodynamics) were analysed more deeply.

It is important during the development of a research project that alternative proposals can be generated and assessed rapidly. They have to be conceived to satisfy all technical requirements, but not to provide more capability or perfor-
Table IV: Main characteristics of the parent ships

<table>
<thead>
<tr>
<th>Ship</th>
<th>L_{CA} (m)</th>
<th>L_{BP} (m)</th>
<th>B (m)</th>
<th>T (m)</th>
<th>C_{F}</th>
<th>C_{X}</th>
<th>C_{WP}</th>
<th>C_{BP}</th>
<th>Trailer (no.)</th>
<th>PL/W</th>
</tr>
</thead>
<tbody>
<tr>
<td>FUTURA(proto)</td>
<td>206.80</td>
<td>188.00</td>
<td>22.00</td>
<td>6.00</td>
<td>0.587</td>
<td>0.878</td>
<td>0.812</td>
<td>0.675</td>
<td>157</td>
<td>0.363</td>
</tr>
<tr>
<td>ECONOMY</td>
<td>198.90</td>
<td>160.80</td>
<td>23.87</td>
<td>5.74</td>
<td>0.584</td>
<td>0.859</td>
<td>0.784</td>
<td>0.649</td>
<td>157</td>
<td>0.429</td>
</tr>
<tr>
<td>ECOFAST</td>
<td>204.70</td>
<td>166.10</td>
<td>22.88</td>
<td>5.91</td>
<td>0.581</td>
<td>0.850</td>
<td>0.770</td>
<td>0.642</td>
<td>152</td>
<td>0.415</td>
</tr>
</tbody>
</table>

mance than specified. All design alternatives developed must provide data in sufficient detail to permit a comparative assessment of performance and costs required to make sensitivity studies and thorough decisions. To this purpose, a systematic mathematical series has been set up around the ‘ECOFAST’ parent form in order to quickly estimate main characteristics of realistic variations of the novel hull concept. A trade-off has been made among different features discussed in the sequel. Based on current knowledge, it was considered that the parameters which have not so high effect in resistance and seakeeping are C_{X} and X_{B}. Thus, while maintaining the midship section coefficient constant (C_{X} = 0.85) the following prime parameters have been varied giving way to practical hull forms:

* L/B from 7.5 to 8.5 in steps of 0.5;
* B/T from 3.25 to 4.25 in steps of 0.5;
* C_{B} from 0.46 to 0.52 in steps of 0.03.

The families of hull forms were obtained very fast by deforming the parent hull forms with their local details through BLINES code [4], while maintaining fixed all other parameters established for the parent hull. The main characteristics of the alternative designs are reported in Table V. The last three digits of the alphanumeric code name designating each ship refer to fixed values of L/B ratio, B/T ratio and C_{B}, respectively.

In the meantime, an experimental hydrodynamic programme on parent hull has been carried out at ICEPRONAV to tune up theoretical computations for resistance, wake field, cavitation, seakeeping and manoeuvering. Speed, range, seakeeping, deck areas, weight, stability, etc., of each ship design are all interrelated and are functions of ship dimensions and configuration. Care has been taken to ensure that the level of confidence associated with each procedure incorporated within a module is acceptable.

The economic importance of the relationship between fuel cost and ship hydrodynamics compels to new research in this field. Criteria for economical ship propulsion are directly coupled to factors such as hull form, machinery and fuel costs. Other criteria to be considered are the quality of propulsion and the
presence or absence of propeller cavitation, noise and vibration. Slender medium-sized ro-ro ships can require dramatic design changes for optimum fuel efficiency.
Hull form

In determining the principal dimensions and appropriate form parameters, a number of restrictions have been imposed, mainly on length and draught because of shipyard and port limitations. Improvement of hull selection has to explore the disposition of cargo space concurrently with form selection. Since high cruising speed in a seaway is the main technical objective, a form with high slendernees ratio has been selected, meant to significantly reduce the primary resistance hump, although it yields slight increases in structural weight fraction. The design water line with fine entrance runs at full beam almost all the way to the transom, resulting in a buttock flow astern. 'V' shaped sections are fitted together with increased freeboard and flare, in order to reduce the negative effects due to more motions exhibited by slender ships with respect to usual hulls, although these features probably induce some extra cost and loss of deadweight.

Since many recent accidents depended on bad turning behaviour, the following design features have been avoided: small GM, high windage, XB near to amidships, aft-body lines with flat sections on the at-rest waterline. Trim by the stern is advised. For a ro-ro ship, the hull depth is a function of clear deck heights and double bottom height.

An early lines plan has been developed in order to derive hull scientific information and to obtain deck cuts and sections used for arrangements. Modifications of initial forms have been performed after analysis of streamflow tests and axial wake surveys performed in the wind tunnel of ICEPRONAV [5]. A soft semitunnel has been sized to accomodate two controllable-pitch propellers. Figure 2 shows an isometric view and the body plan of EF322 hull form.

Internal arrangement

Provision of space and its efficient utilization for ro-ro trailer vessels has a great importance on the general ship effectiveness so that it is necessary to consider alternative layouts which satisfy goals and constraints set by designer since concept design stage. Exploration is focused here on the main areas of the ship. The use of space for stowage of trailers and for efficient and speedy loading/unloading have been optimized. The arrangement devised for subdivision of vehicle decks has fully taken into account safety considerations.

The analysis of a number of layout designs has produced a detailed breakdown of the location of each trailer on the vessel both in terms of its geometric centre and its assumed center of gravity. Thus it has been possible to assess the effect of various loading arrangement on the overall displacement and minimum acceptable stability of the vessel. General arrangement plan of 'FUTURA' vessel is shown in Figure 3.

With a double bottom height of B/10 and imposing a nominal trailer height of 4.5 metres, the resulting depth for the ro-ro ships of the series range between 12.9 and 13.3 metres. Salt water ballast tankage is arranged in such a way to
provide operational flexibility and to minimize any negative effects on the ship’s economic viability resulting from damage stability requirements.

Figure 2: EF322 Vessel

The double bottom under the machinery space, although limited in volume, is available for distilled water, sewage, dirty bilge, and other miscellaneous small tanks. Fore and aft peak tanks are available for salt water ballast to control trim. Potable water tanks are located in a cofferdam aft of the machinery space. Fuel tanks and fuel oil tanks are located in deep tanks situated away from the side shell, so reducing the risk of fuel and fuel oil spill in the event of side damage. High standard accommodation, amenities, and a pilothouse are located forward also to facilitate trim by the stern imposed to increase propeller diameter, to avoid propeller ventilation, and to provide effective protection for the trailers stowed on deck. This avoids a forecastle, offers advantages for the new IMO
visibility requirements, and isolates crew's living quarters and cabins from the noise and vibration associated with the propulsion machinery. The lower headroom of the medium speed diesel plant will significantly improve access in way of the two fixed internal stern ramps giving access to the tanktop and the upper deck with a maximum allowable 12 percent slope.

The midship section consists of a double bottom, a main deck and an upper deck, and alternatively of two longitudinal bulkheads positioned at B/5 with cross floodings or of a so called "C-format configuration". The latter solution improves ro-ro survivability and safety but with a certain loss of payload, which is however less than the loss due to adoption of transverse bulkheads or transverse doors [6].

Figure 3: EF322 Vessel’s arrangement plant

Structures

Ro-ro vessels often have complex structural configurations which are dictated by standard dimensions of trailers, limitations on clear heights, etc. The distribution of hull scantlings for the majority of the stiffening and plating has been
established from the one visible in some Italian ro-ro ships built in recent years. In terms of hull girder bending moment and hence required girder strength, the finer block coefficient results in a very slight decrease in the required strength. Therefore, the usual scantlings can be used safely for this project, providing a hull girder strength in accordance with the requirements of international classification societies.

Higher tensile steel is used for the twin-deck girder. In selecting components of a ship decisions can be taken on the basis of selecting the material and its distribution, that do the most to enhance the ship's overall measure of merit. Longitudinal strength is decisive for these long and slender forms. The maximum stillwater bending moments occur in the hogging conditions because of the low block coefficients associated with high vessel speed.

**Lightship weight and centres**

Weight reduction is necessary to facilitate high speed for a ship intermediate in performance and cost between contemporary ro-ro ships and advanced concepts such as multihulls. Ro-ro trailer vessels exhibit the characteristic of high lightship to deadweight ratio. A strict control of the steelmass becomes necessary through the combined use of mild and higher tensile steels in hull structure, aluminium in superstructure and lightweight outfit materials. Different standards of weight reduction have to be economically justifiable, and multicriterial design approach can assess the trade-off reliably. Weight reduction will improve stability because of reduced top weight, eventually inducing a reduced breadth to achieve the same stability standards.

Estimate of steelmass, outfit, and machinery weights together with estimate of corresponding centres of gravity are derived from expressions given by Watson and Gilfillan [7], which have been revised according to confidential information received by the authors. Different weight subgroups have been studied and different variants within weight subgroups have been examined to determine the influence that changes in the design features might have on the lightship weight. The estimate of lightship weight has been completed through its breakdown into three categories, i.e., ship structure, outfit and machinery. Weight of ship structure includes hull structure, superstructure, foundations for machinery and other equipment. In the case of the "C-format" configuration the calculated light ship weight has increased in the order of magnitude of 5%. Outfit weight is based on a square number method. The machinery weights are obtained from information supplied by the engine manufacturer.

**Stability**

Comprehensive stability assessment is a major factor in hull form selection to make a design viable. Intact stability is considered in terms of maximum permissible KG values measured against IMO intact criterion, for a range of draughts
using two extreme loading conditions. Some limitations on wind area of superstructure arrangements have resulted by imposing IMO weather criterion.

**Flooding**

Recent introduction of more stringent damage stability requirements clearly indicates that contemporary ro-ro ships are vulnerable to flooding. In fact, they are more susceptible to capsize than other ship types. It is thus important to introduce flooding since concept design stage. Instead of applying the prescriptive rules (the IMO 1990 stability regulations) governing passenger-carrying vessels, an alternative approach based on setting targets is applied. Some systematic evaluation seems to indicate that freeboard associated with B/T ratio are main parameters to be included in damage stability assessment. For the time being, the mean line capsize results plot devised by Dand [8] is used as a qualitative target which relates the wave-height non-dimensionalised with respect to flooded freeboard $H_f/F$ with the non-dimensional parameter $GM_f \cdot C_B \cdot T/B^2$. All ro-ro vessels considered are two-compartment ships.

**Seakeeping performance**

The propulsion performance in waves is perhaps the key topic in the overall economy of the design project. The seakeeping ability determines the vessel's operability as well as ride comfort and habitability on board. Since two active folding type fin stabilizers and anti-rolling system are fitted to avoid high roll motions, the analysis is bound to vertical plane responses. Added resistance calculations have been performed in long-crested head seas only, since the most critical motions affecting involuntary speed reduction usually occur in that case. As one of the main goals of the project is to assure time schedule during the whole year, added resistance in waves were calculated for sea-state 5 in Mediterranean seas, area 27 [9]. The effects of added resistance in waves have been conglobated into powering module to evaluate the ability to maintain speed in severe seas. The merit characteristics of the series of alternative vessels are investigated based on evaluation of seakeeping capabilities in severe operating conditions [10]. The merit rating analysis covers the use of seakeeping computations to give a reliable prediction about the basic seaworthiness which the vessel should possess, thus enabling the designer to perform a thorough evaluation of the design alternatives. The following strategy has been designed when performing this evaluation [11]:

- Main factors affecting the operational performance are utilized for a reliable assessment of the vessel's seakindness and seaworthiness;

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* This assessment considers the long-term forecast in the seaway where the vessel will operate;
* At an early stage in the design process the vessel’s merit is determined by the occurrences limiting the vessel’s operability.

Here, the merit rating has been examined by means of an analytical procedure which yields the percentage of vessel’s operating time by applying different seakeeping design criteria. The long-term probability distribution of the seaway conditions has been introduced analytically by an explicit expression and the maximum wave heights have been determined by considering when the operability is unsatisfied at the minimum economical service speed.

The operability limits have been established by assuming criteria of ship behaviour in severe seas [12] as follows:

* Pitch: the probability of exceeding a r.m.s. double amplitude of 2.0 degrees is less than 2.5%;
* Absolute vertical acceleration: the probability of exceeding 0.4g at bridge is less than 5%;
* Slamming: the probability of occurrences is less than 2% at station 0.15L aft FP;
* Deck wetness: the probability has not to exceed 2% at FP.

The first two attributes can be referred to a stable platform requirement, whereas the minimization of the two latter assures high mobility in a seaway. Propeller emergence is not included as the vessel is designed to run at a constant stern draught, corresponding to the full load stern draught.

The mathematical representation of the probabilities for different events at given limits can be stated in terms of Weibull distribution, except for the vertical acceleration to which Rayleigh distribution has been applied. For each event the minimum significant height $h$ among the $N$ heights represents the operability limit for the vessel in a given sea state having a certain mean period $T$ and a significant unit height $H_{1/3}$. This can be stated as:

$$h_i(T) = \min\{H_{1/3}(T)\}_p, \quad i = 1, N$$

Thus, for every vessel at each speed and heading, the significant limits for each of the $N$ operative limits can be obtained. Minimum limit height in previous equation divides the plane height-period into two regions, where the lower region represents the aggregate sea states where the vessel at given speed and heading will operate within assumed limits. The percentage of operability is given by the probability to encounter such sea states $P\{h_i(T)\}$. The percentage of the vessel’s operational effectiveness at different speeds and headings has been obtained for all period groups weighted with the marginal probability of occurrence $M_j$ related to each period range, found by summing up the elements of each column in the statistical sea table. Then, the vessel’s operating time as a percentage is expressed by integrating previous equation, i.e.:
The operating time resulting when assigning equal weights to times correspond­ing to pitch, vertical acceleration, slamming and deck wetness, constitute the score to be included into the rank procedure.

**Powering**

An estimate of the power and propeller revolutions per minute has been made both in trial and service conditions at full load displacement. Resistance evaluation has been based on the statistics provided by Fung [13], corrected according to the measurements carried out for FUTURA prototype at ICEPRONAV. Propulsive coefficients are based on Holtrop’s regression formulae [14] tuned up according to authors’ data base of self-propulsion tests. The propeller design had to meet the 0.75 maximal \( A_p/A_0 \) requirement for a five-bladed controllable-pitch propeller with a hull/tip clearance equal to 26 percent of the diameter. Propeller performance characteristics have been based upon the Wageningen B-screw series introducing CPP correction on the efficiency according to Koning, as referenced in [15]. In addition a mechanical efficiency of 0.97 has been used in determining brake power required. A machinery maintenance margin of 10 percent is used to calculate trial and cruising speed.

Then, the engine power required has been converted, via specific fuel consump­tion assumed equivalent to 140g/kWh, to the amount of fuel needed to complete the loaded leg of the voyage for a week, plus 20 percent margin for emergencies. Fuel required for electrical generation and hotel services is fairly independent of ship speed. It has thus been straightforward to determine the total fuel consumption per year.

**Power plant**

The selection of main power plant to be installed is primarily governed by the need to achieve high power to weight ratio and fuel economy. The main propulsion apparatus is based on four medium-speed diesel engines coupled to two gear boxes fitted to controllable-pitch propellers through two shaft lines. The ship has three shaft alternator sets rated at 1000kW for electric load. They are normally operated with two on line and one on stand by. Manoeuvering is enhanced by three electrical driven bow thrusters, each rated at 800 kW. Air conditioning is supplied by two air conditioning units (2 x 800 kW). Ventilation to the ro-ro decks will be provided by ten axial flow reversible fans.

Thus, it has been possible to determine which of the engines stored in a database of engine particulars are suitable, giving information on output, fuel consumption, revolutions, weight and main dimensions.

\[ h=100\sum P(h,T)Mj \]
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For the time being, the use of the gas turbine in Mediterranean (and Black sea) basin should be avoided because of the non-availability of good-quality fuel at a relatively cheap price at all the possible scheduled ports. In any case, for this ro-ro ship concept of conventional layout, the gas turbine electric propulsion system will always be more expensive when compared with diesel engines of equivalent power. Consequently any proposal to use such a system must be justified by other than initial investment, for example, increased space for trailers and reduced maintenance.

Hull vibration

The fast ro-ro ship will operate at high powers in relation to size and weight, thus causing vibrations to feature significantly. At concept design stage frequency coincidences have to be avoided in the vicinity of blade frequency and double blade frequency. First approximation to the four modes of natural vertical frequencies have been estimated through the virtual masses and inertias, using empirical formulae derived from vibration data collected by Brodarski Institut [16].

Manoeuvrability

Certain rules concerning ship manoeuvrability are to be satisfied since concept design, at least in calm conditions. Manoeuvrability in port must be easy and possible with a minimum of turnings. Use has been made of the turning ability index expressed in terms of Nomoto indices and of the dynamic stability condition suggested by Abkowitz, through evaluation of acceleration and velocity derivatives according to regression analysis equations provided by Clarke et al. [17]. The new ship concept’s high degree of manoeuvrability is promised by the CP propellers and the twin active spade type rudders. The controllable-pitch propellers have been assumed to turn inwards in order to improve manoeuvrability, particularly astern. Since a fast ro-ro vessel has to operate on tight schedules, generally berthing without tug assistance, the fitting of two bow-thrusters and a stern thruster is recommended.

ECONOMIC MODEL

Engineering economics form an essential portion of the project analysis as an advisor for putting orders and a necessary guide for obtaining the optimal free variables of a ship. It is a necessary tool to rank ships according to their techno-economic qualities, preliminary to decision-making procedures directed to the achievement of maximum economic effectiveness of the ship’s exploita-
tion. Thus, decisions on geometric design parameters affecting technical factors are based on search for maximum economic benefit.

The developed model uses an additive cost approach where relationship between economic factors are very simple also for naval architects and single costs are simply summed up. In optimizing economy of a fast ro-ro ship operation incomes as well as costs must be considered. For freight-earning vessels, annual income can be regarded as a function of trailer fare x average payload units per voyage x number of voyages per annum, finally producing cash flow and rate of return on investment.

Among the most commonly used economic cost functions here the required freight rate (RFR), i.e., that rate per trailer at which the present worths of incomes and costs are equal, giving zero net present value (NPV), is assumed as measure of merit.

\[ RFR = \frac{\left( CRF \right) P + Y_o + Y_v}{C} \]

where: \( CRF \) = a capital recovery factor large enough to return the investment plus a reasonable level of profit after tax; it is assumed to have a mean yearly rate equivalent to 13 percent of acquisition price;

\( P \) = capital investment;

\( C \) = average annual quantity of trailers;

\( Y_o \) = annual operating costs;

\( Y_v \) = annual voyage costs.

Capital charges have been evaluated for uniform cash flows and single payment acquisition; they are affected by a straight-line depreciation. Since at early design stages the designer is primarily concerned with differences among alternatives, it is not so important to search for precise and absolute values of costs but to obtain the correct relative costs. Nevertheless, a breakdown of cost information analysis is summarized overleaf.

Construction cost

The total construction cost can be split into material costs, labour costs, and overheads. The approximate method for early total construction cost estimation follows the scheme suggested by Carreyette [18].

The cost of steel construction utilizes the prismatic coefficient instead of block coefficient as a ‘shape factor’, because the former gives a better indication of curvature distribution along the hull and therefore of work content. It decreases linearly with a gradient of \( 1.3 \times 10^{-3} \) per ton of steel weight increment. The cost per ton of outfit is assumed independent of ship size. The cost of machinery has been obtained from information supplied by a manufacturer of large medium-speed diesels. From ‘The Motor Ship’ surveys it has been determined that for ro-ro ships employing medium-speed diesel engines for main propulsion,
the total cost of machinery, including hull engineering, is 2.1 times the cost of
the main engine.
The model of labour cost makes use of man-hour coefficients proposed by
Winkle [19] and tailored according to records obtained by an Italian shipyard. To
convert steelwork man-hours to total steelwork labour costs, an Italian average
wage rate, overheads 100%, and profit 10% have been applied.
Finally, the cost equation comprehensive of profit for the shipbuilder is used as:

\[
\text{Total Construction Cost} = \text{Total Material Cost} + \text{Total Labour Cost} + \text{Profit}
\]

Then, this first cost has been updated because of special equipment incor-
porated in the ship, such as twin-screw installation, controllable pitch propellers,
thrusters, stabilisers, etc. Previous equation allows to immediately evaluate the
revised cost of alternative ships around the parent vessel, by running new
estimates of steelweight, outfit weight and engine(s) power.
The shipbuilder cost includes also cost for design and supervision, plus any
immediate financial charges.

**Operating costs**

The annual operating costs are estimated according to Benford formulations
[20], revised on the basis of confidential information received by the authors.
These costs are independent of the trade routes in which the ship will be
engaged. They include maintenance (manpower, material, overhead) costs, crew
wages and benefits, insurance and port costs, ship and management costs, and
loan repayment.

**Voyage costs**

They cover fuel and oil costs, port and light fees, and miscellaneous port ex-
penses. The fuel cost is based on fuel annual requirements. The voyage costs
are a function of the number of voyages per year.

**PREFERENCE ORDER FOR EVALUATION**

The need for rational decision making is especially significant during early stage
design, provided that the designer has the ability and the synthesis tools to
rationally evaluate the design alternatives he can produce. Here the design
problem is to optimize the dimensions of a fast ro-ro trailer ship for a costal
trade in the Mediterranean basin. In order to come closer to the 'real world' of
the ship design process, all single criterion or single objective procedures have
been avoided. Thus selection of the best possible ship among a discrete number
of alternatives which results to be the best achievable compromise when technical and economic requirements are simultaneously considered, calls for a multiattribute decision-making procedure (MADM). Without the mathematical complexities of other nonlinear optimization methods such as multiple objective decision-making techniques, the MADM procedure is safe of failure in the process of design selection. Use is here made of the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) developed by Hwang and Yoon [21], fully illustrated by Trincas [22] for optimizing propulsive performance of fishing vessels in a seaway. In the present paper it is sufficient to summarize the main successive steps of the procedure.

The attribute values (scores) reached by each alternative ship form the following design matrix D including designs which are technically feasible.

\[
D = \begin{bmatrix}
X_1 & X_2 & X_3 & \cdots & X_N \\
A_1 & x_{11} & x_{12} & \cdots & x_{1N} \\
A_2 & x_{21} & x_{22} & \cdots & x_{2N} \\
A_i & x_{i1} & x_{i2} & \cdots & x_{in} \\
A_m & x_{m1} & x_{m2} & \cdots & x_{mn}
\end{bmatrix}
\]

where: \( A = \) the ith design
\[ X_{ij} = \] the numerical score of the ith alternative with respect to the jth attribute \( X_j \).

The scores are assumed to be known with certainty. Since the various attributes, measured in different scales, must be compared, the design matrix is then normalized by eventual accommodation of a set of weights \( w = (w_1, w_2, \ldots, w_j, \ldots, w_n) \) from inter-attribute preference matrix via hierarchical structures [23], to introduce heuristic judgements of the decision maker (the designer, the owner, etc.). After determination of ideal \((A^+)\) and negative-ideal \((A^-)\) solutions, calculated by introduction of Euclidean distances in the n-dimensional attribute space, the separation measures \( S_{i+} \) and \( S_{i-} \) of each alternative from \( A^+ \) and \( A^- \) are evaluated. Finally the preferred solutions are extracted through ranking among the set of alternative ships by calculating the relative closeness to the ideal solution, defined as

\[
C_{i+} = S_{i+}/(S_{i+} + S_{i-}) \quad 0 < C_{i+} < 1, \quad i = 1, 2, \ldots, m
\]

The process of design selection is basically interactive since the designer might like to vary and refine his preference through sensitivity study. The set of alternative designs can now be ranked according to the descending order.
STRUCTURING THE DESIGN PROBLEM

The relative merit of shorter and longer ships is not so straightforward to be determined. Large ships are cheaper per unit of trailer at sea in terms of construction cost, as well as in terms of fuel and crew costs. Limits are set by various operating diseconomies, including higher costs in port and difficulties in maintaining service quality and efficient operating patterns as ship size increases in relation to the amount of traffic flow. The main diseconomies of large ship operation are encountered in the port sector where at any given handling rate ship costs relatively increase with both size and speed. It is therefore necessary to control the overall balance between economies at sea and diseconomies in port. There are also diseconomies of speed which are a reflection of the fact that the daily costs of a fast ship are greater than those of a slow ship even when it is at berth. An important measure of merit is the payload/weight ratio, which not only depends on the type of the vessel or its speed but also on the length of the route. On long routes, such as Trieste/Ancona/Split/Patras, Civitavecchia/Tunis, Barcelona/Civitavecchia, fast vessels should carry substantial bunkers which reduce the trailer capacity.

A total of 30 design alternatives, i.e., the parent hulls and the series set up from ECOFAST vessel has been investigated. After preliminary technical design of the considered set of alternatives, estimate of their first cost, and of operating and voyage costs have been carried out, thus performing a global economic evaluation. The trade route chosen is meant to represent the trailer traffic from Trieste to Bari. The worths of competitive designs have been analysed under application of different preference requirements. The design requirements and criteria to establish goals for the fast ro-ro ship's performance and capability are the following:

* Ship is to be Italy-built and operated;
* Propulsion is to be by conventional geared medium speed diesels, twin-screw;
* Design draught is limited to 6 metres;
* Range has to assure transit for seven days, plus a 20 percent margin;
* Cost levels are to be taken as appropriate to 1994, with bunker oil at 110$ per ton;
* The income tax rate is 48 percent;
* The economic life and tax life are taken at 15 years, with zero-salvage value and straight-line depreciation;
* The after-tax yield (for RFR) is to be 10 percent;
* Average deployment is 340 days per year.

The MADM model evaluation combines naval architecture and economic targets, consisting of the following seven attributes: calm weather speed ($A_1$), service speed in a given seaway ($A_2$), operating time in winter ($A_3$), safety against
capsize in damage conditions ($A_4$), payload-to-weight ratio ($A_5$), acquisition cost ($A_6$), and RFR giving zero NPV ($A_7$). The first five attributes are benefit criteria, the others are cost criteria. Other naval architecture features, i.e., longitudinal strength, intact stability, hull vibration, and manoeuvrability, are used as first level constraints to produce feasible designs. Alternatives which do not meet these constraints are dropped.

Given all the above, the task is to find the best possible vessel among the competitive ships. Preliminary calculations of each attribute have been performed off-line. The attributes have been assumed independent, which allowed to break down the evaluation of multiattributed alternatives into single evaluations.

Results of powering calculations are given in Table VI, where PB(trial) and PB(tserv) are referred to main engine power required to reach 28 knots and 24 knots in trial and service condition (sea state 4-5), respectively. As the installed power is varied by changing the number of cylinders in discrete steps, fuel consumption per year has been evaluated by modifying obtained power values on a per-cylinder basis. Both the main engine and the generators use the same heavy grade fuel. The propellers have the same diameter for all the ships ($D = 4.7$ m). The payload has been considered independent of the variation of speed in the sense that the bunkerred fuel remains the same for all the alternative designs.

For every alternative design the absorbed brake power required to run at 24 knots in sea state 5 is always less than the power necessary to reach 28 knots in trial condition. This allows some margin if one considers uncertainty in predicting added resistance when using linear seakeeping theories. The last two rows in Tables VI indicate the trial and service speed attainable by each candidate vessel with the same propulsion system fitted, running at 90 percent MCR. The obtained values can be considered as merit indexes for ship speed requirements, being aware that for the smaller ships installation of such engines would imply modifications in internal arrangement and subdivision.

As far as seakeeping is concerned, factors affecting operational effectiveness are reported in Table VII in terms of percentage of operating time when winter sea state environment in East Mediterranean area is specified, and maximum permissible values are introduced according to previous discussion. The proportion of time entering in the preference merit procedure is obtained from the equiweighted sum of the scores reached by the four seakeeping attributes.

All the ships of the series are assumed to run at almost the same draught ($T = 5.97$ m). Piecemeal deformations of hull shape, such as minor variation of block coefficient, have very little effect on the operating time as a result of little variation of ship motions in the vertical plane. Analysis of results show the major importance of changing the length-to-beam and beam-to-draught ratios, and consequently the waterplane area coefficient and the vertical prismatic coefficient. Larger L/B and B/T ratios are seen to increase all the seakeeping features and then the operating time, as a consequence of the lower excitations from the waves and of the larger added mass and damping coefficients as-
## Section III - Ships, Ports and Safety Issues

### Table A

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### Table VI

Associated with increased displacement. Wider beams give lower levels of pitch motion and vertical acceleration. Slamming is poorly penalized because of sufficient draught established. A large forward waterplane gives favourable changes in both absolute and relative motions and in the probability of slamming.

Damage stability is accounted for by transforming position of each candidate vessel with respect to Dand's capsize mean line into safe and unsafe target. Unsafe ships are cut off, while increasing numerical values are assigned to growing qualitative attribute (safety against capsizing in damage condition) by using the 'bipolar scale' introduced by MacCrimmon [24] for benefit attributes.
**FUTURA - A fast Ro-ro Ship for Mediterranean Coastal Trade**

<table>
<thead>
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<td>23.00</td>
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**Table D**

**Table VII**

as illustrated in Table VIII.

Once the building cost and the annual operating costs have been determined, the economic model which takes also into account depreciation and taxes, is applied over the economic life of the ship. In this way, the required freight rate giving zero NPV is iteratively determined as an operation success indicator, assuming a load factor of 70 percent for all the alternative ships.
The total invested capital is assumed to be borrowed from a bank or as a subsidy from government at a specified rate of interest. The return after tax to the owner is determined taking into consideration the loan period as well as the period and the amount of down payment. The repayments are paid in equal annual amounts, each consisting of the interest payment and the annual share of the loan quantity.

**SENSITIVITY STUDY**

Once the attributes have been described in numerical form, the designer has to rationally evaluate the design alternatives. His main duty is to assign weighting factors which reflect the relative contribution of each attribute to outranking relation. The weights serve as scaling factors which reduce all the score scales to a common scale of measurement. An over-all score defined by the relative closeness to the ideal solution $C_i^+$ may be assigned to each multiattribute design. Its value represents the relative worth of each alternative ship in the outranking relation.

In our case study designs EF112, EF113, EF331, EF332, and EF333, have been dropped on the basis of basic requirements and first level constraints. Results from damage stability analysis have shown that ships EF111, EF211, EF212, and EF213 are unsafe. The design matrix have been thus reduced to 21 alternatives. The normalized design matrix reads
The TOPSIS algorithm can assign the inter-attribute numerical weights (cardinal) allowing the designer to reach synthesis, that is, the capability to rank the alternative ships according to the descending order of closeness to the ideal solution. Different weights have been applied to the seven attributes in the normalized matrix simulating eventual preferences of the decision-maker (see Table IX). Case (a) equiweights between naval architecture and economic attributes; case (b) accommodates weak importance to economics over technical qualities; case (c) accommodates dominance of economic attributes.

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<td>(a)</td>
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<td>0.050</td>
<td>0.200</td>
<td>0.100</td>
<td>0.100</td>
<td>0.300</td>
<td>0.100</td>
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<td>(c)</td>
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<td>0.075</td>
<td>0.200</td>
<td>0.300</td>
<td>0.200</td>
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Table IX: Vectors of weighting factors
Consequently, the following preference orders have been yielded:

Case (a): EF311, EF131, EF221, EF321, EF121, EF312, EF231, EF313, ...
Case (b): EF131, EF231, EF321, EF221, EF121, EF311, EF132, EF322, ...
Case (c): EF131, EF231, EF321, EF221, EF132, EF331, EF322, EF232, ...

It seems that vessels EF131, EF321, and EF231 are the best solutions according to the rank. They present lower power absorption also in waves, high operability effectiveness, and low required freight rate. The main drawback seems to be the relatively low payload-to-weight ratio thus calling for lighter trailers. It results that the longer ships are to be generally preferred although they are more expensive if the same propulsion system is fitted. Then the question is whether there are sufficient advantages associated with the bigger ships to justify their selection. A preliminary answer can be given by examining the scores reached by the best candidate designs for the attributes considered. The figures from the naval architecture model show that the long hull forms have lower fuel consumption and a higher service speed in a seaway than the short ships. Moreover, for target speeds the longer ships present lower motions and dynamic effects, giving higher effectiveness in severe weather conditions. Among the others, the latter induces substantial advantages in operating costs, on the basis of days lost at sea, and lower involuntary speed reduction.

CONCLUDING REMARKS

The basic aim of this paper is to propose to some prospective shipping company of shipowner a fast ro-ro ship design for maximizing the profitability of trailer traffic flow along Mediterranean routes. The ro-ro ship concept suitable to the fulfilment of potential for seaborne trailer transport has been developed after application of a MADM procedure. It has been reviewed and optimized through systematic calculation on a 'ad-hoc' set-up series, making it faster while guaranteeing global safety, high performance, and low manning and operating costs.

Further improvements from the economic, technical, and commercial viewpoint, depend on a technological jump based on sound research. In the meantime, a prototype of FUTURA concept has been submitted to systematic experimental studies (performance prediction, powering in waves, seakeeping, manoeuvrability) at ICEPRONAV, in order to validate analytical and numerical computation tools as well as check the range of applicability for future ships of this type.

It is difficult to forecast the long term development of the ro-ro trailer vessels, because this depends mostly on development of ro-ro traffic, transport policy in EU, competition with road-based transport. The harbour system remains the key flowing junction in the intermodal transport system. Maritime services have to offer frequencies and capacity adequate to traffic flows, i.e., carriers should
FUTURA - A fast Ro-ro Ship for Mediterranean Coastal Trade

...group into intermodal companies to provide efficient waterborne conveyance. Nevertheless, a number of elements which form the basis for the design of the ‘ro-ro trailer vessel of the future’ have been enucleated. The size of the vessel selected should be later subject to closer scrutiny, but it will be usually not changed to a great extent. The fact that such ships do not currently exist does not mean that they can be discarded ‘a priori’. In fact, the analysis has pointed out that slight increases in acquisition cost are more than balanced by superior performance and effectiveness as well as by lower life-cycle costs.

ACKNOWLEDGEMENTS

The authors wish to gratefully acknowledge the financial support received from the University of Trieste and from the Research and Design Institute for Shipbuilding of Galati. Italian authors are indebted to technical staff of ICEPRONAV for fruitful discussions on design of experiments, to Mr. B. Fontanot and Mr. Eng. R. Prever for their contribution in designing and drawing hull forms, and to enthusiastic people from design offices and shipyards who gave them necessary information to build up the design model.
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ARE RORO FERRIES SUBSIDIZING LOLOS?

By E. Heirung

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ARE RORO FERRIES SUBSIDIZING LOLOS?

Ship measurement and port tariffs had some kind of logic in the last century when admiral Moorsom introduced his rules - perhaps. Ever since they have become increasingly illogical and even controversial. However, since the stevedoring and terminal handling costs were many times higher than the ship and cargo dues levied by the port authorities, the latter costs were paid little attention.

When the seafaring countries agreed upon the 1969 convention on new rules for ship measurement, it was not particularly aimed at port tariffs - it should be a fair change eliminating the abuse practiced, especially by the open shelter-deckers which also influenced the manning rules.

Today stevedoring costs have been reduced, relatively speaking, and for selfdrive roro ferries the stevedoring costs are practically nil. For these operations the ship and cargo dues are relatively important.

WHY PORT DUES?

It is quite natural that ports invoice the vessels for the use of the port facilities - capital cost, wear and tear and administration. Up till now this has usually been linked up with the ship volume - Gross Register Ton (GRT) or Net Register Ton (NRT) - and charged per 24 hours. In some countries the port dues are viewed as a source for financial income for the governments (Africa, the Philippines), some ports are run on a commercial basis by private companies charging as much as the market can bear, and some countries subsidize their ports generously in the belief that this will promote trade, industry and welfare.

However, many ports balance their dues to cover their expenses, and this is the case in Norway. We even have a law based on the cost centre principle, stating that port services should not subsidize each other.

The new rules, which will be effective July 18 1994, are also based on ship measurement/volume and are more logical than the previous ones as an expression for the volume of the vessel. The superstructure, the funnel and even masts, are measured and included in the new gross tonnage. What relevance this has to port dues (and manning) is another question.

Ship dues and cargo dues are levied separately and with little reference to the use of port facilities. Ship dues are paid per 24 hours, even for ferries staying only one hour in port. Cargo dues are the same for cargo staying 2-7 days in
Are Roro Ferries subsidizing Lolos?

port, discharged/loaded from/to lolo vessels, and for cargo from a roro vessel leaving the port after half an hour.

If a 1599 GRT general cargo vessel, roro or lolo, brings in 1500 tons import cargo, loads 1500 tons export cargo and stays less than 24 hours in port, the ship dues in the port of Oslo will be about NOK 2700, and the cargo dues will be about NOK 40,000. Under the new measurement rules the GRT will increase in average for lolos with 130% and for roros with 160% for vessels calling Oslo, but this will have only a marginal effect on the ratio between the ship and cargo dues.

Shipowners are protesting vividly against the increase in ship dues, but there are not so many protests against the cargo dues - perhaps because these are very often paid by forwarders and covered in the total door/to door freight. Further, the forwarders make a profit on adding a percentage to the cargo dues which are equal for all user of the port.

It is strange that port authorities continue to practice such an illogical and counterproductive tariff system, but it is even stranger that roro and ferry operators do not scream louder. The same applies to users of roro services.

The natural thing would be for vessel and cargo jointly to pay for the use of the port facilities - quay front plus sq.m port area - and for the time occupied. This is quite easy to introduce for operators with their own terminals, these could pay a monthly rent irrespective of the tonnage and passengers handled. For common user berths a fair solution might be more difficult to establish, but the existing system is wrong and counterproductive - it even promotes inefficient modes of transportation. An example from Oslo will exemplify this:

One section in Oslo handling lolo traffic - Ormsund - has about 40,000 sq.m port area. Yearly traffic is about 60,000 TEUs corresponding to about 40,000 lifts and 400,000 weight tons (1992 figures).

Gross ton per year is about 900,000.

| Yearly ship dues | about NOK 800,000 |
| Cargo dues paid by the customers | about NOK 5,600,000 |
| Total income to the port authority | about NOK 6,400,000 |

The two container cranes charge NOK 135 per lift. It is calculated that the container cranes show an annual deficit between NOK 3 and 4 million based on normal depreciation, reducing the contribution from this section of the port to about NOK 3 million. Adding some storage rent, the yearly income is NOK 4 million or about NOK 100,000 per da.

An other section of the port - Hjortnes - handles ferry traffic to Germany and Denmark - about 30,000 sq.m port area.
The yearly traffic is about:

- 600,000 tonnes, all ro-ro, selfdrive and articulated;
- 800,000 passengers;
- 180,000 passenger cars;
- 3000 buses;
- 15 million gross tonnes.

The income picture is:

<table>
<thead>
<tr>
<th></th>
<th>NOK</th>
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<tbody>
<tr>
<td>Ship dues</td>
<td>7.8 mil/ion</td>
</tr>
<tr>
<td>Customer dues</td>
<td>14.8 mil/ion</td>
</tr>
<tr>
<td>Total</td>
<td>22.6 mil/ion</td>
</tr>
</tbody>
</table>

There are no costly container cranes, and if we assume that the wear and tear is about the same, this gives a gross revenue to the port authority of about NOK 700,000 per da.

If Norwegian law was followed - applying the cost centre principle - and no cross subsidizing was allowed - the port and cargo charges per TEU should be increased by about NOK 200 and the crane charge by about NOK 80 at Ormsund.

The charges on TEU basis should be reduced by about NOK 200 at Hjortnes, giving a difference in port charges including crane use of about NOK 480 between the two sections of the port.

Compared to freight rates Norway-Germany and Norway-Denmark, which are about NOK 2000 per TEU in round figures, this would definitely have a marked influence on the customers’ choice of transport mode.

As the port of Oslo is short of space, a switch from lolo to ro-ro would also benefit the port and the city.

Comparing a 300 TEU lolo vessel with a 150 40’ trailer ro-ro vessel (equivalent to 300 TEUs) the price per slot on the ro-ro vessel is more than three times that for one on a lolo vessel - roughly USD 100,000 compared to USD 30,000. In addition comes the need for trailers: road trailers or slave trailers. The capital cost of a ro-ro vessel is much higher than for a lolo vessel. On the other hand, time in port and port installations needed are simpler and cheaper, but most port authorities try to deprive the ro-ro owners and users of their rightful bonus for efficient port handling.

I would also give a reference to the Philippines. The archipelago should be ideal for ro-ro operations, but with a few exceptions, this technique has not yet been introduced. The reasons are mainly the following:
Are Roro Ferries subsidizing Lolos?

* Liner shipping has been strictly regulated. The franchising system has not permitted owners to utilize time saved in port (this has been changed recently);
* Vessels and cargo pay the same dues irrespective of handling method;
* The free storage time is long;
* The stevedoring and terminal handling tariff (arrastre) for breakbulk, lolos and even selfdrive loros, are about the same.

These rules and practices have constituted severe hindrances to technological progress in the inter-island shipping in the Philippines. Fortunately the new government is working hard to implement productive changes. A consequence of this is that the cargo freight level in the Philippines is about the same as on the North Sea for comparable routes, in spite of a ratio in wage level of about 1:30.

When coastal roro is nonexistant in India, it is not only because of trade union rules and practises, but also because of counterproductive port tariffs and custom routines. When the World Bank grants huge sums of money for modernizing ports in the developing countries, these factors should be given much more attention than what has been done to date.

**NEW MEASUREMENT RULES - THE 1969 CONVENTION**

The new convention should establish fairer and more logical measurement rules, and at least it would stop the unfairness created by the open shelterdecker concept. In a hearing paper, the port of Oslo states:

*Though the aim is to keep the sum of the harbour authority’s income unchanged, a comprehensive redistribution of the shipping fees is expected caused by the composition of the fleet using Oslo harbour as to vessel types and ages. However, insofar as the 1969 convention supplies correct directions for measuring vessels, and insofar as GRT is a relevant basis for calculations, the new distribution of the burdens between the shipping companies will be just.*

In port context the new convention represents little new, only a change in irrationalities. When the basics are absurd, original results are incurred! There is no fairness.

As stated before, ship volume is the wrong basis for levying port dues, and it is strange that port authorities maintain this illogical tariff system and that
otherwise efficient roro owners and users continue to accept it. Payment should be based on the use of the port facilities.

It should also be clearly stated that the value of the port area should be brought into the picture - I concede that this is a very difficult question, as it has to be fair compared to how rail and road pay for their use of land.

In the case of Oslo there is one section of the port with a market value of about NOK 5 million per da. The interest on this could pay for the difference in trucking of the cargo to/from nearby ports if the other sections of the port of Oslo cannot cope with the potentially added traffic demands - this problem could most probably be solved by a change in the tariff with the consequential move from lolo to roro.

Although the new measurement rules are more "fair", they also favour the lolo vessels as the deck cargo is not measured. Short sea lolo vessels might have three tiers of containers on the weather deck while roros can only carry one tier. For lolo and roro vessels with equal cargo capacity (short sea), the roro vessels might easily measure 100% more than the lolo vessels. No credit is given for the faster turnaround in port and less use of port area for the roro vessels.

Norwegian ports are introducing the G factor equivalent to (length + breadth)x draught, masterminded by the Norwegian Ministry of Fishing. This factor is not more fair than the previous ones, and might turn out very different for the various types of vessel calling the port. One port has introduced a 75% reduction of the G factor for roro vessels and 50% for lolo vessels.

Another port in the Oslofjord area, being desperate to attract cargo to their underutilized port installations, has announced that they will only charge cargo dues, down to one container, and no ship dues!

Slow-working, conventional vessels are also subsidized by modern vessels as the following example will show:

LOADING NEWSPRINT IN OSLO

Some time ago a Chinese, multipurpose tweendecker with ordinary derricks loaded about 10,000 tons of newsprint in Oslo. Because of the inefficient gear and the general arrangement of the vessel, the loading lasted more than ten days.

From this loading the port authority had the following income:
Are Roro Ferries subsidizing Lolos?

* Berth charges: 10,000 grt à NOK 0.50 x 10 days  
  NOK 50,000
* Cargo dues: about NOK 8 per weight ton  
  NOK 80,000
* Total dues to the port authority  
  NOK 130,000
* Income to the port authority per day  
  NOK 13,000

The Port of Oslo is regularly frequented by Star Shipping vessels - open bulkers with two gantry cranes, size approximately 30,000 grt. These vessels pick up part loads of about 10,000 tons of newsprint. Because of efficient loading gear they manage to complete the loading in one, maximum two days. One day - 24 hours - is always possible, but there are union and environmental restrictions on night work in Oslo. For this vessel the picture will be as follows:

* Berth charges: 30,000 grt à NOK 0.50 x 2 days  
  NOK 30,000
* Cargo dues: about NOK 8 per weight ton  
  NOK 80,000
* Total dues to the port authority  
  NOK 110,000
* Income to the port authority per day  
  NOK 55,000

The Star Shipping vessel was slightly bigger than the Chinese vessel, but used the same berthing facility. Why should the modern vessel, which by any comparison is a much safer vessel than the old Chinese multipurpose vessel, pay more than four times as much for the use of the port facility?

Not long ago a Norwegian shipping official said that he would suggest that ship measurement be ruled out as it is misleading. This is controversial as it will make a number of people redundant, but there is much sense in it. The ports should give data on the cargo handled and number of calls.

It is also worth noting that manning of ships has moved away from being based on gross tonnage and is now usually based on actual safety manning needs. In many ports even the tugs use deadweight instead of gross tonnage as a basis for their charges.

SAFETY

Mr. Ir. E. Vossnack of the Netherlands Foundation for the Coordination of Maritime Research states bluntly: *Gross-tonnage rules are frustrating the development of better, safer ships.* This because the use of gross-tonnage measurement have a negative effect on the reserve buoyancy of vessels, which means *safety.* Further, it is rather unfair that the new tonnage rules also give an incentive to reduce crew quarters.
CONCLUSION

By practicing wrong tariff systems the ports not only favour lolos at the expense of roros, they also reduce the competitive edge of roro traffic and thereby indirectly strengthen road and rail traffic in short sea operations, hurting their own interests.

Because of this, the ports should change their tariffs in cooperation with the ship owners. This can be done without damage to the profitability of the ports - it could even strengthen their economy.

Generally, the gross-tonnage measurement should be given up as it leads to wrong conclusions. The new convention is actually outdated before it is ratified.
SAFETY IN A MODERN PERSPECTIVE

By J.A. Stoop

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SAFETY IN A MODERN PERSPECTIVE

1 INTRODUCTION

Shortsea shipping is favoured not only for its economic benefits. On a European level it offers promising alternatives to congestion on highways and railways and has favourable characteristics. The advantages of shortsea shipping are described as; no necessity for very high additional infrastructural works, an almost unlimited capacity at sea and only limited distain on scarce space in and near ports, a high degree of safety and a relatively friendly impact on the environment (Jacobs 1992).

To maintain the advantages some effort must be put into the design and management of short-sea shipping lines. The method of achieving the advantages is not self-evident, therefore a safety management policy should be developed. Safety is at a premium, in addition to the demands of cost reduction developments in the sea going shipping industry. This contribution focusses on one of the critical situations of a vessels' voyage; sailing in dense traffic areas, in and close to ports. From the beginning, the policy of a safe and sound passage has been embraced by Pilotage and VTS. However, the situations in which and the way in which this task has been performed, have been changed continuously. Each change creates new and sometimes contradictory requirements, which have to be incorporated into operational practice. A number of developments have had their influence on the future of Pilotage and VTS and these will pose problems in the execution of a safe and sound passage in sight of port.

Short-sea shipping is included in mainport developments in order to provide feeder lines to hubs and inland waterways networks. These networks put logistic and managerial constraints on shortsea shipping with respect to capacity, punctuality and efficiency.

Strict time management, local and regional planning considerations, reduce the margins for those who have to warrant the safety in operational practice. Mainports, by their nature, are complex and large-scaled and may suffer from unforeseen interactions and tight couplings which may result in accidents (Perrow 1984). Moreover, mainports and networks must be integrated with regional developments, putting external constraints on their operational practice with respect to environment, safety and sustainability. Experience in aviation and railways, indicates that mainports and transportation corridors are vulnerable if safety is not taken into account in their design or guaranteed during operational practice.

Research findings indicate that smaller vessels may be exposed to an increased risk in dense traffic areas which are under pressure in order to maintain produc-
Safety in a Modern Perspective

tion. This can result in them exceeding their capabilities, irrespective of weather and sea going conditions. Pilotage and VTS play a significant role in quality control over the traffic flow management and may also serve as a facilitator in order to maintain production under conditions of a congested traffic flow. Future requirements on the role and function of pilotage and VTS raise additional questions both about the role of fairway and harbour authorities and of the required levels of skills and responsibilities of Vessel Traffic Service operators, pilots and of crews on the bridge.

2 TRANSPORTATION IN PERSPECTIVE

The dominant question is not if safety can be ensured, because everybody will respond in a positive manner. More pertinent is the question: how is safety weighed against other factors? Who pays the costs, who reaps the benefits? Two developments which dominate the perspective of transportation in The Netherlands will be discussed: Rotterdam as a Mainport and the 'Nederland Distributieland' concept (The Netherlands Distributing Country).

Mainport Rotterdam

Rotterdam reveals itself as a Mainport, one of the most important entrances to Europe with a major transit function. Is the 'mainport' only a label, a selling argument or is it a new dimension in the development of ports, with inherent challenges? Rotterdam is not on its own, Schiphol airport also reveals itself as a mainport.

Is it possible to define any 'mainport' characteristics?

* Large-scaled: there is a considerable change in volume. Substantial growth is present, disproportionally distributed between the various sectors of the ports activities, thus requiring new and substantial infrastructural developments;

* Tightly coupled logistic chains with a complex interaction, 'Just-in-Time' tuned to a quick throughput of goods, with as little trans-shipment as possible. There are strict managerial requirements on capacity, efficiency, punctuality and synchronism;

* Multimodal nature. The input and throughput are based on the availability of various transport modes: roads, railways, shipping or multi-modal systems which have yet to be developed;

* Support by high-tech applications such as information technology, automation, telematics, EDI, decision support systems and automated traffic control systems;
Section III - Ships, Ports and Safety Issues

* Complex decision-making, characterized by numerous, autonomous stakeholders such as shipowners, port authorities, forwarders, national and local authorities and trade and industrial organisations. Decision making has a long term emphasis and effects a balance between numerous aspects and often conflicting interests;

* Integration within regional development and planning schemes; economic development; social aspects such as environmental issues, external safety, sustainability and social climate.

In this mainport concept, a gradual shift occurs in the roles and positions of the stakeholders. The manager of the infrastructure is no longer passive and facilitating, but active and therefore puts constraints on both customer and user. This is in order to optimize his returns on the huge investments, under conditions of environmental and qualitative demands.

At the same time, the governmental organizations step back from a number of administrative and enforcement responsibilities with respect to tasks such as Pilotage or Air Traffic Control and restrict themselves to a supervisory and conditioning role. The responsibility for Quality Assurance is put onto industry itself by the introduction of a system of certification.

In the mainport concept, three developments are becoming visible which have a bearing on safety aspects:

* The tight coupling between processes requires careful tuning. The assurance of interconnections becomes important; in addition to capacity, punctuality becomes a process parameter. The production pressure to deliver 'Just-in-Time', puts pressure on traffic flow management to make the harbour in time, irrespective of aggravating circumstances, such as sea swell, poor visibility or strong wind. It becomes increasingly important to maintain the traffic flow;

* Volume growth means more vessel movements: the traffic intensity in the approach area is increasing and will have to be managed with proper safety measures, also under aggravated circumstances. The probability of accidents shortly before a traffic flow becomes congested, is increasing. High traffic intensities put increasing pressure on the separation of traffic, the traffic control facilities, the capability and proficiency of crews and pilots, the equipment of vessels and on the support systems ashore;

* Tight coupling and the number of stakeholders requires a stricter control of dispatching. New, supra-organizational coordination teams will have to be formed. In such teams safety must be an integral part of their deliberations and must be explicitly quantified in the decision-making process and in the weighing of aspects. In other words: safety must become a quantifiable aspect in the management and decision making of the mainport, up to the highest managerial levels. Therefore, the process must be
Safety in a Modern Perspective

made transparent to all agencies by the registration and analysis of accidents and incidents as undesired disturbances of the regular performance of the system.

The Netherlands Distributing Country

The transportation industry in The Netherlands is undergoing major changes in the light of the development of The Netherlands as a distributing country in a Europe without borders. This process is being accelerated by the increasing access to East European markets. In addition congestion on the roads as well as stricter environmental requirements call for widespread changes. The transportation industry is one of the economic growth sectors in our country. The development of this sector can be characterized by new infra-structural concepts such as transportation corridors, mainports, transferia and principal transportation arteries. These should be incorporated in regional developments with regard to their effects on environment, social life, local planning and sustainability.

In order to spare the environment, a tight coupling between transportation modes into corridors and hubs is frequently preferred. This tight coupling puts additional emphasis on the external safety of inhabitants and other activities. It also constrains the use of transportation arteries by formulating zoning requirements with regard to allowable noise levels, risk contours for harmful effects of dangerous substances and to allowable risk levels for disasters. In operational practice one is confronted with new categories of constraints, formulated on external safety and environmental grounds, which have their drawbacks on the internal operational practice and traffic management.

That this may lead to a complex stress situation between internal and external safety has already been demonstrated in the areas of shipping and aviation. Some examples are: the intended construction of buildings alongside the roadstead of Terneuzen, the re-routing of vessels transporting hazardous goods on the North Sea and the noise and environmental restrictions of flight procedures around Schiphol Airport, which may be at the expense of the margins for a safe flight execution.

Tight coupling has a second effect; the developments within the transportation artery may influence each other in such an unforeseen and unwanted manner, that safety is endangered. During the summer of 1992 the tight coupling between motorway and railroad became evident by the blocking of the railroad alongside the A 16 motorway, after two incidents with tank-lorries near Dordrecht and Prinsenbeek.

The design of a transportation hub may also be criticized. In the Integral Plan for the Northern Ledge of Rotterdam (Integraal Plan Noordrand Rotterdam) a motorway underneath the runway of the airport is planned. Just ahead of the thresholds of the runway the motorway bends away from the runway. Close to the eastside of the runway a High Speed Train and Metro station is planned. Statistics show that about 20% and 50% of aviation accidents occur at take-off and landing respectively. If we realize that most of the time due to the prevail-
ing Western winds, the hub is directly under the landing threshold it is not
difficult to see that a high risk situation has been designed.
A tight coupling in the design of a transportation artery without a strategy
which mitigates foreseeable residual risks, makes a hub or transportation artery
vulnerable. If, in such a vulnerable design, an acceptable safety level is to be
guaranteed during operational conditions, a considerable and costly effort is
required. The control of intensive traffic is indispensable. High qualifications
with respect to professional skills, local knowledge, and insight into the possible
(safety-)consequences of their decisions are demanded of those who must
guarantee operational safety. It may offer impossible options to captains, pilots
or traffic controllers. For example, should a ship-to-ship collision be selected
with possible fatalities, injuries and environmental damage or is a grounding or
collision with a costly infrastructure preferred, with liability claims involved?

3 BALANCING SAFETY AGAINST COSTS

How are the development of Pilotage and VTS related to these developments?
The control of the Pilotage has changed during its existence from private,
through Naval and Ministry of Transportation and back again to privatized
organization. Consequently the involvement of government, industry and port
authority with the tasks of the Pilotage and the safety management has been
changed. In the former situation, the government was involved by the employ­
ment of fully qualified pilots and the port authority was involved by the employ­
ment of harbour pilots. Nowadays, the government is withdrawing due to the
policy of cost reduction and the development of mainports and the port
authority has no direct involvement with pilotage any longer. Unpiloted pas­
sages are possible by a Declaration of Exception and a compulsory piloting fee
no longer exists.
Who takes care of safety in this field of forces?
Shipowners do not supply in-house training, in which region-specific problems
are incorporated for pilots whose local expertise is limited. They supply the
captains during their careers with a variety of vessels, with which they have to
become familiar, without legally based radar or simulation training, no legal
knowledge and no bridge resource management training. This picture fits in with
the criticisms on current operational practice with respect to the safety of the
international shipping trade.
Captains mostly qualify only once at the beginning of their career, obtain less
local expertise by infrequent visits, do not attend refreshmes courses and have
insufficient or no expertise of changes in the local infrastructure. Sister ships
are not fully identical in equipment or characteristics, while the shore based
support systems are under pressure, particularly where aggravated conditions
obtain.
Safety in a Modern Perspective

The Pilotage can supply helicopter support during heavy seas, but cannot service all ships. The smaller vessels especially, frequently apply the Declaration of Exception from compelled pilotage. In a cost effective way this is not unprofitable for pilots: small vessels require a similar effort but offer less returns with comparable costs. The Pilotage therefore, has less costs if it does not have to pilot smaller vessels. There are major differences in regions, as Pilotage is cost-effective nationally. Therefore, there is a ratio of distribution to compensate cost-ineffective regions. To a privatized pilots organization, it is profitable to dispose itself of market segments which are economically unattractive, to refuse smaller vessels and to optimize the staffing. Such a financial approach has its disadvantage: it will be at the expense of the business core of the pilotage: to guarantee a safe and sound passage in sight of the harbour for all segments of the sea going shipping trade.

In the trade-off between safety and economy, a number of conflicts are present due to direct cost-effectiveness considerations; government, port authority, ship-owners, captains and pilots. The aspirations towards mainports and Nederland Distributieland put an additional time and planning pressure on safety by additional requirements in operational practice and by the limitation of operational flexibilities.

4 CURRENT OPERATIONAL PRACTICE

How does operational practice appear under the circumstances? Is there a causal relation between accidents which have been occurring in practice and the developments as previously described? Will future developments decrease the present safety levels and endanger the developments in short sea shipping if the safety policy is not adapted. A picture of the current operational practice has been drawn up by analysing accidents, as described in the verdicts of the Dutch Maritime Court (Stoop 1993, Stoop 1994). There are few but mainly serious accidents on the open sea. The majority of accidents occur in the vicinity of harbours and in coastal waters but are of a less serious nature. The majority of the vessels involved in accidents belong to class 4 and 5, i.e. are smaller vessels (Table I). The vast majority of the accidents occur under (a combination of) aggravated conditions such as darkness, strong wind or fog. To leave smaller vessels unpiloted in waters relatively unknown to them, is not without consequence. Accident patterns are occurring, which can be allocated to accident scenarios, containing specific combinations of classes of vessels, sailing areas, types of accidents, external conditions and pilotage (Table II). These scenarios indicate that inaccurate position finding, inappropriate use of aids-to-navigation, inadequate preparation of a journey, limited communication between captain and helmsman, combined with relative unfamiliarity with the sailing area, may bring smaller vessels into difficulty. If pilot assistance is rejected on cost considera-
tions, an increased risk bearing situation is present, especially under aggravated weather, visual and sea state conditions (Table III).

<table>
<thead>
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<td>7</td>
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<td>5</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>9</td>
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</tbody>
</table>

Table I: Vessel class - accident number per year distribution 1989-1992

Pilots, although rarely, may run into problems. On one hand, experienced pilots may be taken by surprise during a routine passage by aggravated weather conditions.
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<table>
<thead>
<tr>
<th>Scenario</th>
<th>Darkness</th>
<th>Wind</th>
<th>Fog</th>
<th>Darkness + Fog</th>
<th>Darkness + Wind</th>
<th>Total</th>
</tr>
</thead>
<tbody>
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<td>3</td>
<td>1</td>
<td>4</td>
<td>14</td>
</tr>
<tr>
<td>b = 6</td>
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<td>-</td>
<td>-</td>
<td>4</td>
<td>-</td>
<td>6</td>
</tr>
<tr>
<td>c = 19</td>
<td>8</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>16</td>
</tr>
<tr>
<td>d = 9</td>
<td>3</td>
<td>1</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>53</td>
<td>18</td>
<td>4</td>
<td>5</td>
<td>8</td>
<td>7</td>
</tr>
</tbody>
</table>

Total of 53 cases

- 5 extraordinary
- 6 daytime, good visibility

Deletion:

Remains:

- 33 darkness
- 42 (combination) of aggravating circumstances of which involved

Table III: Scenario - external conditions

conditions, reduced visibility or the strength of the current. On the other hand, pilotage requires a considerable amount of professional skill, experience and carefulness. Pilots are not familiar in detail with the manoeuvring characteristics and state of the vessels they sail and may run into difficulty by a poor bridge layout or by their unfamiliarity with the details of the equipment under critical conditions. Transfer of information and communication between captain, pilot and shore based support requires carefulness, in which the task-concept of the captain plays an important role (Stoop 1994).

Further analysis indicate areas of interest for vessels, fairways and ports with respect to vessel traffic management systems, pilotage, vessels bridge equipment and crew qualifications (Stoop 1994):

- a. Fulfilling horizontal and vertical navigation requirements: avoiding stranding and collision with the fairway boundaries;
- b. Participation in a simple or complex traffic situation: avoiding interference and incidents, especially collisions, with other traffic participants;
- c. Keeping the uncertainty of the navigation and traffic participation within acceptable limits.

a. horizontal and vertical navigation

In the execution of these tasks a 'manoeuvring envelope' could be defined, which contain the uncertainty to keep clear of fairway boundaries and other traffic participants. This 'envelope' is related to vessel length and a time con-
stant characteristics defined by the manoeuvering capabilities of the vessel itself and deals with the normal ship-fairway and ship-ship interaction. There is a relation between the size of the vessel and the dimensions of the fairway and surrounding infrastructure. Vessels, manoeuvering in marginal situations are restricted in their behaviour by their relative size to the fairway. Although such situations are encountered at the moment only for large vessels in harbours, in the near future it seems very well possible that shortsea shipping might encounter similar problems when entering rivers and inland sailing areas. The relative dimensions are important to deal with the vessel-fairway interaction in marginal conditions (Visser 1990).

A certain time-period is necessary for decision making of the man on the bridge. Scaling up the decision making, to a higher level of attention and from a skill to a knowledge based mode, requires a certain response tolerance to the situation during which the man on the bridge should be able to perform a recovery action (Hale et.al. 1988).

b. simple and complex traffic situations

Simple and complex traffic situations are essentially different. In a complex traffic situation the participants do not only have to find their own way through the fairway by preparing a voyage plan, but also have to deal with other participants. Therefore they have to create an image of the traffic flow and situation in order to plan and execute their participation in the traffic flow. Such a strategic and tactical image is necessary in order to obtain an accurate indication of their own position in the traffic flow, to generate expectations about the behaviour of other vessels and enables them to 'negotiate' their way through the traffic flow. Active and passive participation in the verbal communication becomes essential in order to have an up-dated image for their short term strategic and tactical task performance. The building of such a mental image of the traffic situation bears similarities with aviation, where the verbal interaction between air traffic controllers and pilots is known as the 'partyline effect'.

c. limiting uncertainty

In all situations the man on the bridge wants to control the rate of uncertainty in the execution of the navigation task. There are three main areas which may reduce the uncertainty for the man on the bridge:

* Accuracy in position finding. The accuracy may be significantly improved by the introduction of very accurate position finding equipment -such as GPS- and the representation of this information in an unambiguous way to the man on the bridge -such as ECDIS and integrated VDU-;

* Knowledge about the traffic situation. Such knowledge can be derived from the information provided by a VTS system and can be applied on board as well as on shore. The recommendations of the Maritime Court
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indicates possibilities for improvements in procedures, regulations and legislation in a national and international context;

* Communication on board as well as between ship and shore based stations about the state of the fairway and the traffic. Information about the traffic situation should be communicated between the members of the crew on the bridge, between the captain and the pilot on board and between the captain or pilot and the shore based stations. In order to improve expectations on the behaviour of other vessels a fed-forward supply of information becomes necessary. Improvement of the communication could be achieved by bridge crew resource management or bridge crew co-ordination courses. The individual capabilities both on board and ashore could be improved by proficiency checks, certification and recurrent and emergency training as already applied in other branches such as the aviation, process and nuclear industries (Helmreich 1987, Schimmel and Shelton 1987, Kanki and Foushee 1989).

Conclusions on the role of VTS and Pilotage

In establishing the precise role of VTS and Pilotage, a variety of factors play a role, such as strategic versus tactical advice, future developments with respect to increased density of traffic, the complexity of the fairways, logistic and production pressures on the bridge crew performance.

Elaborating the notion of complexity in safe task performance a distinction should be made between complexity of the sailing area and that emerging from the traffic situation. To deal with the complexity of a sailing area, the man on the bridge should be able to identify very accurately his position, his course and speed. He should inform the fairway authority of both his voyage plan and tactical intentions in order to enable this fairway authority to compose a traffic image of the sailing area and the traffic flow.

To deal with the complexity of the traffic situation, the man on the bridge should develop a strategy in order to manage the conflicts in the interaction with the other traffic participants in the sailing area.

The role of VTS and pilotage could be beneficial, especially if the man on the bridge fails to detail his voyage planning adequately. If the first, globally performed preparation before the start of his voyage is not followed by a detailed plan, he might run into problems during the execution of the planning. Also he might run into problems when he does not adjust his planning due to aggravated circumstances. If his primary aid-to-navigation, his external visual cues, are reduced or deleted, he has to compensate for this loss by changing to an internal visual aid such as radar, or to aids-to-navigation of another nature such as pilots, radio communication or VTS/shore based advice. The installation of VTS and pilotage have positive effects on the traffic flow safety. They may eliminate certain types of accidents, increase vigilance and
situation awareness, improve position finding and may more clearly define traffic flow expectations by accurate position finding and communication with other vessels and shore based stations.

5 PROBLEMS AND SOLUTIONS

In aviation, it is not uncommon to clear bottlenecks in safe and sound traffic flow management by means of technological improvements to infrastructure and equipment. Mainport Schiphol allocates large investments for the improvement of air traffic control and for the coupling of automated flight handling in aircraft and on the ground. A fifth runway is planned. Is such an approach also possible for the pilotage of vessels, for instance by the introduction of remote pilotage or the expansion of VTS facilities?

For four reasons such a development is not obvious:

* Comprehensive automation of control processes has negative side-effects. Increased automation may lead to accidents, as demonstrated by the well known ‘ARPA assisted collision, in the maritime sector or the ‘Controlled Flight into Terrain’ in aviation. Man is very well equipped to recover from mistakes and errors and to regain control over the situation, based on his experiences and on his professional skills, which cannot be formalized in control algorithms. In aviation ‘situation awareness’ is known, a phenomenon by which the human operator is no longer capable of understanding the system configuration under critical conditions due to his limited monitoring tasks and thereby not capable of taking over the control tasks in the system. Finally, automation necessitates further support by additional equipment in order to detect or to correct undesirable deviations.

* The Bijlmermeer air disaster has underlined the importance of proper organization and quality control. The safety audit by EAC/RAND has demonstrated that the best gain in safety improvements of a mainport like Schiphol, is rather in the improvement of organization and quality control of the various processes related to traffic control, than in increased automation. A close cooperation between the various stakeholders is mandatory. The most relevant recommendations for the safety of Schiphol were the introduction of an Integrated Safety Management System, including the registration and analysis of accidents and incidents, the maintaining and enforcement of quality standards and the introduction of an independent, qualified and impartial organization to guarantee the weighing of safety in the decision making process (ref RAND).

* Technological solutions, appropriate for one mode of transportation are not necessarily transferrable to another, adjacent mode. In analogy with
Safety in a Modern Perspective

Air Traffic Control in aviation, Remote Pilotage seems to be promising for shipping in the future, but the conditions for a social acceptance are not yet present;

* Sustainable and efficient solutions demand a thorough expertise in the examination of problems and their causes, indicating balanced packages of measures and multiple-solution strategies. Complex organizations and structures are in contradiction with a monodisciplinary or mono-aspectal approach. The nature of the process control and decision-making requires co-operation between a variety of mostly autonomous stakeholders and also requires a weighing of interests and aspects beyond the level of individual organizations and decision makers. The obtaining of a transparency of the processes, structures and the tasks involved is the basis for such a cooperation and decision making. One of these tasks is to guarantee a safe and sound passage in the vicinity of the port.

6 RECOMMENDATIONS

As stated in the beginning of this paper, the advantages of short-sea shipping are described as; no need for very high additional infrastructural works, an almost unlimited capacity at sea and only limited strain on scarce space in and near ports, a high degree of safety and relatively friendly impact on the environment. To achieve these advantages of short-sea shipping to congested roads, a number of conditions have to be fulfilled:

The slogan is no longer ‘Safety First’ but; ‘Safety Too’. This looks like too modest an approach in view of the pressure which is put on the safety of all transportation modes at the moment. Rather than a pendulum swinging in time causing a temporarily ad-hoc overexposure on safety due to serious accidents and incidents, a plea is made for a pro-active and continuous, balanced attention.

Risk taking behaviour of captains may be induced by logistic and economic motives, reducing safety limits. Therefore, operational cost-benefit considerations should carefully be made, avoiding a ‘pennywise-poundfoolish’ attitude in the weighing of safety aspects against costs.

Policy decision-making for traffic flow management in ports and in busy shipping areas, should carefully address the issue of investing in pilotage and VTS because of their evidential benefits to a safe, efficient and smooth traffic flow. Although technology may add to the safety of maritime traffic by the introduction of dedicated navigation and communication systems, the most promising gain in safety lies in the design, management and organisation of mainports and transportation corridor concepts, including high quality standards and qualified crews.
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THE SINGLE MARKET AND THE REMOVAL OF OBSTACLES TO THE GREATER USE OF SHORTSEA SHIPPING

By F.M. Everard and C.P. Boyle

Choose shipping first! Wherever sending goods by sea - either directly or as part of the intermodal chain - is feasible, our aim as shipowners is for shippers and forwarders to choose shipping first.

Over the past forty years shipping’s market share in the UK has declined dramatically in comparison with road (Table I).

<table>
<thead>
<tr>
<th>Year</th>
<th>Road</th>
<th>Rail</th>
<th>Water</th>
<th>Pipeline</th>
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<td>31</td>
<td>37</td>
<td>20</td>
<td>0.2</td>
</tr>
<tr>
<td>1962</td>
<td>55</td>
<td>26</td>
<td>24</td>
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<tr>
<td>1972</td>
<td>88</td>
<td>21</td>
<td>29</td>
<td>3.5</td>
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<tr>
<td>1982</td>
<td>95</td>
<td>16</td>
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</tr>
<tr>
<td>1992</td>
<td>127</td>
<td>15</td>
<td>55</td>
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</tr>
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(Source: Transport Statistics Great Britain 1993)

Our goal is to increase this market share. There are various recipes around favouring differing degrees of intervention as to what must be done by industry and legislators if this goal is to be achieved. We shall consider the effects on the competitive position of short sea shipping of current Community initiatives designed to promote greater integration, such as the Trans-European Networks, as well as industry efforts towards greater efficiency. The purpose of this paper is to assess whether our chances of success in competing against other modes are better now in the era of the Single Market, or whether the Single Market ethos will need to be balanced by wider policy considerations such as environmental imperatives.

We start by accepting the philosophy underlying the Single Market: that the removal of barriers to trade generates greater competition, enhanced choice and level of service for consumers releasing formerly unproductive labour and capital for other purposes so making best use of resources. In tandem, the philosophy...
must demonstrate a willingness and flexibility to look at best practice in terms of efficiency and innovation and adopt and adapt as appropriate. Properly and fully implemented, it should work as well for shipping as any other sector of European industry.

"1992" has come and gone leaving us with what should be a liberalised shipping market with a streamlined system of controls and procedures at frontiers. Reality in 1994 looks different but experience is teaching us it takes time to create an integrated market - 2004, for example, is the date finally agreed for the implementation of the last tranche of liberalisation in the European cabotage markets - and even then liberalisation will only extend to vessels under EC flags.

What is beginning to happen albeit slowly is that the removal of national barriers and general liberalisation within the Community is producing a different sort of transport market to meet changing patterns of trade and customer requirements. Research shows many businesses are marketing Europe-wide.

As a progression from the 1992 programme, the Commission and Member States are taking steps to facilitate the free movement of goods, people and services throughout Europe. Transport is one of three elements (together with energy and telecommunications) which is the new spearhead of European integration: the Trans-European Networks programme. Some ECU 220 bn has been put aside for transport infrastructure projects over the next few years.

The purpose of these networks is to provide the interconnection and interoperability of national networks and access to them - taking account of the need to link island, land-locked and peripheral regions with the more central areas of the Community. They must both ensure the efficient flow of goods and people and provide a lifeline for the periphery. Existing networks have developed on national lines "designed to satisfy the European nation states of the 19th Century," in the words of Commissioner Christophersen and this fragmentation is perceived to be frustrating the Single Market concept and damaging to Europe's competitiveness: Italian lorries, for example, must thunder through the Rhine Valley on their way to Rotterdam at least in part because of lack of efficiency in Italy's ports.

There is little point in creating a system which serves only to funnel traffic into limited corridors exacerbating existing congestion and pollution. The new networks have therefore to be balanced, efficient and environmentally friendlier than at present. Greater use of maritime transport around the coasts of Europe serving the vast range of Community ports is seen as one way of achieving the stated aims of the programme. But as they are shaping up, the networks are in danger of developing only the most obvious cross-border links with exactly the sort of funnelling to main arteries which the programme was conceived to avoid. Could it be otherwise? The major European centres of population and industry lie largely in the so-called "golden banana" which stretches from S.E.
United Kingdom to Northern Italy. The Single Market with its emphasis on rationalisation and economies of scale is to date encouraging centralisation. Conversely, can the building of infrastructure to peripheral regions on its own prevent this centralising trend?

The question of congestion has been under examination for several years by the Commission and various Member State governments with a view to ways of shifting freight from road to rail or sea. However, in the era of the Single Market new forms of discrimination which favour one sector over another have not been acceptable. The preferred policy is the removal of unfair advantages (in the form of subsidies or monopoly) and the creation of open access - letting modes compete on an equal footing. Active intervention by Member States/Commission to require a modal shift has been unacceptable because of possible distortions to competition. The shipping industry itself is as wary of such intervention as governments. Even if governments can be persuaded that environmental concerns merit positive action for shipping, the problem lies in devising a mechanism to promote shipping which does not favour one operator over another.

If little can be expected from Trans-European Networks or the likelihood of fair and balanced intervention - what can the industry do itself to compete with other modes and boost its market share.

Costs at the port interface are estimated at between 30-80% of the waterborne freight and usually above 50%. Port efficiency has been identified as a key area for improvement if shipping is to be able to compete more successfully with other modes. To keep costs to a minimum and reduce transit time, the Short Sea Panel of the Maritime Industries Forum identified the following pre-requisites for an efficient port based on users’ experience and needs. It should be stressed that Government help is required to set the right legislative framework in which ports can provide:

* Easy and safe access, including availability of navigational aids;
* Round the clock availability of services;
* Design/adaptation of port infra and superstructure with specific short sea needs in mind;
* Smooth interface with road/rail/inland waterway connections;
* Competition in ports’ services - abolition of monopolistic and restrictive practices;
* Greater use of EDI;
* (MARPOL) reception facilities;
* Transparency of tariffs.

Coupled with improved documentary procedures, action to ensure such pre-requisites are met should boost shipping’s appeal to the user. The ownership/operating structure of a port is also a vital element to its efficiency.

European Shortsea Shipping
The Single Market and the Removal of Obstacles

Whilst there are clearly various successful models, the experience of recent port privatisation in the UK has produced greater flexibility and a stimulus to use commercial freedom and imagination to seek new trade and pursue new methods.

The discipline of having to examine and eliminate obstacles to growth if they are to survive and prosper in what is undoubtedly becoming a less protected, more competitive climate is stimulating short sea operators, ports and customers alike. At present this is truer for those parts of the Single Market which have gone further in liberalising and deregulating but what is seen to be done successfully in one part of the Single Market may now be more readily copied or adapted for use in another. We may well be on our way to achieving some degree of cohesion/integration through market forces.

But is greater efficiency and a willingness to be dynamic enough to make shipping the first choice for shippers/forwarders? Other modes have been undergoing the same processes of liberalisation, modernisation, privatisation and have taken advantage of greater efficiency to cut costs and streamline. Research into the de-regulation of road haulage in Europe suggests an overall drop of 15-20% in road haulage rates is likely once the full benefits of new legislation come into play. International road haulage services from UK to the Continent via ferry have achieved significantly improved transit times as a result of the removal of border restrictions - over longer routes, such as Birmingham to Barcelona or Manchester to Milan, by as much as 24 hours. From the fact of being an island, the UK has through necessity built up a large network of more than 100 regular shipping services, giving access to all parts of mainland Europe and Ireland, which collectively make up Britain’s largest trading area. Many of these services are roll-on/roll-off, allowing the direct transfer of trailers, accompanied or unaccompanied to many European markets. However, from March 1994, competition with the Channel Tunnel is anticipated to see the estimated journey times in Table II.

Despite our best efforts might we not be in the same relative position of disadvantage vis-à-vis road and even rail (whose own market share in the UK has fallen more dramatically than that of shipping over the last forty years)? This is not an argument for complacency or against becoming more efficient - it is possible to lose out yet further to road, whilst for ports the neighbouring port is always a competitor.

There are other factors necessary to creating an open and fair Single Market. Governments are beginning to address questions of unfair pricing structures between modes. The privatisation and demonopolisation of railways is on the agenda together with an examination of ways of making the polluter pay for transport-generated pollution through such mechanisms as the carbon tax. Such
Section III - Ships, Ports and Safety Issues

<table>
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<tr>
<th>Route</th>
<th>By Rail (hrs)</th>
<th>By Road (hrs)</th>
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<td>36</td>
</tr>
<tr>
<td>Manchester-Milan</td>
<td>32</td>
<td>60</td>
</tr>
<tr>
<td>Birmingham-Vienna</td>
<td>31</td>
<td>66</td>
</tr>
<tr>
<td>Liverpool-Stuttgart</td>
<td>28</td>
<td>48</td>
</tr>
<tr>
<td>Wakefield-Bordeaux</td>
<td>32</td>
<td>60</td>
</tr>
<tr>
<td>London-Munich</td>
<td>24</td>
<td>42</td>
</tr>
<tr>
<td>Cardiff-Paris</td>
<td>15</td>
<td>18</td>
</tr>
<tr>
<td>Middlesbrough-Perpignan</td>
<td>33</td>
<td>60</td>
</tr>
</tbody>
</table>

Table II: Channel Tunnel estimated journey times

programmes are likely to take years to agree and implement. In the meantime -
the removal of the type of obstacles outlined above are alone not enough to
achieve our goal.

The other major action the industry can take for itself is marketing. The current
invisibility of short sea shipping suggests that the marketing of this sector is
poor and this is indeed confirmed by shippers. This need not be the case and a
recent example will show that the UK industry has been able, through market-
ing, to capitalise on the confused state of the British Rail freight industry. Within
the past eighteen months rail freight users were informed that there would be a
150-200% price rise for the carriage of traditional bulk cargoes of grain, china
clay or oil. The reasons are complex but in an environment of artificially created
rail freight pricing structures, with little commercial understanding about what
the customer wanted and was prepared to pay for, there was an overnight
modal shift away from rail. Unfortunately the vast majority of such traffic flows
were naturally suited to road transport - a mode with vast over-capacity and
resultant low rates.

However, seeing an opportunity, the short sea shipping industry honed its
marketing skills and for the first time ever was able to make some headway
against the still subsidised railways. On its current performance, short sea
shipping appears to be able to compete very favourably in terms of price and
quality to win specific types of traffic such as grain flows from the East of
England to the North East coast of Scotland.

Within the last year rail in the UK has also lost a traditional flow of deep sea
container feeding to Comar's visionary coastal service between Thamesport
and Grangemouth.

Are these just isolated examples or are they the tip of an iceberg as far as short
sea shipping potential is concerned? UK short sea owners are now actively
marketing in areas which were unknown to them five years ago.

European Shortsea Shipping
The Single Market and the Removal of Obstacles

For many shippers facing the demands of an increasingly congested European motorway network, the availability of short sea shipping, hopefully from their local port, often comes as a complete surprise. The current invisibility of operation is a problem which must be overcome.

Potential winnable markets must be identified if promotion is to have any chance of success.

Selling short sea shipping services must be able to capitalise on its manifest merits:

**Availability of services** - short sea shipping offers attractive transport choices to destinations all over Europe.

**Reliability and punctuality** - enabled by set timetables and operating efficiency.

**Programmed delivery** - regularity of service enables deliveries to be planned according to a set schedule and provides a floating warehouse.

**Price competitiveness** - highly favourable in comparison to other transport modes.

**Customer responsiveness** - point to point solutions to meet the specific needs of the customer.

**One transport contractor** - enabling the customer to resolve specific problems.

**Environment friendly** - relieves traffic on land routes and offers energy efficiency.

**High safety standards** - compliance with strict safety regulations established internationally.

**CONCLUSIONS**

The issues covered and the views expressed here will not be new to you but by seeing them within the framework of an integrating European market what often appear as piecemeal actions show some underlying coherence.

However, caveats must be entered as to whether Cinderella will actually go to the ball as short sea shipping’s supporters suggest.

First - for the benefits of the Single Market to flow, everyone involved must play their role effectively:
Section III - Ships, Ports and Safety Issues

- Governments must ensure they meet fully their commitments to the legislation they have agreed. This is not currently the case in shipping as we see from the notable intransigence of Spain in the current Cenargo case which is denying a British company access to a Spanish/Moroccan ferry route for wholly political reasons.

- The shipping industry - operators, ports and customers must act as if the Single Market exists and exploit it. Where it finds hindrances and problems to its efficient operation complaints must be made and action demanded at local, national or European-level to remedy them. Recourse to law may be necessary to change entrenched positions.

Secondly - although the environmental benefits of shipping make it an attractive option - is the way the transport system of Europe is being developed via the Network Programme likely to make use of these advantages if it follows the centralising trends of the Single Market? The siting of industry away from already dense centres of population and consequent congestion is one of the much wider political questions which governments will have to address if they are serious about environmental concerns and European gridlock.

Governments must also seize the nettle of unfair transport pricing and look seriously at actions to address pollution and congestion costs, and existing subsidies.

Thirdly - the industry must be prepared to make more strenuous efforts in marketing itself and in co-operating with ports and local Chambers of Commerce in the search for new business.

Finally - to return to our initial questions - the underlying philosophy used in the nineteen-eighties to hasten the integration of the European County: removal of barriers to trade and full play of market forces is beneficial to short sea shipping in the same way it benefits all other industries - by forcing it to be more competitive. However, the centralising tendency which integration produces does not favour the use of direct shipping services.

The Single Market is encouraging European countries to trade more and more with each other. The nature of what we mean by short sea shipping is broad - the solutions for winning greater share of Europe's growing trade will vary accordingly. With the right marketing short sea bulk should benefit most from a modal shift from rail to sea. Whereas for liner services - the flexibility of the container must encourage greater use of intermodal transport providing there are adequate hinterland connections for road, rail and inland waterway interchange.
# Container Traffics in Europe - Changing Patterns and Policy Options

By P. Sutcliffe and M. Garratt

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European Shortsea Shipping
CONTAINER TRAFFICS IN EUROPE - CHANGING PATTERNS AND POLICY OPTIONS

1 INTRODUCTION

MDS Transmodal has recently completed the third edition of its publication 'The European Freight Market - Containers by Sea', to be followed shortly by the complementary study 'The European Freight Market - Containers Inland'. The first edition covered the statistical year 1982, the second was based on 1986 and the current edition is based on the year 1992.

It is largely from the research undertaken for these studies, now reflecting a decade's experience of the subject, that this paper is derived.

Containers by Sea covers all aspects of European container shipping. It estimates the volumes of ISO containers moving between eight port regions. Flows between port regions distinguish between:

* Pure inter-European trade;
* Trade transhipped in Europe to and from extra-European destinations and origins (feeder traffic).

The figures are compared with the equivalent values in previous editions and changes in route size, feeder (transhipment) volumes and the main players noted. The modal share of non-bulk cargoes, especially between trailer and container, is estimated and significant trends noted.

A full description of each route is provided and the leading ports and container carriers identified, as are the principal factors determining mode and route.

The purpose of the research has been to provide an aid to the marketing and planning strategies of the various participants involved in container shipping, both in Europe and world wide where an European element is included. These interested parties include:

* Shipowners and operators;
* Port authorities;
* Terminal operators;
* Combined transport operators
* Freight forwarders;
Section IV - Shortsea Shipping Case Studies

* Road hauliers;
* Rail freight operators.

In addition to those listed, the studies are also designed to be of assistance to research organisations, financial institutions and Government departments involved in European trade and transport. We shall describe such a case study in the second half of the paper.

Over the period of the studies, there have been many political and economic changes in Europe affecting the levels of trade, and now physical developments such as the Channel Tunnel and the Scandinavian fixed links are also factors. These changes have in turn influenced the nature and pattern of container movements in Europe in various ways.

The major influences since 1986 have been:

* the GATT negotiations;
* German unification;
* political liberalisation of the former East Bloc countries;
* the Maastricht Treaty;
* EU legislation;
* the abolition of dock labour schemes in France and the UK.

The GATT should help to prevent separatism and promote inter world areas trade, important in view of the creation of large trading blocks such as the North American Free Trade Area, the European Union and the ASEAN countries.

The unification of Germany, and the political shift from command to market economies amongst the former Combloc countries offers a huge new trade potential which must be realised over the next few years.

The Maastricht Treaty will intensify the economic union of the current member countries and those applying for membership. Monetary union, a fundamental aim of the treaty, will facilitate intra European trade, encourage growth and give stability to the EU’s trade with extra European countries.

EU legislation in relation to transport covers liberalisation, harmonisation (particularly in the tax fields), the investment in a European transport structure, the promotion of maritime links and the opening of national railways to private operators. All these have and will impact the pattern of European container activity.

The abolition of dock labour schemes in Great Britain and France has encouraged an improvement in the performance of the ports in those countries although at the time of writing there continue to be labour relation problems in France. Labour difficulties still linger on in certain countries and until these are
Container Traffics in Europe - Changing Patterns and Policy Options

resolved, the deepsea container lines' port choice in Europe will continue to be influenced by labour inhibitions.

With the Channel Tunnel due to open in the Spring of 1994 and the development of the fixed links in the Scandinavia region, there will be effects on the modal patterns of container movements. This is particularly so in the latter case where the competitive position of road and rail will be enhanced at the expense of shortsea shipping.

European container trade in 1992, both intra and extra amounted to 22 million TEU. This represents a 38% increase over the previous study year of 1986 despite a background of a cycle of economic growth then recession in Europe. As the recession bottoms out (depending on the country), container trade should increase proportionately. Trade with the Americas is more or less steady and the main growth area is trade with the Far East, particularly westbound.

The five leading container ports in Continental Europe are Rotterdam, Hamburg, Antwerp, Bremerhaven and Le Havre, in order of container volumes. Rotterdam is by far the largest handling over four million TEU in 1992 and only Le Havre handled less than one million. The other major port in Europe is Felixstowe in Great Britain, which handled one and a half million TEU in the same year. Table I illustrates the comparative position of the five main European container ports and the rate of container handling growth they have enjoyed.

<table>
<thead>
<tr>
<th></th>
<th>'000 TEUs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rotterdam</td>
<td>177</td>
</tr>
<tr>
<td>Hamburg</td>
<td>977</td>
</tr>
<tr>
<td>Antwerp</td>
<td>796</td>
</tr>
<tr>
<td>Felixstowe</td>
<td>678</td>
</tr>
<tr>
<td>Bremen/Bremerhaven</td>
<td>563</td>
</tr>
</tbody>
</table>

Table I: Estimated European container throughput for leading ports, 1992

For the sake of good order, the rest of the paper will be confined to the 1992 edition and experience.
2 METHODOLOGY

Definitions had to be established to make the studies manageable. Containers are defined as solely for maritime use and of ISO specification, i.e. 20' and 40' in length. For statistical convenience, container units are generally expressed as TEU.

The studies measured container movements between port areas between and within port areas. The ports involved include those in Scandinavia, the Baltic, North Continent, British Isles, Iberia and the northern coastline of the Mediterranean as far east as Greece.

European container flows are derived from two separate patterns of international trade, i.e. intra European trade, and trade between Europe and non-European countries. Clearly the latter is mainly deepsea but is relevant to the subject of shortsea shipping because it generates substantial interport container feeder traffic between European countries. This latter type of flow is a fundamental concern of the study.

Together, the eight areas defined, generate a total of 36 possible routes of which 34 have positive flows. The key flows, ranked by route are shown in Table II.

<table>
<thead>
<tr>
<th>Route</th>
<th>Flow (TEU)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Channel-GB</td>
<td>1040</td>
</tr>
<tr>
<td>Intra N Med</td>
<td>885</td>
</tr>
<tr>
<td>Nordic-Denmark/Germany</td>
<td>485</td>
</tr>
<tr>
<td>Atlantic/Channel</td>
<td>312</td>
</tr>
<tr>
<td>Channel-Ireland</td>
<td>309</td>
</tr>
<tr>
<td>Nordic-E Baltic</td>
<td>60</td>
</tr>
<tr>
<td>E Baltic-GB</td>
<td>50</td>
</tr>
<tr>
<td>Atlantic-Denmark/Germany</td>
<td>41</td>
</tr>
<tr>
<td>Channel-E Baltic</td>
<td>40</td>
</tr>
<tr>
<td>Intra Nordic</td>
<td>38</td>
</tr>
</tbody>
</table>

Table II: Total European container traffic, ranked by route (000 TEU)

As shown in the earlier surveys, the Channel - Great Britain route dominates European container traffic with some 20% of the total in 1992, but that percentage is decreasing having been 28% in 1982 and 25% in 1986. In all, 15 routes now exceed 100,000 TEU (in 1986 the equivalent was 11 routes). Those 15 routes together generate 89% of the total traffic.

2.1 PORT DATA

To create the necessary database, questionnaires were sent to all the ports concerned with the exception of the ports in the UK, for which HM Customs
Responses were generally good, particularly from the major container ports. Channel, Denmark/Germany and Nordic areas responded well but were less comprehensive from the North Mediterranean and East Baltic areas. The data so assembled formed the basis on which container flows were estimated and corresponding areas generally correlated well.

In addition to this, personal visits were made to most of the high volume European container ports during which discussions concerning local container traffic were held with port authorities and some terminal operators. These visits included Hamburg, Bremen, Rotterdam and Antwerp.

2.2 SHIPPING COMPANY INFORMATION

It is estimated that some 80 shipping companies carry containers on European routes and if roll on-roll off (ro-ro) ferries and deep sea wayporting is added, the actual total must exceed 100.

To obtain detailed information on the European container shipping trades, a sample of 23 European and deep sea lines were interviewed personally, the sample including most of the major operators. The interviews also provided details in relation to the mechanics of European container traffic. Statistics of route flows obtained from these interviews permitted a cross check with the port data and correlation was in most cases acceptable.

2.3 TRADE DATA

A variety of public sources were used to establish the estimates of European non-bulk trade used in the study, and these are expressed in terms of tonnes weight. Non-bulk trade has been defined as total trade less that which is shipped as bulk cargoes eg fuels, minerals and ores.

2.4 DATA CORRELATION

For each route there are three possible sources from which to derive an estimate of the route flow, ie the ports at each end and shipping companies trading on it.

All route figures are estimates because on certain routes, especially those involving southern Europe, there were gaps in the data. To overcome this, other sources had to be used such as previously published data or figures related to previous years. Despite this the general magnitude and relative route and area
sizes are consistent. General confidence limits for all quoted route flows are plus
or minus 15%. Desk research supplemented the information.

The estimates of container flows made in the studies are the sum of container
movements between European ports areas imports and exports, full and empty.
Empties are not freight earning but are a significant element in the flows largely
reflecting non-bulk trade imbalances, both intra and extra Europe.

3 THE STRUCTURE OF EUROPEAN FREIGHT TRANSPORT

European ports handled a total of just under 22 million TEU in 1992, some 21%
of the estimated world total of 103 million. This is a lower share than in the
previous edition reflecting the faster growth of traffic elsewhere, mainly in the
Far East. To highlight this, the top three container ports in the world are Hong
Kong, Singapore and Kaohsiung. Together, those three ports account for almost
19 million TEU of the world total, more than 18%.

Of the European total, container traffic between and within European areas
amounted to 5.2 million TEU (9.2 million handlings), of which approximately 3
million TEU (57%) were inter-European and the balance the feeder trades. These
latter have increased share since 1982 from 30% to 43% reflecting the fact
that deep sea vessels have become larger and make fewer port calls in Europe.

Containers were conceived as an intermodal form of freight carriage, and
generally with a maritime element, which is where their origins lie. On routes in
Europe as elsewhere, containers compete for non-bulk cargoes with road, rail
and inland waterway. Even where sea passage is unavoidable, the growth of
ro-ro ferries carrying accompanied and unaccompanied trailers, and even rail
wagons is also a threat to the container's market share. Thus, for example,
trailers travelling overland now account for up to 40% of unit load traffic
between Portugal and the UK, using the short ferry crossings over the English
Channel.

Sea carriers in Europe also compete modally for container traffic on many
routes. Examples of this include the heavy flow of containers between Rot-
tterdam and Antwerp, a route dominated by road, rail and inland waterway.
Another clear case is between Hamburg and Jutland in Denmark, a route that
has excellent road and rail links giving those modes a high market share.

The majority of containers move to and from inland destinations rather than
solely between ports. It follows that the inland modes are an essential element
in the overall movements. For deep sea itineraries this is without conflict but for
intra-European container shipments, it is less clearly defined as in many cases
the inland mode can undertake the entire door to door movement if geography and cost is appropriate.

Despite this, there are significant port to port flows in Europe, mainly the re-positioning of deep sea containers which for environmental reasons should ideally move by sea. However, economic market forces prevail and road and rail present formidable competition for the sea carriers on these routes in many cases.

4 INTER-EUROPEAN NON-BULK TRADE

Total inter-European non-bulk trade stands at 320 million tonnes and containers have a very modest share estimated at about 6 - 7%. Containers by sea do not compete at all on many European routes, for instance where land frontiers are involved and/or movements are intra country. To highlight this, Germany and France both have major container ports but containers make little penetration into the non-bulk trade between them.

The container does compete more strongly in inter-European trade where geography favours its original concept ie intermodal maritime use. Examples of such routes include Great Britain - Continent, Great Britain - Ireland and in the Scandinavia and Baltic regions.

Port statistics themselves often make it difficult to relate the identity of inter-European container traffic to inter-country trade. This arises from the fact that a high percentage of containers are in transit through ports in one country, but destined or originating in another. For instance, a container from Italy may cross three or four land frontiers before being shipped out of a Benelux or French port to Great Britain. Port returns would simply record the movement between the latter two countries.

5 EXTRA-EUROPEAN TRAFFIC

It is possible to estimate the relative importance of different port areas in extra-European traffic. This category is mostly deep sea traffic but does include short sea trade with North Africa, the Mediterranean and other near islands. It also includes the feeder trades between Europe and these places.

As in 1986, the data shows the same high concentration of deep sea traffic in four European port areas. Of the total of 14.935 million extra-European TEU handled by European ports in 1992, 97% is accounted for by North Mediterranean, Channel, Denmark/Germany and Great Britain together.
Section IV - Shortsea Shipping Case Studies

Feeder traffic, estimated at 2.234 million TEU, constitutes 15% of extra-European moves and as such, shows the proportion of the latter transshipped. Mediterranean figures are less reliable than others and its feeder volume could be understated.

Generally speaking, a strong deep sea presence is reflected in a low feeder share of total moves generated by extra-European trade despite the extra transshipment moves gained. Conversely, a weak deep sea presence reflects a high feeder proportion.

6 INTER-EUROPEAN TRAFFIC

Inter-European traffic amounted to 2.955 million TEU in 1992, representing 57% of the European total, slightly lower than in 1986. Table III shows the distribution of the traffic on the main routes, including intra-area traffic.

The Channel-Great Britain route continues to be the largest accounting for 23% of the total, down from the 27% of 1986. Eleven other routes exceed 100,000 TEU. Intra-area traffic exists on North Mediterranean, Denmark/Germany, Nordic and Atlantic routes amounting to 300,000 TEU in total.

<table>
<thead>
<tr>
<th>Route</th>
<th>1992 (000 TEU)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Channel-GB</td>
<td>690</td>
</tr>
<tr>
<td>GB-Ireland</td>
<td>281</td>
</tr>
<tr>
<td>Channel-Ireland</td>
<td>240</td>
</tr>
<tr>
<td>Intra-N Med</td>
<td>200</td>
</tr>
<tr>
<td>Nordic-GB</td>
<td>196</td>
</tr>
<tr>
<td>Channel-E Baltic</td>
<td>40</td>
</tr>
<tr>
<td>Atlantic-Nordic</td>
<td>30</td>
</tr>
<tr>
<td>Denmark/ Germany-E Baltic</td>
<td>27</td>
</tr>
</tbody>
</table>

Table III: Inter-European container traffic by route 1992 (000 TEU)

Inter-European non-bulk trade has grown more slowly over the last decade than the previous ten years but still over 50% in the period. Growth from 1986 to 1992 has been at about 2% per annum. Table IV illustrates this growth.

Overall, containers appear to have a market share of around 7% of European non-bulk trades, a similar figure to those in 1982 and 1986.
Container Traffics in Europe - Changing Patterns and Policy Options

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Million tonnes</td>
<td>188</td>
<td>217</td>
<td>218</td>
<td>299</td>
<td>337</td>
</tr>
</tbody>
</table>

(Source: Eurostat)

Table IV: Inter-European non-bulk trade

7 TRANSHIPMENT (FEEDER) TRAFFIC

European feeder traffic amounts to 2.2 million TEU, representing 43% of the European total, slightly more than in 1986 when the equivalent figure stood at 39%. Overall, feeder traffic has increased by 66% between 1986 and 1992.

Table V shows the main routes, including intra-area traffic.

<table>
<thead>
<tr>
<th>Route</th>
<th>1992</th>
<th>1986</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intr N Mediterranean</td>
<td>685</td>
<td>466</td>
</tr>
<tr>
<td>channel-Great Britain</td>
<td>350</td>
<td>290</td>
</tr>
<tr>
<td>Denmark/Germany-Nordic</td>
<td>350</td>
<td>147</td>
</tr>
<tr>
<td>Channel-Atlantic</td>
<td>200</td>
<td>40</td>
</tr>
<tr>
<td>Atlantic-N Mediterranean</td>
<td>160</td>
<td>20</td>
</tr>
<tr>
<td>Channel-Denmark/Germany</td>
<td>90</td>
<td>130</td>
</tr>
<tr>
<td>Intra Channel</td>
<td>85</td>
<td>54</td>
</tr>
<tr>
<td>Intra Denmark/Germany</td>
<td>80</td>
<td>50</td>
</tr>
<tr>
<td>Denmark/Germany-E Baltic</td>
<td>70</td>
<td>10</td>
</tr>
<tr>
<td>Channel-Ireland</td>
<td>69</td>
<td>40</td>
</tr>
<tr>
<td>Channel-Nordic</td>
<td>58</td>
<td>60</td>
</tr>
<tr>
<td>Great Britain</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td>Intra Nordic</td>
<td>12</td>
<td>10</td>
</tr>
<tr>
<td>Intra Great Britain</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Denmark/Germany-Great Britain</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Channel-N Mediterranean</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>N Mediterranean-Great Britain</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>Nordic-E Baltic</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>All other flows zero</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>2244</td>
<td>1347</td>
</tr>
</tbody>
</table>

Table V: European feeder traffic by route (000 TEU)
Intra-North Mediterranean continues to be the largest market followed by Channel-Great Britain and Denmark/Germany-Nordic. There have been major changes between 1986 and 1992 but in view of the volatility of feeder flows, it is to be expected.

The Mediterranean continues to generate feeder traffic and the various ports in the region compete strongly for it. Location on deep sea shipping routes is more important than hinterland to the success of a port in the North Mediterranean area. The growth of ports such as Algeciras illustrates this. At that port, 72% of container handlings in 1992 were transhipment with Maersk and Sea-Land controlling 95% of the port’s 780,000 TEU throughput. Other ports in the region dedicated to transhipment include Marsaxlokk in Malta, and more recently, Giao Tauro in the south of Italy, is being developed for this purpose.

The Channel-Great Britain route, another busy feeder flow, could be affected in the future by two factors. Firstly, the Channel Tunnel will offer road and rail operators, particularly the latter, the opportunity to compete with sea feeders more strongly than on the present ro-ro links, although rail rates quoted to date have not proved competitive. Secondly, the abolition of the UK Dock Labour Scheme has allowed an improvement in performance of the deep sea ports which has led to more deep sea vessels calling direct to the UK, with the concomitant reduction in feeder flows, a trend that may well continue.

With deep sea calls being negligible in the Nordic area, German ports dominate the resulting feeder flows. Again, the fixed links being developed may affect the market balance, as the effect may not simply be to transfer containers to other the modes, but to re-route them by road and rail, direct from deep sea port to destination or vice versa, cutting out the Nordic ports from the itinerary.

The other major factor in the European feeder patterns has been the re-unification of Germany and the switch from command to market economies amongst the former Comecon countries. Deep sea vessels previously required to call at Baltic ports because of political factors can now respond to the natural market forces and use North Sea ports as hubs and tranship by all modes. The decline of Rostock as a container port bears witness to this trend.

These physical and political impacts on the European container feeder patterns are dealt with in more detail in the complementary study, Containers Inland.

Lastly in this section, it is significant that the size of deep sea container vessels utilised by the major inter-continental carriers has steadily grown, with 4800 TEU vessels being the present generation’s point of reference and 6000 TEU now a serious proposition in the near future. Clearly, operators of container vessels of that capacity and physical size will, for cost and port accessibility reasons, further limit port calls and the growth of hub ports and feeding by all modes will increase further.
FACTORS DETERMINING CONTAINER THROUGHPUT

When considering the factors determining the level of European container port throughput, the feeder and inter-European trades have to be examined separately although there are certain common factors.

Feeder flows are dictated by the deep sea lines' European transhipment patterns. As previously discussed, the major deep sea lines are using vessels of increasing size. This is by no means universal as for many lines there are physical and commercial restraints that limit vessel sizes on certain trade routes. However, on the growing Far East trades with Europe, and the North Atlantic services amongst others, vessel sizes are increasing.

The general result is less port calls in Europe. Many lines now call at either Hamburg or Bremerhaven, Rotterdam or Antwerp but in each case, not both. This generates high volumes of feeder traffic between the two ports in each area, and arises because the lines are obliged to offer Bills of Lading to and from each port. This is generally a requirement of their customers, the shippers and receivers.

Whilst much of the inter-port feeder traffic moves by land modes and is lost to the sea carriers, the one port-one area practice of the deep sea lines also generates additional sea feeding to more distant ports. Clearly, for the ports that receive the main line vessels, throughput is enhanced, not just by the deep sea vessels' calls themselves but by the additional handling to and from the feeder vessels.

For the adjacent ports, both handlings can be lost if land modes are used heavily, and the more remote ports receiving the sea feeder services only, have small throughputs and will only handle the containers once. Low throughputs tend to raise ports costs. In this latter case the development of more fixed links in Europe could further exacerbate the traffic loss in those ports as containers are transferred by road or rail, directly between customers' premises or inland freight stations, and the deep sea port.

Overall feeder growth is dictated by the deep sea lines' container volumes and the degree of their commitment to the hub port principle. Containerisation of further deep sea areas in the world, currently served by general cargo services is unlikely to generate significant additional container volumes in the foreseeable future.

Inter-European container traffic is led by the level of non-bulk trade between European countries and the container's market share of the total. Inter-European non-bulk trade grew between 1986 and 1992 but more slowly than the
previous five years, no doubt reflecting the recession that has variously affected Europe in recent years. It is true to say that non-bulk trade and containerisable trade are not wholly the same thing but the growth in inter-European container handlings over the decade is in fact a reflection of the increased inter-European non-bulk trade.

9 THE MAIN CARRIERS

There are over 100 lines carrying intra-European container traffic, including the ro-ro and ferry operators as well as the wayport calls by deep and short sea lines. Most lines are either feeder or inter-European carriers and many are a mix of the two in varying degrees. Feeders can be dedicated or partly dedicated to the schedules of their deep sea customers, others are wholly common carriers.

Some of the deep sea lines offer their own intra-European services, these including Maersk, Sea-Land, K Line and NYK, again a mix of feeder and inter-European. Also in this category is Portlink, a wholly owned subsidiary of CMB.

The twelve leading operators companies account for 34-50% of the total traffic of 5.2 million TEU, a very similar percentage to 1986, implying that the market dilution which occurred between 1982 and 1986 has been halted.

10 A SUMMARY OF THE SURVEY

The salient results emerging from the study and their relevance to the previous two editions are:

* In percentage terms, European container handlings are down in relation to the world total, compared to the previous study years, standing at 22% in 1992;

* In real terms, European container volumes are up, rising from 2.2 million TEU in 1982 to 5.2 million in 1992, in increase of 136%;

* The feeder share of European container flows has increased from 30% to 43% in ten years;

* The inter-European share of European container flows has fallen from 70% in 1982 to 57% in 1992;

* The container share of inter-European non-bulk trade has remained more or less constant at about 7%;
Container Traffics in Europe - Changing Patterns and Policy Options

* One in six of all deep sea containers handled in Europe are transhipped at least once.

11 APPLICATION OF DATA TO POLICY OPTIONS

From a policy point of view one of the values of such a survey is that it establishes a broad database which allows for the discussion of various maritime options.

The survey illustrates some remarkable contrasts in the success of the container mode in capturing market share. Thus, for example, we find that there is a larger volume of containers moving between Ireland and the Continental mainland than with Great Britain, although the unit load market overall is larger with the UK.

<table>
<thead>
<tr>
<th></th>
<th>'000s TEU</th>
<th>million tonnes liner traffic (approximately)</th>
<th>Estimated container market share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ireland - UK</td>
<td>240</td>
<td>10.5</td>
<td>17%</td>
</tr>
<tr>
<td>Ireland - Continent</td>
<td>309</td>
<td>3.0</td>
<td>75%</td>
</tr>
</tbody>
</table>

Table VI: Container market shares with Ireland

A different type of contrast prevails in trades between Great Britain and Denmark and Spain respectively.

The maritime distance in both cases is approximately 400 nautical miles. Despite the fact that the UK - Denmark market is only approximately half of the size of the UK - Spain market (ie so ships are more difficult to fill), over 90% of Danish traffic moves by direct shipping, while only 30% so moves from Spain. The remainder follows the 1000 kilometre road transit of France.

12 A CASE STUDY: THE ATLANTIC ARC

We have examined some of the factors which underlie this contrast in a study recently completed for the Atlantic Arc Commission. The study was designed to determine whether regional ports in the Atlantic Arc area had a substantial future in the liner trades. It became evident that the success of such regional ports would go hand in hand with the development of a maritime network cor
responding to the principles described in EC directives concerning combined transport. That is, a network which would provide a unit load shipping service within 150 kilometres for most origins, and long distance maritime routes to provide for a variety of destinations on a regular basis.

The area of study covered potential maritime markets between the Iberian peninsula and Western France with the British Isles, and including potential routes between Ireland and the Bay of Biscay to the Continental Channel ports.

13 THE ATLANTIC ARC MARKET

In 1992, there was little no direct roro traffic in this market area. The sum total amounted to only some 12000 trailers, or the equivalent of only 1.5 weekly shiploads.

Our survey of the container industry indicates that there are approximately 3 million TEU of intra-European traffic moving by direct container shipping. Some 780,000 TEU moves within the Atlantic Arc area.

<table>
<thead>
<tr>
<th>Route</th>
<th>'000s TEU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ireland - Continent</td>
<td>309</td>
</tr>
<tr>
<td>Iberia - N Continent</td>
<td>312</td>
</tr>
<tr>
<td>Iberia - UK/Ireland</td>
<td>159</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>780</strong></td>
</tr>
</tbody>
</table>

(= 520,000 units at 1.5 TEU/unit)

Table VII: Estimated direct intra-European container traffic, Atlantic Arc routes

Our analysis of relevant trade data suggests that there are approximately 17.4m tonnes (1992) of liner trades in these markets, equivalent to some 1.58m freight units.

It follows that only a third of potential shiploads of unitised cargo in the area actually use the longer maritime mode. The challenge is to identify a commercial, route and port structure which can satisfy the market in terms of tariff and service quality.
Our analysis of trade data (source Customs and Eurostat), and regional data from the key countries (the UK, Spain and France) enabled us to develop an origin - destination matrix for the area of opportunity. Freight was categorized by trade classification at the five digit SITC level to estimate potential liner tonnages. Where this could be compared against tonnage data by unitised modes, it was found each country to country flow so checked was within 4% of our estimates of ‘liner tonnes’.

The next stage was to convert these tonnages into the number of units (containers or trailers), and then into potential ‘shiploads’. We assumed a mean conversion rate of 11 Customs tonnes per unit, to take into account empty trailers and containers.

<table>
<thead>
<tr>
<th>m tonnes</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ireland - N Continent</td>
<td>2.4</td>
</tr>
<tr>
<td>Ireland - Spain</td>
<td>0.1</td>
</tr>
<tr>
<td>Ireland - Portugal</td>
<td>0.1</td>
</tr>
<tr>
<td>UK - Spain</td>
<td>2.7</td>
</tr>
<tr>
<td>UK - Portugal</td>
<td>0.7</td>
</tr>
<tr>
<td>N Continent* - Spain</td>
<td>8.5</td>
</tr>
<tr>
<td>N Continent - Portugal</td>
<td>2.9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>17.4</strong></td>
</tr>
</tbody>
</table>

Equivalent to approx 1.58 m freight units

* excluding France. All N Continent routes include Germany.

Table VIII: Potential shiploads available from each Atlantic Arc area

This can be converted to approximately 1.58m freight units per annum. Loaded onboard roro ships of about 1000 lane metre capacity, that would equate to about 220 shiploads in each ‘direction’ per week (60-65 units per ship).

The Atlantic Arc shipping analysis was restricted to coastal port hinterlands between Southern Spain and the Netherlands, so that German traffic was then excluded. That reduces the total market to the equivalent of 140 shiploads per week.

We tested the proposition that a half of this total volume could be attracted to longer distance maritime routes. That is, that the maritime share rises by 50% from a one third to a one half market share, by offering more frequent services and using roro container ships to accommodate trailers as well as containers. This is described in Table IV. The table lists each Atlantic Arc area by the
number of 'potential' shiploads per week (each direction) that might be available to a maritime network. Only traffics trading 'within' these areas are included.

<table>
<thead>
<tr>
<th>Area</th>
<th>Total shiploads per week</th>
<th>Flows over Inter area</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2/week</td>
</tr>
<tr>
<td>E Spain</td>
<td>18.2</td>
<td>6</td>
</tr>
<tr>
<td>Ireland</td>
<td>17.2</td>
<td>3</td>
</tr>
<tr>
<td>Netherlands</td>
<td>14.2</td>
<td>2</td>
</tr>
<tr>
<td>Portugal</td>
<td>12.1</td>
<td>3</td>
</tr>
<tr>
<td>SE England</td>
<td>11.2</td>
<td>2</td>
</tr>
<tr>
<td>SW England</td>
<td>9.3</td>
<td>2</td>
</tr>
<tr>
<td>NE France</td>
<td>8.9</td>
<td>2</td>
</tr>
<tr>
<td>NE Spain</td>
<td>8.5</td>
<td>0</td>
</tr>
<tr>
<td>N England</td>
<td>8.3</td>
<td>0</td>
</tr>
<tr>
<td>Belgium</td>
<td>7.8</td>
<td>2</td>
</tr>
<tr>
<td>NW Spain</td>
<td>5.3</td>
<td>0</td>
</tr>
<tr>
<td>SE France</td>
<td>4.7</td>
<td>0</td>
</tr>
<tr>
<td>Scotland</td>
<td>3.8</td>
<td>0</td>
</tr>
<tr>
<td>SW Spain</td>
<td>3.7</td>
<td>0</td>
</tr>
<tr>
<td>NW France</td>
<td>2.8</td>
<td>0</td>
</tr>
<tr>
<td>SW France</td>
<td>2.7</td>
<td>0</td>
</tr>
</tbody>
</table>

Table IX: Potential shiploads available from each Atlantic Arc area

Only two maritime area (one of which is actually on the Mediterranean) generated two flows which could justify three sailings per week to another region. Some areas had no potential flows which could generate two shiploads per week (eg NW Spain or Scotland). Of approximately 60 long distance routes available, only 12 could generate two 'shiploads' per week.

The Study highlighted six main features:

* Overland routing was more expensive than direct shipping, but only if port charges were charged at North European levels;

* Port charges varied widely, and tended to discriminate against longer shipping routes;

* There was rarely sufficient traffic to justify high frequency services between individual regions;

* A substantial proportion of forwarders required service frequencies of three times weekly;
**Container Traffics in Europe - Changing Patterns and Policy Options**

* A substantial proportion of the market was now committed to trailers;
* Maritime systems could offer competitive transit times.

Providing that the problem of high port charges in some countries could be addressed, the crucial problem, therefore, is neither the cost or speed of the maritime mode, but one of identifying sufficient volume to justify a competitive frequency. Nevertheless, if (as above) we assume the maritime mode can capture half of the available market, each area is able to generate sufficient total volume to justify a competitive frequency: three sailings per week. Unfortunately, traffic actually 'spreads out' to several areas, and it is essential that some means be found of aggregating several are-to-area flows within the same vessel.

**14 NETWORK OPTIONS**

We examined four different approaches which could address these challenges. These were:

a. Small ships, so that a given volume would permit a competitive frequency to a wider number of destinations;

b. Multi-porting; to achieve the same objective by assembling several markets on the same ship;

c. 'Super-routes' over longer distances, with larger catchment areas;

d. Transhipment, to expand the number of destinations which could eventually be served from a given sailing departure.

A small ship approach could not succeed commercially. It is a feature of these markets that the existing 'base-load' traffic moving by sea is that which is prepared to accept a low frequency to achieve economies of scale through using larger ships. Such services would not bear the cost implications of operating smaller ships. The operators could not be persuaded to lose economies of scale, as they would be under immediate threat from competitors who did not so adapt.

A multi-port approach over the distances available with the Arc proved uneconomic; the cost of diversion so raised shipping costs as to render the option expensive and slow, because of delays at intermediate ports.

The most likely opportunity lay in 'super-routes'; new routes between such ports as Bilbao and Southampton designed to capture roro traffic through offer-
ing several sailings per week. There can be no doubt that a substantial proportion of the market prefers the use of trailers. Approximately 70% of the UK-Spanish market uses the roro mode despite the cost of haulage across France. However, the reason why longer distance roro services are still in their infancy can be largely attributed to the high charges levied in Iberian ports, and particularly the practice of charging goods by value bands and not weight. This obviously discourages maritime trailer traffic, as that traffic tends to be the most valuable.

15 COMBINED TRANSPORT PRINCIPLES

Unfortunately, such routes would still not conform to the principles of combined transport. Long road hauls (in Spain and Great Britain) would still be required. That lead the study to also consider transhipment, to provide the means whereby an individual region could support a local service two or three times per week, providing that it passed through a transhipment port where some cargo could be transferred to other services, to provide a comprehensive network.

There are two principle drawbacks to transhipment. Firstly, there may not be a suitable port infrastructure available to satisfy the geographical characteristics required of such a port, and secondly, the shipping industry is unused to the degree of inter-line co-operation that would be required. Furthermore, it could only achieve its potential if the cost of port cargo transfer was low. Its viability is the subject of further studies.

It would have been pointless to identify a maritime opportunity if rail could be shown to be capable of better fulfilling the objective. The study therefore compared the potential cost of maritime services with the charges which an efficient rail network could offer, working under the principles of EC directive 91/440 whereby infrastructure owners should not discriminate between train operators.

This comparison drew attention to the contrast between intermodal handling rates between rail and shipping, and the way in which the public sector railway industry is able to develop operating networks (such as Intercontainer and through the members of the Union Internationale Rail-Route) in a way the private sector shipping industry seems viable.

Intermodal rail-road handling costs are typically 30 Ecu per unit. Sea to road charges in the Iberian peninsula are typically 200 Ecu per unit. Insofar as network development is concerned, the railway system has developed techniques of train-sectioning at ‘hubs’ to provide the means of offering daily services between European regions. The maritime industry has no such equivalent flexibility.
16 SUMMARY

One of the effects of the Single European Market has been to reduce drastically the availability and reliability of intra-European freight transport data. It is, therefore, all the more important to be able to develop alternative methods of tracing the development of intermodal traffics if the success and potential for maritime combined transport is to be understood. We have illustrated in this short paper, how such data can be collected, collated and then applied to policy issues in the Community, and allied with market intelligence and transport cost information to debate and develop policy options. The preliminary conclusions from the Atlantic Arc Study were that existing ship technology is able to deliver a cost effective and rapid level of service, and that the challenges lie in minimising port charges and addressing the commercial structure within which the maritime industry functions.

17 THE EUROPEAN CONTAINER FREIGHT MARKET: CONTAINERS INLAND

This complementary study to Containers by Sea covers all aspects of the inland movements of containers in Europe. It analyses and quantifies the movements of maritime containers between European countries and regions, and places the analysis into the context of the many changes that have and are taking place in the European domestic freight transport. For each country covered, the competition between road, rail and inland waterway is evaluated and the resulting container carrying infrastructure compared. Containers Inland will be published in May 1994.
Section IV - Shortsea Shipping Case Studies

STRATEGIC PROFILES FOR TRANSPORT COMPANIES: THE CASE FOR DUTCH FOREST PRODUCT CARRIERS

By A.A.C.M. Wierikx and J. van Riet

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European Shortsea Shipping 337
1 INTRODUCTION

The Dutch shipping industry is in a crucial phase of its development. Increasingly Dutch shipowners choose to register their vessels under foreign flags. Last year the total number of ships under Dutch flag declined with another 10 percent. This development worries the national government, because it believes it is important to maintain shipping activities within the Dutch borders. A group of successful shipping companies will be beneficial to the further development of the Dutch transport and distribution industry and the improvement of The Netherlands as a mainport of entrance for global cargo flows into Europe.

The government is presently considering to change its focus from direct financial support for the industry to other types of transport policy. The future goal of government transport policy will be to stimulate Dutch shipping companies to maintain their activities in The Netherlands and also to attract new shipping (related) activities from abroad. One of the ways to help the industry is to provide information about strategic market opportunities in different market segments.

In 1993 a number of studies was carried out for the Dutch Ministry of Transport to investigate the current position of the Dutch shipping industry and to give recommendations for future development of the shipping industry and the potential role of the government therein. At the same time INRO-TNO carried out a study regarding the strategic development of transport companies in general, which resulted into a method to determine the strategic possibilities for these companies. So far, this method has been applied to a number of, mostly land-based, transport markets.

At the moment shortsea shipping seems to offer bigger opportunities for shipping companies than deepsea trades. In this paper the results of the different studies mentioned will be combined to determine the strategic opportunities for Dutch shortsea shipping companies. The focus mainly will be on the shipment of forest products. In one of the studies for the Ministry, the logistic chain of forest products was analysed in order to gain knowledge about the position of shipping companies within this chain as compared to other participants involved.
The results of the studies have been discussed with government officials, industry representatives and managers of a number of shipping companies. Their reactions, though critical, have so far been mainly positive. The authors believe that the results of the studies do not only apply to the Dutch situation, but can be relevant for other European shipping companies and governments as well. Also we are convinced that the ideas are not limited to forest products and shortsea shipping alone, but can also be applied to other trades and commodities.

In this paper the general method to determine strategic opportunities for transport companies (called TOVER) will be discussed. The next step will be to analyse the current situation of the transport market for forest products. This analysis will result in a market segmentation, based on market and product characteristics. After that, the current position of Dutch shipping companies within the given segments will be determined. These steps are necessary to be able to come up with the strategic opportunities that these companies have to improve and expand their position. Finally some conclusions and recommendations for shipping companies involved in forest product markets will be given. Also attention will be given to the relevance of the presented ideas for other markets and commodities.

2 TOVER: METHOD TO DETERMINE THE STRATEGIC OPPORTUNITIES FOR TRANSPORT COMPANIES

Making choices is essential for the strategic management of every company. Logistic service providers do not make an exception to this rule, especially because their environment changes rapidly. Without adaptation to new circumstances their existence might very well be endangered. Logistic developments are quickly emerging and cause a need for improved logistic services. All logistic service providers, including shipping companies, have to position themselves into the markets that they wish to operate in. Successful companies will develop from operational transport firms into fully equipped companies that deliver extensive logistic services. This requires quite a metamorphose. Large investments in people, equipment and systems are necessary if companies want to follow this path. In some cases the return on investment is not clear, so the actors have to select the timing and optimal design of these investments carefully. The market for logistic services certainly is not a homogenic one and what is a good strategy for one firm could very well mean a disaster for another. For some firms an ideal strategy would be to focus on a dedicated service for a small number of clients, whereas for others more generic services are appropriate.

In the TOVER study (van Riet et.al., 1993), regarding the future role of transport companies, strategies are determined that can be followed by logistic
Strategic Profiles for Transport Companies

service providers in order to avoid the threats and make full advantage of the possibilities that apparently exist. A number of steps need to be followed for these strategies to come about:

I. Definition of the relevant market;
II. Determination of the current position of a company (or a group of companies) in terms of activities and relationships;
III. Analysis of the external circumstances;
IV. Determination of strategic opportunities for improvement of the current position;
V. Determination of strategic opportunities for expansion of the current position.

These steps will be briefly discussed. However, it is important to mention first that the TOVER method is based on earlier research into strategic management by, a.o., Porter (1980) and Ansoff (1984). Also the strategic development of transport companies has been the subject of a number of other research projects in The Netherlands. The method described hereafter is basically an integration of two different viewpoints:

* The first approach to strategic development is related to the products and markets that companies are focusing their activities on. Ansoff is the main prophet of this line of thinking;
* The second approach looks at strategic behaviour of companies from a competitive perspective. According to Porter companies react to the competitive forces they experience as a result of the actions of other parties.

The combination of both approaches leads to the following steps:

I. Definition of the market

Before the strategic options for a specific company (or a group of companies) can be found, it is essential to define the relevant market that needs to be studied. Transport markets can be defined by:

* Market characteristics (such as geographic area, density of demand and supply points, type of regulation);
* Product characteristics (such as volume/weight density, value density, necessity of conditioning);
* Technological characteristics (such as transport mode, information technology used, handling equipment);
* Logistic characteristics (such as shipment size, order time, reliability).

It is important to find the relevant and dominant characteristics of a particular market. These characteristics determine the possibilities for certain strategies.
Section IV - Shortsea Shipping Case Studies

For example, in an already very specific market, the chances for further specialisation are little.

II. Determination of the current position

Based on one of the viewpoints mentioned above a company’s strategic position can be described by the activities it carries out. For transport companies these activities can be displayed by the use of a three-dimensional diagram. This diagram (figure 1) shows on the axes respectively geography, network activities and logistic activities. The activities of a transport company will always be a combination of these three dimensions.

![Diagram](image)

Figure 1: Strategic development axes

The geography axis represents the geographical area of operation of the transportation company. This area can be local, regional, national, continental and/or intercontinental.

The network axis represents on the one hand the complexity of the network and transportation activities and on the other hand the level of control the company has over the transportation activities within the network.

The logistic activity axis contains two aspects as well. On the one hand it represents the complexity of the storage related logistic activities offered. On the other hand this axis represents the level of control the transport company has over the activities that are carried out within the logistic chain.

III. Analysis of the external circumstances

An important step in the method is to analyse the external circumstances and developments the company faces. Aspects that need to be included are ex-
Strategic Profiles for Transport Companies

pected development of volumes, changing needs of customers, number of competitors, etc. Especially important is the position, the strategies and the power of other participants in the logistic chain(s) in which the transport company participates.

IV. Strategic possibilities to improve the (current) position

With the input of market definition, the current position and the external circumstances, now the strategic options can be determined. This can be done in two steps. The first step will focus on the possibilities for consolidation (improvement) of the current position. The next step describes the possibilities for changing (expanding) the position.

Given the current position in the diagram (geography, network activities and logistic activities), a company can try to find a more profitable position, where it has some level of protection against its competitors. By pursuing a certain competitive strategy a company can try to make the most of its current position. This can be done in the following ways (based on Porter, 1980):

Value adding: This means that the operator possesses or develops a number of unique characteristics for its organisation. These characteristics are only valuable when:

* the competitors do not have these characteristics;
* the customers recognise and appreciate these characteristics;
* the customers are prepared to pay higher rates.

Specialisation: The second possibility to improve the position is specialisation. This means a further concentration on certain market segments, based on one or more of the earlier mentioned characteristics: product, market, technology and logistics. Also specialisation is only possible if a company can get a higher price for its services.

Price/service ratio: The last possibility for transport companies is to improve the price/service ratio. When there are no more possibilities for value adding or specialisation, price competition is the only opportunity left. For Dutch transport companies with their high labour costs, this is most of the time not a very attractive option.

Figure 2 shows the combinations and priorities of the three possibilities in general.

In many transport markets it is difficult to find ways to escape price competition (Korver et.al., 1991). One could argue that in some markets there is a cyclical process going on. Strategic advantages, like unique characteristics and specialisations, can be, and increasingly are, copied by competitors. Therefore
operators continuously need to take action to stay out of price competition. But as time goes by they are running out of possibilities for value adding and/or specialisation. Finally, all possibilities are exhausted and no further improvement is possible within the current position. Figure 3 gives an illustration of this process in which possibilities for improvement of the position are getting increasingly narrow.

V. Strategic possibilities for changing the current position

Besides the possibilities for improving the current position, there are also strategic possibilities for changing (expanding) the current position of a transport company (Vermunt & Ruijgrok, 1993). These changes in the position can be visualised as one or more moves within the three-dimensional diagram presented earlier.

Geographic axis: On this development axis, transport companies can expand their geographic service area (expansion strategy). For instance, new customers in other countries can be pursued.

Transport/network axis: The transport and network activities of a transport company can be developed by (diversification strategies):

* Moving the focus from carrying out transport activities to increased control of subcontracted transport activities within the network and/or:
* Developing the transport activities from a simple network to a more complex network.

Logistic activities axis: The third direction is finding a new position on the axis of logistic inventory related activities. This can be done by:
Figure 3: Cycle of declining possibilities for value adding or specialisation strategies

- Developing from simple to more complex logistic activities, and/or
- Changing the focus from carrying out inventory related activities to increased control of activities in the logistic chain.

It is obvious that most of the time there is no or/or discussion. The possibilities for development along the axes have to be found within the limited means that a company has available. Therefore often expansion in one direction is accompanied by concentration in another direction. Expanding the network with pick-up and delivery services for example could mean that further concentration on a limited geographic service area is necessary.

After a change of position, a company again needs to make a choice how to implement the chosen new position. This of course can be done by value adding, specialisation or price/service competition. Again the transport company can use these tools until its possibilities for upgrading its competitive position are dried out. This will probably result in the need for a new change (expansion) of the position of the activities of the company. These continuing changes are necessary for a company to escape the situation of price competition. In highly competitive markets this can eventually result in a (second) cyclical process that is visualised in Figure 4.
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Figure 4: Cycle of continuing strategic improvement

3 MARKET ANALYSIS AND DEFINITION FOR FOREST PRODUCTS

The TOVER-method was used to find possible corporate strategies for Dutch forest product carriers (Wierikx et al., 1993). As mentioned in chapter two, the first three steps consist of a definition of the relevant market, a determination of the current position of the shipping companies and an analysis of the external circumstances. Although steps one and three were carried out separately in the study mentioned, in this paper they are discussed together.

3.1 MARKET ANALYSIS

The forest products industry can be divided into a number of application areas. The base material, wood, is used for: (percentages in 1991)

* Fuelwood (52%);
* Pulpwood/woodchips (13%);
Strategic Profiles for Transport Companies

* Industrial roundwood:
  - Sawn logs/veneer logs (28%);
  - Other industrial roundwood (7%).

Although it is the largest category, fuelwood is mostly consumed locally in the areas of origin and therefore not transported over long distances. Most important in value are the paper and paper product chains, which are part of the pulpwood application area, and the sawnwoods chain.

To gain knowledge of the market developments that are to be expected, it is important to look at the position and logistic requirements of the actors in these chains. In the forest product industry the following developments can be recognized:

* Production companies are merging their activities to avoid excess capacity and to take advantage of economies of scale. Cargo flows increasingly become intra-company flows;
* Production companies are building market positions in developing countries by increasing production capacity and buying forests;
* The increasing use of recycled paper in the production process causes transfers of areas of origin (from forest to cities);
* Paper supply nowadays is more diversified and of higher value. Transportation companies need to react to these developments;
* To reduce inventory costs, production companies are searching for new, efficient and controllable distribution systems;
* Given the customer driven markets, the power of the buyers is increasing. This results in a more customer driven production and smaller and more frequent shipments.

Within the scope of these developments, it is expected that relations between shippers and buyers will intensify to reduce costs and insure quality. Transportation companies and logistic service providers can play a very important role in these developments.

When comparing market demand, product characteristics, transport distance, logistic chain and other important elements in the transportation of forest products, a differentiation can be made into five segments, each describing unique combinations of the elements mentioned above:

* Main stream deepsea transport;
* Additional deepsea transport;
* Dedicated shortsea transport;
* System shortsea transport;
* Standard shortsea transport.
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In the next paragraph, every segment will be described in more detail. Although the deepsea segments are less relevant here, they are discussed in short, to give a complete overview.

3.2 SHORTSEA AND DEEPSEA SHIPPING SEGMENTS

3.2.1 Main stream deepsea transport

Characteristics

For long distance transport of forest products, large multi-purpose carriers are used. The vessels are equipped with gantry cranes and open hatches. They basically carry primary bulk products (low value density). Mostly they only call at a few east- and a few westbound ports. They can operate their services either as a tramp or as a line carrier.

Within the forest products trade, this segment is dominated by Gearbulk (41 vessels, tramp service) and Star Shipping (26 vessels, line service). The rates on intercontinental trades are set by these carriers. Dutch shipping companies are not involved in main stream deepsea transport.

Market perspectives

Rates are expected to decrease with a further increase of the capacity of vessels. In the next decade capacity will probably grow beyond maximum demand. However, in the beginning of the 21-st century, new markets will probably open and GATT can bring some improvement of the market situation.

3.2.2 Additional deepsea transport

Characteristics

Additional deepsea vessels operate in the same trade as main stream deepsea carriers, but with a higher degree of flexibility. DWT of the vessels in this segment is much smaller than in the main stream segment, which makes these vessels also suitable to call on smaller ports. Besides the higher degree of penetration, the quantity per shipment is smaller and the value density is higher. Customer service plays an important role in this segment. The Dutch forest products operator Spliethoff is involved in this segment.

Market perspectives

Nowadays, the additional deepsea carriers are working in the shadow of the main stream deepsea traders. It is expected that, in the future, this market will
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Customers are demanding smaller amounts, higher quality and more varieties to be delivered faster and more reliable.

3.2.3 Dedicated shortsea transport

Characteristics

In this segment, shipping is part of the logistic chain of a specific production company. Carriers (are forced to) operate in service to the benefit of the whole company (e.g., Finncarriers). Therefore, the ships are equipped for transportation of a small number of commodities. Their cruise speed is high and their port-time is minimised. They operate in line-service with a minimum amount of calls. The combination of line-service and special equipment makes it difficult to acquire back-haul.

The "Reels-On-Wheels System", developed by the Delft University of Technology (Wijnolst, 1993), is classified as highly dedicated and will, whenever it will be implemented, belong in this category. It is equipped to handle and transport paper-reels in a very efficient way.

Developments

Because of the economic recession, the need for back-haul is growing. Very often the rates offered by operators in this segment for back-haul are low. This can be explained by the lumpsum prices calculated for the specialised commodities. However, the possibilities to transport other commodities are limited.

3.2.4 System shortsea transport

Characteristics

The main goal for the operators in this segment is maximisation of occupancy ratio. The vessels need to make as little miles in ballast as possible. To achieve a high level of payed miles, operators are setting up system-traffics. The system traffics are recognised by a few large contracts for shipping commodities. These contracts are mostly based on weekly shipments without further time restrictions. Additional cargo is acquired to make the round-trip payable. Commodities that are often transported in back-haul are china clay, waste paper and steel. Depending on the additional cargo, roundtrips are carried out in A-B-C-A-like systems. Vessels in this segment are flexible within the system-traffic. The vessels do have a certain specialisation (box shaped holds and loading/unloading gear), but are able to transport other commodities.
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Developments

The market perspectives for carriers in this segment are relatively good. An increasing number of shippers will be involved in fixed schedule product flows, that are very well suited for this type of transport service.

3.2.5 Standard shortsea transport

Characteristics

In the standard shortsea transport segment, the transported commodities can be characterised by low value-density. Logistic requirements are not very important. Low rates are most important for shippers. The average maintenance condition of these ships is worse than in the other segments. Operators in the system shortsea transport segment use the standard segment to escape. Whenever there is no shipment available in the system segment, they agree with shipping cargo against spot market prices. They then transfer temporarily to the standard segment.

Developments

Although most operators prefer to establish more long-lasting system-traffics, their will be always a need for additional standard shortsea shipments. It is expected that the market situation for this segment will not change dramatically in the future.

4 CURRENT POSITION OF SHIPPING COMPANIES IN FOREST PRODUCT TRADES

After discussing the shortsea shipping market for forest products, in this chapter the focus will be on the current positions of the Dutch forest products carriers in the three different shortsea segments. These positions will be determined by using the method described earlier.

In the Netherlands about 8 shipping companies are active in the forest product trade. They operate either worldwide in deepsea trades or continental in shortsea trades. Because competition and crew costs are increasing, they are looking for possibilities to specialise. One of them sets up special system traffics, another specialises in great flexibility and another one focuses on port-port tramp-services.

The vessels used are from a diverse range, equipped to carry bulk, neobulk and/or customer products. The variety of products and changing sources and
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markets pose commercial and technical challenges to ship operators. Concepts like Sto/Ro, Ro/Ro, 'Reels-on-wheels', cassette, COB, etc. are a few examples of the level of innovation within the forest products trades.

In all shortsea segments the current position of Dutch shipping companies involved in forest products on the geography axis is limited to Northwest Europe. Concerning the network and logistic activity axes, there are several differences between the shortsea segments. Therefore, they are discussed separately.

network axis

In the standard shortsea shipping segment the network consists of relatively simple port to port transport activities. In the system-traffics segment, transport tends to be somewhat more complex. Some operators transport wood and paper products on a carrier-haulage basis (port to door). This means that the shipping company has a responsibility for and control over inland transport. In the dedicated shipping segment, the trades are part of a more complex network, that includes all land based movements for the shipper. So far these networks are not controlled by the operators but by the shippers or the consignees.

Conclusion: There is some difference in the complexity of networks between the three segments, but in the current situation this difference is relatively small.

logistic activity axis

Concerning additional logistic activities the approach is similar. Operators active in the standard segment only transport and do nothing more. Operators active in the systems traffic-segment only take responsibility for transshipment when the occupancy ratio of the vessels increases. Other logistic activities in this segment are very rare.

In the dedicated segment sea-borne traffic is part of the total logistic operation of a production company. Although vessel-operators are part of a complex network, they are not responsible for the operation of other logistic activities. These activities (like stevedoring, trucking, etc.) are carried out and controlled by the producer or third party companies hired by the producer. It might even be so that the vessel operating company itself is hired and controlled by the producer (eg. Transfennica). The position of the dedicated carrier on the logistic activity axis is then equal to the position of the standard carrier on the logistic activity axis.

Figure 5 shows the current position of the shortsea segments. Since there is no difference between the geographical service area of the shipping companies in all three segments, the geography axis is left out of the diagram.
5 STRATEGIC OPPORTUNITIES FOR DUTCH FOREST PRODUCTS CARRIERS

5.1 IMPROVEMENT OF THE CURRENT POSITION

Within the current position there are a number of possibilities to improve operations and profit. In this step we will talk about the possibilities for operators in general and the situation in the different shortsea segments.

Value adding

To distinguish oneself from the competitors, additional value can be added to the service of the operator by improving aspects as flexibility, quality of the crew, reliability and excellent maintenance.
Strategic Profiles for Transport Companies

Regarding Dutch forest products carriers, we doubt whether it is possible to extend or even consolidate the current position in this way. At present the Dutch flag already stands for high quality service. Shippers are always tempted to choose a cheaper operator from a low cost country. Besides, the competitive advantage of added value disappears when these competitors offer the same service.

Specialisation

A possibility to escape from price competition is to introduce further specialisations. Specialisation can be achieved on one or more of the following aspects:

* **Products**
  Operators could specialise their equipment on transportation of specific categories of commodities such as paper reels, or concentrate on conditioned transport (e.g. kiln-dried timber).
  The risks for operating specialised ships are very high. These ships offer little flexibility and it is very difficult to find back-haul.
  Besides, many forest products-carriers are already equipped to transport certain commodities (COB vessels, Sto/Ro, Ro/Ro).

* **Market**
  Many operators in the European shortsea market already have a geographic specialisation. For example, in the Baltic specialised ice-class ships are active.

* **Technology**
  Similarly to product specialisation, further technology specialisation will lead to less flexibility and decreasing possibilities to find back-haul. There is a certain relationship between development of loading and discharging systems in the port and technological development of ships. Shipping companies therefore cannot introduce new technologies by themselves.

* **Logistics**
  Further specialisation within logistic characteristics like leadtime, accuracy, shipment size, etc., offers sea-borne traffic fewer possibilities than land-borne traffic. In the present situation shippers are not prepared to pay extra for high speed or high quality services.

When ships become more sophisticated and dedicated the possibilities for finding back-haul are decreasing. However, so far back-haul is essential to survive.

Price/service ratio
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Small Dutch forest products-operators, operating on a high level of costs (linked to expensive crew and security regulations), will never be able to distinguish themselves with a good price/service ratio.

After the discussion of the possibilities for improving the current position in general, we will now switch to the situation for the three distinguished segments

A. Dedicated shortsea transport

Services offered by dedicated shortsea operators are relatively sophisticated. The probability of not finding back-haul and being exposed to high operating costs is therefore large. Operators are totally dependant on their customers. Trying to distinguish themselves with a better price/service ratio is not a feasible option for the shipping companies. Within the current position, offering extra value will probably not be a good choice. Since competition is heavy, shippers rather choose cheaper operators with a lower level of service. However, in the long term the option of improving service is the only way for high cost operators to be profitable. This can only be realised when the shippers are prepared to pay for it.

B. System shortsea transport

Operators within the systems segment have more freedom than dedicated shortsea operators. They can offer more flexibility to customers and they have more possibilities to specialise and find back-haul. The objective for forest products operators in this segment is to maximise the occupancy ratio. To escape from price competition, there are some possibilities to upgrade their current position.

Value adding: This can be done by offering:

* More flexibility:
  Within the existing system-traffics, available capacity can be increased. This means more flexibility for the shippers.

* Offering onboard quality management:
  The value density and complexity of products is increasing. The transportation of these products needs to be done more carefully then before. A competitive advantage can be reached by offering shippers capacity that meets quality standards (concerning crew and maintenance).

Specialisation: The shipping companies can specialise their services on:

* Products
  Within the possibilities of finding back-haul, ships can be specialised in carrying more specific products (under certain conditions).
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* Technology
  From a technological point of view, current services can be upgraded by introducing information technology systems (e.g., EDI).

* Logistics
  Improving logistics within the current situation can be done by introducing faster ships or quick loading gear.

Whenever introducing these aspects, operators must think of shipper's needs, their willingness to pay and the availability of similar services from other operators.

C. Standard shortsea transport

The standard transport segment offers minimum service for low prices. Operators in this segment are competing on price/service basis, so having the lowest costs in the business is the goal. Shipping companies carry out nothing more than port to port transportation and try to offer the lowest possible rate. As long as the occupancy rate and profits are sufficient, there is no need to upgrade the current position. Shippers generally will not be willing to pay extra for further improvement or specialisation of services.

5.2 CHANGING THE CURRENT POSITION

Besides upgrading the current position, shipping companies within the shortsea segments have the opportunity to expand along one or more of the three axes mentioned earlier.

The possibilities for expansion are based on the current position (possibilities of upgrading) and logistic, economic and other developments. Below the possibilities for changes of position along the axes are discussed.

Expansion of the geographic service area

For all segments there are possibilities to expand geographic services:

* Southern Europe
  With the establishment of the Common market trade between the Northern and Southern European countries is increasing. An important part of trade with the South European market is now being served by road-transport. In the future, further growth of road transport is less desirable because of environmental problems. This leads to opportunities for rail-transport as well as for shortsea transport to take over part of the position of road transport.
  The recent negotiations for membership of Austria of the European Community led to the decision to maintain environmental limitations for crossing the Alps at least until the year 2005. This offers an important chance
for setting up shortsea services between North Europe and Italy, Greece and, to a lesser extent, Spain and Portugal. Pilot projects should start as soon as possible and operators have about 10 years to take advantage of the circumstances.

* **Eastern Europe & former USSR**
A number of new countries have opened up to foreign trade. However, economic development in these former communist states stagnates. Opportunities are mostly open for carriers in the standard segment, since most of the trades are port to port. When these economies start to perform better there are chances for all segments. Cooperation between operators can lower the risks on services to Eastern European countries.

**Network development**

On the network development axis there are some possibilities for operators as well:

* To gain better control over network operations, they could develop their services from port to port to door to door. This would mean involvement of shipping companies in other transport modes.
* A second possibility is linking shortsea activities with deepsea activities. Until now, deepsea and shortsea activities are performed independently by different operators.
* A third possibility is setting up system traffics in cooperation with the shippers.

The opportunities that the possibilities mentioned offer for the three segments are different. Shipping companies within the dedicated segment are already active in complex networks, which means that they have limited opportunity to further develop along this axis. It might even be a better choice to lower their dependency by offering their transport services to more than one shipper. Network development by standard operators will result in a move into the direction of the system segment. The most favourable opportunities are available for operators within the system shortsea transport segment.

**Development of logistic activities**

On this axis operators can aim to take over certain logistic activities from their customers. This will only be possible in cooperation with port-related activities. Extension of these activities should be combined with upgrading relationships with customers (shippers and consignees). This will result in a move in the direction of integrated chain management, which offers operators an opportunity to change from a shipping company into a logistic service provider.
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In this role they can gain a strong position compared with other participants in the logistic chain. At present, logistic service providers can be found mostly amongst (former) road transport companies.

An interesting example is the combination and integration of forest products-stevedoring in the port of Antwerp. Stevedoring company Varant is controlled by Finnpap which is the marketing group of a number of Finnish production companies. Besides stevedoring, Varant is also responsible for hinterland transport (shipping on a ‘free delivered’ basis). Shortsea vessels are operated by Transfennica and Finncarriers and can be classified as dedicated. The only critical remark that can be made is the difficulty to find back-haul. Because of the line service the flexibility is small. There is no time to wait for back-haul.

6 CONCLUSIONS AND RECOMMENDATIONS

In this last chapter some conclusions are drawn and recommendations are given. These are not only relevant for the forest product trades. Although the examples given are derived from the forest product chain analysis, we think that the market segmentation and the TOVER method can be used in other shipping markets as well. The way this can be done, will be discussed in Paragraph 6.2. Paragraph 6.1 gives an overview of the conclusions from the forest products chain analysis study.

6.1 STRATEGIC PROFILES FOR SHORTSEA FOREST PRODUCTS OPERATORS

The application of the method for shortsea shipping of forest products results in strategic profiles regarding the future development of operators. Generally, in the present situation, carriers mainly focus on increasing specialisation of seaborne transport activities, together with an increase of added value. The operations are optimized by improvement of quality and flexibility of crew and vessels. In the long run, this will not be sufficient to stay out of price competition.

Strengthening of the strategic position can either be done by improving within the current position or by expanding the current position in one or more of the three possible directions (geography, network and logistic activities). A description of the possibilities within the Dutch shortsea forest products market can best be done by dividing the market into three segments (standard, system and dedicated).
Standard shortsea shipping

Many older ships are active in this segment. The operators in this segment perform port-to-port services. The products they transport and the networks they are involved in, do not request high level logistic service. Their strength is low costs and therefore low rates. In general this segment is used as a shelter for operators from the system segment. Whenever there is lack of cargo in the system segment, the capacity can be temporarily transferred to the standard segment (with its spot markets).

An improvement within the current position for these operators is almost impossible. Customers will not be prepared to pay higher prices for added value to the service or for further specialisation.

Expanding the present position is possible along the geographic axis. Services to and from new countries like Croatia, Russia and the Baltic republics can at this moment best be done by low cost operating vessels. Shippers from these economies are only interested in low-profile port-to-port transport.

System shortsea shipping

Forest products carriers in this segment have a certain level of specialisation (box shaped holds and loading and unloading gear). Their service consists of transportation of one or two main commodities (in this case eg paper reels) and additional back-haul commodities in a A-B-C-A- like network.

Until now, vertical chain integration has not been one of the main operators' objectives. Optimization of occupancy ratio so far was the main goal to achieve. However, given logistic strategies of production companies and limitation of road transport, there are opportunities for operators in this segment. One of the most important opportunities is the expansion of services to Southern Europe (growing markets and substitution of road transport). This geographic expansion can best be combined with a further vertical chain integration by taking over activities from other participants.

Forest products producers are increasingly orientating themselves towards global markets, global sourcing and decentralisation of production activities. On the other hand they want to control the whole network. With their worldwide contacts, operators are able to help shippers/consignees in setting up this network. But they need to focus on other than shipping activities only. Attention must be paid to network integration. Their core-business must move from vessel operating company to logistic service provider.

The overall conclusion for the system shortsea shipping segment is that it offers the best perspectives for the future. A move towards more dedicated services for a smaller number of customers seems to be the best strategy.
Strategic Profiles for Transport Companies

Dedicated shortsea shipping

This segment consist of vessels especially equipped for the transportation of a few commodities and operating in the shippers' network. Due to the line services the shipping companies are involved in, it is very difficult to acquire suitable back-haul. In the current position, vessel operating companies are very much dependant on a few shippers. Their services (vessels, trades, etc.) are totally dedicated to these shippers. To lower the risks and increase the occupancy rate, operators should commit themselves to more shippers, take over the control of related logistic activities (such as stevedoring) and link their services to the objective of increasing the occupancy rate.

The overall conclusion for the dedicated shortsea shipping segment is that an increase of the number of customers and the formation of system-like networks is the most attractive strategy.

A new segment?

Based on the conclusions for the dedicated and the system shortsea segment, the best perspectives are offered by a (theoretical) segment that can be positioned between system and dedicated: a dedicated-system segment. In this segment vessel operating companies operate networks of shipping services with additional logistic activities. Their vessels are specialised to transport a certain range of commodities and can be managed in a flexible way. Their networks consist of a few large contracts with a limited number of shippers and a some additional back-haul commodities to maximise the occupancy ratio. The service the operators sell to the shippers is not based on a port to port vessel operating service but on a door to door logistic service.

An illustration of expanding logistic activities in another trade is given by the container shipping company Bell Lines. They recently established the new daughter company Bell Distribution and opened a distribution centre for consumer products in Ipswich.

6.2 APPLICABILITY OF THE METHOD

In this particular study the TOVER method was used to define opportunities for vessel operating companies in the forest product chains. Based on the analysis of the markets, vessels, trades and activities, three segments describing shortsea shipping were distinguished. These segments can be classified as clustered companies on a meso level of aggregation. The earlier conclusions and profiles are therefore formulated on this meso (forest product segment) level.

1. The authors believe that the TOVER method can also be used for definition of profiles on a micro or macro level:
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a. The latter means that TOVER can be used by governmental organisations to detect opportunities for their national shipping industry. Their attention should not only be on sea-borne traffic, but also on other logistic activities (stevedoring, inventory management, etc.) It will then be possible to support shipping industry in other ways then direct financial support or shipbuilding subsidies;

b. Using the method on an micro level, results in the formulation of specific strategies for individual companies, that can be followed to consolidate or expand the company's market position.

2. The segmentation used in this paper to describe developments in the forest products division can also be distinguished for other commodities such as containers, reefer products, ore and oil trades, etc. Within the framework of the study and this paper, it was not possible to discuss these applications in further detail.

7 ACKNOWLEDGMENTS

The authors would like to thank Rob C. Bagchus of the Directorate-General of Shipping and Maritime affairs of the Dutch Ministry of Transport, Public Works and Water Management for his ideas and critical remarks.
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INTEGRATED TUG-BARGE SYSTEMS FOR SHORT SEA SHIPPING IN EUROPE

By E.G. Frankel

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INTRODUCTION

Short sea shipping of bulk and break bulk commodities is distinguished by the comparatively short sea or ocean distances between ports and often large numbers of port calls. Another important distinction of this type of service is that port capabilities and handling rates vary widely as do shipment sizes at the different ports. In dry and liquid bulk short sea shipping, we meet complete ship loads on some routes. Yet port loads and multiple port calls on a route are quite common, particularly in break bulk trades.

Container traffic has become of increasing interest in short sea shipping as mainline, long distance containerships make fewer load center port calls and short sea carriers provide more and more feeder services.

European short sea shipping services traditionally have used self-propelled vessels, often of unique design, such as North Sea and Baltic Sea carriers. Although short sea shipping had declined in Europe for many years, the trend is now being reversed as a result of its cost advantage over road and rail transport, road and rail network congestion, and environmental considerations.

In most cases, this growth in demand for short sea shipping has not been paralleled by port investments and improvements. As a result, short sea shipping requires long port times and resulting long origin-to-destination or delivery times. Integrated tug-barge systems which permit the drop off and swap of cargo barges at ports may provide significant advantages to short sea shipping, as it has in American coastal shipping. The technology, operations, economics, and management of integrated tug-barge operations in coastal trades are discussed in this paper and methods for routing as well as scheduling of tug-barge systems are presented.

OCEAN-GOING INTEGRATED TUG-BARGE SYSTEMS (OITB)

Recent advances in push-tow linkage technology have resulted in ocean-going barges being developed capable of carrying large amounts of cargoes (more than 85,000 dwt) of various types (petroleum, oil, dry bulk, wheeled, and containerized) at moderate speeds (up to 13 knots) in coastal trades, including open ocean routes. Such services now operate along the U.S. East and West
Coasts, in U.S.-South American trades, in the West Coast-Alaska trades, and more.

OITBs of today not only are as capable as ships of equivalent size and speed, but exhibit the added advantage of separable propulsion and cargo units. They also have lower capital costs than ships of equal capacity and performance. Similarly their lower loaded draft, which is usually only 65-75% of that of a ship with comparable capacity, offers the advantage of using larger unit vessels at a particular port subject to draft limitations in its approaches, or make more ports accessible than when ships of equal capacity are used.

Many modern OITBs have linkages that give them the same capability as ships of the same size and speed in transocean or coastal operations.

The primary advantage of propulsion and cargo unit separability is the ability of OITBs to operate in a drop-and-swap mode. In this method of operation, the tugboat drops off the barge at a port to be unloaded and then proceeds independently or with another (empty/loaded) barge to another port or operating area. This allows the costly tug and its crew to be utilized more efficiently since they will be spending more time transporting cargo rather than waiting for cargo operations. On the other hand, in many commercial operations, this also results in lower barge utilization since it has to await the return of a tug before it can be moved. Dropped barges, on the other hand, serve as floating storage. This lower barge productivity may make drop-and-swap operation uneconomical in commercial trades where port times are short compared to sea times and/or where only a few large OITBs can handle all the cargo movement requirements.

Push-towed, ocean-going tug-barges have been in use for over 25 years now and vary in size from 5,000 dwt to 85,000 dwt. Their major attractions are:

1. Significantly lower investment and operating costs when compared with ocean-going or coastal vessels;
2. Greater operating flexibility by virtue of the ability to separate the manned propulsion from the unmanned cargo unit;
3. Lesser draft, usually only two-thirds of the draft, of a vessel with the same deadweight carrying capacity; and,
4. Ease of construction and repair.

Typical integrated tug-barge systems are shown in Figures 1 through 5.

Typical characteristics of integrated tug-barge vessels which can be designed as tanker, dry bulk, or container (or combined) carriers are as follows.
## Table I

The underway or normal horsepower is 70-80% of the installed horsepower and similarly the underway speed of 10-12 knots is calculated at 70-80% of installed horsepower. Various configurations of barges exist, yet most are designed as single purpose tank, bulk, or container barges.
Figure 1

European Shortsea Shipping
Figure 2: Typical modern large push- -towed OGTB’s. (Source: Tug Barge Systems, Inc. Company Brochure)
Figure 3: (Source: Seabulk Corporation Company Brochure)
Figure 4: L.O.T. 2nd Generation push-towed OGTB, (Source: Interstate and Ocean Transport 1978 Company Brochure)
Figure 5: Bulkfleet marine 2nd generation OGTB system
COSTS

The construction cost of an ocean-going barge is usually about 35-40% that of an ocean-going ship of the same carrying capacity. The tug will usually cost about 22-28% of the cost of a ship for a total construction cost of a tug and barge of 57-68% of that of a similarly sized ship. The major difference though is speed, with tug-barge operating speed usually slower at 10-12 knots versus the 13-15 knots for a tanker or bulk carrier.

Crew and supply costs are only about 50% of those of a ship of equal carrying capacity and, as a result, total daily variable costs (excluding financial, insurance, management, etc. costs) is normally 55-60% of that of a ship with equal carrying capacity. If we account for a 20% shorter travel distance per day, ton-mile or ton-km costs of a tug-barge vessel, including all financial costs (20-year amortization) and insurance costs (4% of value) is about 57-65% of that of a vessel of the same size. The lower draft though would allow significantly large tug-barge systems to serve in a depth limited trade.

Mechanically-linked OITBs are manned with crews of approximately 10 men. There are three reasons why these systems have substantially smaller crews than ships of equivalent deadweight, though inspected and licensed by the same regulatory agencies as ocean-going ships.

The first reason is that their enginerooms are highly automated, typical of diesel tugs, so that they are classed for unattended engineroom service. This means that only a Chief Engineer, an Assistant Engineer, and another qualified member of the Engineroom Department are normally required.

Also since barges are classed as unmanned for the purpose of freeboard reduction, no crew is permitted on them for maintenance while underway. This allows the deck department of the OITB to be reduced to the Master plus seven officers and men who are used primarily for underway watch standing.

Loosely-linked 3rd generation OITBs and pull-towed OITBs have even smaller crews. Since their tugboats are uninspected and usually under 200 GRT, there are practically no regulations pertaining to their Manning. Thus, they can operate with two watches, usually of three men each, on voyages of less than six hundred miles and three watches on longer voyages. Consequently, crews range from 7 to 11 men.

Ships must have officers licensed in accordance with regulations.
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TECHNICAL DEVELOPMENTS IN OITB SYSTEMS

OITBs can conveniently be divided into:

1. Pull-toward, tug-barge systems which are designed for towline operation only;

2. 1st generation push-towed, tug-barge systems where the barge has a small stern notch which the tug uses for pushing in rivers, sounds, and during good weather. In the open sea, the barge would usually be towed;

3. 2nd generation push-towed, tug-barge systems which are designed with a deeper notch and coupling hardware to permit the tug to push much of the time while in the open sea; and

4. 3rd generation push-towed tug-barge systems which are designed to permit the tug to push all the time in any weather condition offshore.

These 3rd generation systems can be further sub-categorized with respect to their type of coupling. Specifically, they can be divided into rigid mechanically-linked (or integrated), semi-rigid mechanically-linked (or articulated), flexibly-linked, and loosely-linked systems.

Different notch configurations and coupling methods are used for various conditions. Their choice depends on:

* Weather and sea state conditions expected in the trade;
* Directional control requirements;
* Expected differences in barge operating drafts; and
* Frequency of coupling/uncoupling required and sea conditions under which such operations are to be performed.

Time required for engagement and decoupling is usually a function of the degree of rigidity of the coupling.

Some rigidly coupled systems use catamaran-type tugs which straddle the stern of the barge hull. Similarly, some couplings are designed to be fitted to ordinary tugs and standard barges.

In recent years, 3rd generation, loosely-linked OITBs have become popular because they are inexpensive and can be operated with 100% push-tow operation in coastal trades at a lower cost, then mechanically linked systems, and very deep notch rigidly-coupled systems. They reduce tug motion in the notch so that separation of the tug from the barge will not be required in any sea state. Such systems use a restraining device at the bow of the tug, tension...
integrated tug-barge systems for short sea shipping in europe

cables to restrict surge motion, and lines to limit tug roll, sway, and yaw. the costs of linkages vary with type and size of tug and barge. typical costs are $300-700,000.

types and uses of integrated tug-barge systems

while most ocean-going integrated tug-barge systems are designed to carry dry or liquid bulk cargo, often as full vessel single customers load their use for the carriage of container and other cargo is increasingly attractive, particularly when bulk transport is one way, which is the dominant condition.

most oil barges use deep well pumps for cargo handling, with one pump well serving 2 to 4 tanks on a barge with a centerline longitudinal bulkhead. this way each tank has a backup pump. pumps are connected to centerline deck-mounted loading and discharge pipes which give such barges a fairly clear, uncluttered deck which can be used for container storage, with the exception of a narrow centerline area.

recent designs of a 30,000 dwt oil barge permit the carriage of 960 teus on deck stacked 3-4 high, with ample stability margins. similar designs have been developed for dual coal/iron ore and container carriage on dry bulk barges. these arrangements are of particular interest in trades where liquid or dry bulk trades move in the opposite direction from containerized cargo trades. the carriage of empty containers on the loaded oil or dry bulk barge usually reduces its carrying capacity by only about 10%. in the above case, for example, the 30,000 dwt oil barge will carry 27,800 dwt of oil with a full (960 teu) load of empty containers.

unlike a ship, a barge does not carry consumables such as bunkers and water, and is therefore able to always accommodate the maximum deadweight allowable by its design capacity. dual use barges are also often served by novel container loading/unloading and transfer equipment. scissor-lift platforms are used to lift or lower prestacked (3 or 4 high) containers in blocks of 6 or 8 containers (12 to 16 teus) and moved to or from their position on deck on a deck-mounted transverse rail system by use of horizontal hydraulic positioning jacks. loading/unloading of containers can therefore be performed quickly and without the need for large container gantry cranes.

in some cases, such barges are loaded/unloaded by long outreach (post-
panamax) container cranes on the offshore side of a docked containership. barges are usually dropped and swapped in effectively designed integrated tug-barge systems. this not only permits effective use of the tugs who spend most of their time underway, but also assures that they are not delayed by long and often uneven port times. on the other hand, barges stay alongside longer than
the minimum time required for cargo transfer, and as a result offer convenient storage facilities and permit cargo to be unloaded/loaded more leisurely, saving double handling, shoreside storage, and overtime costs. In some services, a barge is in fact always alongside serving as a floating tankfarm and container stack which permits significant reduction in the need for shoreside container stacking and oil tank capacity.

**ECONOMICS OF OCEAN-GOING INTEGRATED TUG-BARGE SYSTEMS**

As noted OITBs have lower acquisition and operating costs, and also have a greatly lesser draft than equivalent capacity monohull ships. They also provide major advantages in scheduling and routing which is particularly important in short sea routes where inter-port distances are usually short and port calls are many.

Most of the current experience with OITBs is in the U.S. Northeast and the Gulf Coast. For example, oil is transported between Philadelphia refineries and Boston (268 miles) by OITBs exclusively now (about 22 million tons/year). One barge is at Philadelphia loading, one at Boston unloading, and one is being moved between Philadelphia and Boston at any one time. The tug takes about 24 hours for the transit. Therefore unloading barges are alongside 48 hours at each end and a loaded barge is delivered every 48 hours. Adding one tug and one barge can reduce alongside time and interdelivery time to 24 hours. In this case, 4 barges and 2 tugs would perform the transport work of 3 equal capacity ships. The choice of system obviously depends on port turnaround time required. If it is 48 hours, then 3 barges and 1 tug will do the work of 3 ships. If 24 hours, then 2 tugs and 4 barges will be required.

The cost of transport of oil from Philadelphia to Boston by 25-30,000 dwt or 30-45,000 dwt OITB (assuming 20 years of capital cost amortization and interest or opportunity cost of capital of 8%, a fuel cost of $130/ton for diesel and $96/ton for mixed bunker/diesel, and American crew costs - 18 men on tanker and 10 men on tug) were $2.28/ton of oil delivered by tanker and $1.39/ton for oil delivered by OITB. Today, as a result, all oil transport on this route is carried by OITBs which have replaced over 56% of coastal tanker tonnage in U.S. coastal waters since 1970 and 34% since 1980, a trend which is expected to continue. In addition to transport cost savings, there are significant savings in terminal operating and terminal investment costs, such as inventory holding and tank storage capacity costs which, in the above case, would add another $0.19 cost advantage to OITB transport.

Similarly, dual use OITBs are now under investigation for iron ore/coal transport from deep draft coastal ports in China (Ningbo) to different ports on the Yangtze
Integrated Tug-Barge Systems for Short Sea Shipping in Europe

River, with return cargo of full containers. These services are now provided by coastal vessels who transship at the shallow Port of Shanghai to or from river craft.

This service is designed to deliver and pick up barges at a multitude (6-8) inland ports using a very efficient drop and swap program which includes repositioning of partially unloaded or loaded barges to attain both effective capacity utilization as well as an effective schedule and origin/destination delivery time.

Preliminary estimates are that transport costs of the dry bulk and container cargo between the coastal and inland ports can be reduced by more than 50% while providing more frequent service and on average significantly lower origin to destination times.

Another advantage again will be the availability of floating stockpiles and container stacks at each terminal, as in most cases barges will be alongside at all times, eliminating double handling of cargoes.

A formal economic analysis model of OITB operations has been developed which allows the evaluation of transport costs between any two points of an OITB itinerary, including delivery time as well as terminal, tug, and barge fleet utilization. This simulation model, which is now being rewritten in SLAM II to permit conditional and statistical time and cost factors to be introduced, has been used to determine costs and time of transport for a particular set of swap, port sequence, schedule, barge size, and tug power decisions. It allows for sensitivity tests when each or pairs of these decision variables are changed to converge on an increasingly more effective strategy.

The condition is always that all the cargo must be accommodated. The deterministic simulation model now in use which consists of the basic transport network simulation, with investment cost, operating cost, and cargo demand sub-modules, has been found to be a very effective tool for the analysis of the effect of alternative system design and operating strategies.

EUROPEAN SHORTSEA USE FOR OITBS

There are numerous short sea trades in Europe which could benefit from the use of OITBs. Some are in the bulk trades such as petroleum transport between Norway and countries not tied into a pipeline delivery system or Algeria and Libya and southern European countries. Similarly coal, cement, and grain trades between northern/central/western European producers and southern European consumers may benefit. A brief study of Poland's coal exports to western and southern Europe also indicated the advantages of using OITBs.
Concluding the congestion of European roads and the inability of greatly expanding road capacity general and even containerized cargo may be attracted to short sea transportation by OITBs. This is particularly the case for transport between the British Isles, Scandinavian and the major European gateway ports such as Rotterdam. The increased size of mainline containerships for example (4,600 TEU + ) is already reducing the direct port calls of long distance (transatlantic, Far East, etc.) mainline containerships at UK ports.

In future an increasingly large percentage of UK, Baltic and Scandinavian containerised trade may have to be carried by feeder to/from the large continental load center ports such as Rotterdam. Large OITB floating container stacks may provide a most efficient and economic way to provide for these links while reducing the cost of using both UK/Baltic/Scandanavian as well as continental load center ports, by eliminating the double handling at these ports.

This would provide for example a UK container stack at a UK port and Rotterdam at all times with, for example, one tug and three barges providing a daily service, for which otherwise 3 feeder vessels would be required. These are just a few examples of potential uses of OITBs in Europe. Others abound.

CONCLUSIONS

There are many other examples of the economic advantages of OITBs. The St. Mary's Cement Corporation of Canada, for example, recently converted 18,000 dwt oil OITBs into self-unloading dry bulk carriers (equipped with cargo scoopers) with a discharge rate of 1,200 tons per hour to significantly reduce its transport costs.

Similarly, new applications in Japan, South East Asia, and the U.S. Gulf and West coasts are evidence of the increasing recognition of the operational and economic advantages offered by the use of OITBs. OITB technology is also advancing with many new vessels equipped with radio controlled bow and/or stern thrusters, windlasses, and mooring winches to reduce docking costs, and eliminate the need for docking assistance by tugs.

In some cases OITBs serve as floating moveable container stacks or terminals. The potentials for OITBs are still not fully explored or exploited and their use in European short sea shipping should really be investigated for operational and economic reasons as their introduction could not only help reduce road congestion, but also congestion in ports and seaways.
APPENDIX A: RESISTANCE CURVES FOR OCEAN-GOING BARGES

Resistance curves (Figure 6) were calculated for both the 30,000 dwt and 50,000 dwt barges. The basis of these curves was SNAME Technical and Research Bulletin No. 1-29, "Design Considerations and the Resistance of Large Towed Sea-going Barges". A correlation allowance of .0004 was used and the frictional resistance was obtained from the ATTC line.

An integrated pusher tug adds 12-18% to the resistance of the barge alone. Therefore a 50,000 dwt push-towed barge would have a resistance of 257,000 lbs. at 12 knots. This is about 10% higher than the resistance of a monohull ship with equal dwt at 12 knots.

The resistance of the integrated ocean-going tug and barge also depends on the relative drafts of the tug and barge. Similarly, the propulsive efficiency of the tug is affected by the relative draft.
Figure 6

Section IV - Shortsea Shipping Case Studies
THE ECONOMIC AND SOCIAL IMPACT ON GREEK PASSENGER COASTAL SHIPPING OF THE FREE MOVEMENT OF MARINE LABOUR IN EUROPEAN UNION

By A.M. Goulielmos and M. Milliaraki

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"THE ECONOMIC AND SOCIAL IMPACT ON GREEK PASSENGER COASTAL SHIPPING OF THE FREE MOVEMENT OF MARINE LABOUR IN EUROPEAN UNION"

1 INTRODUCTION

Greece has undertaken the obligation to modify Country’s legislation\(^1\)\(^2\), at the end of 1992, so as to allow European Union’s Seamen to work freely on board vessels belonging to shipowners of European Union States, including Greece. Same applies for Greek seamen for them to work on vessels of a MS of the European Union. Also, free marine labour movement must be established in the European Union, in general.

The above obligation has been undertaken by the Presidential decree mentioned in the footnote in which is written that Greece has to adapt its legislation, (and especially articles 56,57,87,88 of the Code of Public Shipping Law and also Law 192/36 as well as RD 734/68), to the provisions of articles 7 and 48 of the EEC Convention and articles 1, 2, 3 & 4 of EEC Council Regulation No 1612/1968. The effect of the legislative modifications will be: (a) to lift the obstacles that exist in the accessibility of seamen nationals of MS of the European Union to reach (and occupy) work positions on board Greek Commercial Vessels, (b) to allow employment of Greek seamen on commercial vessels with a flag of a MS of the European Union, and (c) to establish the free movement right of working people within European Union for marine labour as well.

The Presidential Decree by its article two specifies that nationals of MS of the EC having the capacity of a seaman (in accordance with the legislative provisions of a M.S.) have the same possibility of access to work positions on board Greek Commercial Ships as that specified for Greek Seamen except for the positions of Captain and its official deputy. European Union seamen must be nationals of a member state, they must have acquired the capacity of a seaman in accordance with the legislation in force in a MS, which means that seamen should be born or come from a Member State of EC.

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\(^2\) Modifications are needed to: (a) Code of Public Maritime law (187/1973), (b) Law 192/1936 and (c) Royal Decree 734/1968.
Impact on Greek Passenger Coastal Shipping of Free Movement of Labour

2 THE PURPOSE OF THIS ARTICLE.

As this is shown above in the introduction, a trend is formulated in the European Union that all working people including marine labour (seamen) are entitled to work freely in any Member-State and on board all commercial vessels having a flag of a Member-State of EC.

As we can see, exceptions are established for Captain and its official deputy, for they must be nationals of the Member-State of the flag of the ship. Greek Coastal Passenger Shipping, however, has been excluded (cabotage) from the free movement of entrepreneurs, and our question is whether this sector is excluded also from the free movement of seamen coming from EC up to 1/1/2004? If this is not so, what will be the effects of such a free movement of EC nationals on board Greek Coastal Passenger Ships? Another important question is what will happen if Euros register is established for European (EC) vessels and what will be its relation to seamen belonging to European Union?

3 THE SOCIAL POLICY OF EEC AND THE FREE LABOUR MOVEMENT.

The social policy of EEC is based on the foundation Treaty (Treaty of Rome) forming EEC (preamble and articles) that has been signed on 25th March 1957 in Rome.

Just from the beginning (1.1.1958) of the enforcement of the Treaty of Rome one of its main targets was to have a steady treatment of the terms of living and working conditions of people of Member States. The articles of the Treaty of Rome could be seen as falling into two large categories: (1) the one connected with the free movement and settlement of working people (articles 48-58) and (2) the one concerned with the general provisions for the establishment of the Common Social Policy (articles 117-112).

Historically, the foundation Treaty of EEC put in force on 1st Jan. 1958, has laid down the bases of a Common Social Policy, which let limited space for differential actions in relation to social provisions. As a result a series of EEC actions were adopted, the majority of which related mainly to the free movement of working people, its social insurance, its equal treatment, its professional education and protection. The foundation treaty had its first review at the occasion when the single European Act started to be in force, i.e. on 1st July 1987. It has been adopted, too, the EEC charter of the fundamental social rights of working people by the Council at Strasbourg (9/12/1989), and this was an effort to show the social dimension of the Single Market through specific measures & specific implementation plan. The Convention for the European Union signed on 7/Febr/1992 in Maastricht (ratified by the Member State Parliaments at the end of 1992 beginning 1993) formed the second review of the Treaty of Rome.
The Treaty of Rome specifies that the progressive adoption in practice of the establishment of the free labour movement can be realised through the adoption of certain EEC actions (like Regulations, Decisions, Directives, Recommendations, Resolutions, Announcements, Conclusions and Statements). In the above framework, the Council of the E.C. has so far adopted adequate number of E.C. actions\(^4\), especially in the form of Regulations and Directives of both general and special nature, which determine the measures needed for the implementation of the above. Also these complete the gaps existed in the Treaty of Rome in this subject. Member States have the obligation to incorporate EC actions in their legislation. This derives from a series of articles of the Treaty of Rome. So, according to article 5: "the member states take every general or specific measure suitable for securing fulfilment of the MS obligations that come from present Treaty or come from the actions of the E.C. organs". Article 189 specifies the forms, and the manner which binds MS as well as the time that EC actions begin to be in force\(^5\).

**Free labour movement in EEC**

Greece had certain transitional periods for implementing some EEC actions. So, Greece according to its Assession Act put in force free labour movement on 1/1/1988. At this date the transitional period specified in articles 44 and 48 of the Assession Act has ended. Especially article 48 specified:

(1) Free movement of working people within EEC is secured the latest at the time transitional period ends;

\(^4\) EEC has taken the following actions in connection with free labour movement:
(a) Council regulation 1612/68/EEC of 15/10/68 for the free movement of working people with in EEC;
(b) Council directive 360/68/EEC of 15/10/68 for the abolition of the restrictions to the movement and stay of working people of MS and their family members within EEC;
(c) Council directive 1408/71/EEC 16/6/71 for the implementation of the systems of Social insurance for people employed and for their families moving within EEC;
(d) Council directive 148/73/EEC 21/5/73 for the abolition of restrictions to the movement and stay of nationals of MS within EEC in relation to their supply of work services and their settlement in a MS;
(e) Council directive 368/75 EEC 16/6/75 referring to the measures facilitating the actual exercise of the right of settlement and free supply of work services for certain professional activities, and also transitional measures for these activities;
(f) Council decision 368/85/EEC 16/7/85 referring to the equivalence of professional titles between MS of E.C.

\(^5\) For Greece article 145 of the Assession Act requires that "Greek Democracy Puts in force the measures that are required for to comply with the provisions of the Directives and Decisions in accordance with article 189 of the Treaty of Rome". The manner that Greece can embody EC actions into Greek legislation can take the form of any legislative, regulative and administrative provisions.
(2) The free movement of working people entails the abolition of any discrimination, due to nationality, to the working people of MS in relation to their employment, reward and other terms of employment;

(3) Only certain restrictions to free labour movement are justified i.e. those related to Public Order, Public Security and Public Health. Otherwise, the free movement of working people means that these are entitled to:

(a) Accept any real offer of employment;
(b) Move freely for the above reason within a MS of EC;
(c) Stay in one MS with a purpose of exercising there a certain profession in accordance with the legislative, regulative and administrative provisions that regulate the employment of the nationals of the MS;
(d) Stay in one MS and when employment in that MS terminates. This in accordance with the regulations for the implementation of this provision that will be issued by Commission.

The provisions of the above articles exclude employment in the Public Sector of a MS, with the exception of Denmark (also few public positions can be filled in by non-MS nationals in France, UK, Ireland & the Netherlands). The above provisions in effect try to establish an equal treatment between nationals of MS that wish to work in any MS provided they can comply with certain provisions of the MS. This may equalise supply and demand, and so wages in the whole EC space. The effort is to secure to the above people more freedom in moving, to stay "freely" in a MS, and paid equally for equal work, no matter people's nationality.

In Greece the free movement of working persons is legislated by two Presidential Decrees. According to the above P.D. no stay or work permit is required for the working persons nationals of a MS of EEC provided an Employer has been secured, who provides employment. The MS national of EEC must, however, present himself to the appropriate Police Station within eight days from his/her arrival in Greece.

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6 These are related to personal behaviour. Previous penal convictions do not prevent a person from work. Cases of illnesses are restrictive only if can endanger Public Health or Public Order. Illnesses or injuries that follow the first work permit in a MS cannot justify work denial or deportation of a person from a MS.

7 The Treaty of Rome also distinguishes labour in two classes: those that are wage earners and those that have an independent activity. The entry and stay in a MS of wage earners is regulated by 36 council directive 15/10/68 and the others by council directive 148 21/5/73.

8 P.D. 525/1983 for the entry and stay of people nationals of MS of EEC that do not offer a paid employment (non wage earners), but exercise an independent profession, and P.D. 499/1987 for the movement and stay of working people nationals of MS of EEC and their families.
4 THE ACCESSIBILITY OF EEC SEAMEN TO GREEK VESSELS

As mentioned in the introduction, Greece by Presidential decree 12/31.12.1992 adapted its legislation so as to remove any legislative obstacles that might existed in the free movement of seamen, nationals of a MS of EEC, to Greek flagged vessels. The reverse was also in the provisions of the Law i.e. Greek seamen to be able to reach freely employment positions on board vessels of a MS of EEC.

The only provision that the Greek Law requires is that a "seaman" should have acquired the seaman capacity in accordance with a MS legislation. So, the term Greek Seamen or Greek Nationality seaman covers from 1/1/1993 and any other seaman of a MS of EEC.

For Greek seamen a sea service run in a MS vessel counts as time for obtaining professional certificates on equal terms if such a service was done on a Greek vessel.

For foreign seamen i.e. non EEC nationals, special provisions are laid down.

"Greek Seamen Pension Fund" and the "House of Seaman", which are public organisations providing pensions and hospital/medical services to Greek Seamen, have also adapted their legislation to the EEC Council regulation 1408/1971 for Social Security to be provided to all working people and their families moving for the purpose of work within EEC.

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9 Articles 7 and 48 of the Treaty of Rome and articles 1,2,3,4 of EEC Council Reg. 1612/1968. Article 7 specifies that "no discrimination on grounds of nationality is allowed".


11 Seamen from a Member State should be born there or come from that MS.

12 Ministerial decision 4803/13/10 a 29.6.1992 regulating entry-exit from Greece and signing on and off.

5 THE SOCIAL SECURITY TREATMENT OF MARINE LABOUR IN GREECE

The social security is provided to seamen in Greece by the Greek Institution called "Greek Seamen Pension Fund (GSPF)", which provides the pensions, and the so called "House of the Seaman", which provides hospital and medical services to marine labour. These two institutions in accordance with the laws that are in force at the time provide the above services to Greeks as well as to nationals of the M.S. of E.C. The interesting matter is in this case that the above services are extended as well to those without any nationality (country less) and the refugees that stay in any M.S. of E.C. All the above, however, must work on board a ship under Greek flag holding the capacity of seaman. The above services cover also the families of the persons entitled and their heirs. It is clear that in relation to Social and Medical Security of Seamen, any national of a MS of the EC is considered as a Greek Seaman in all terms. This provision extends also to people having no nationality and to refugees that stay in a MS and they are seamen by profession in accordance with the laws of a MS.

6 MS SEAMEN’ FREE MOBILITY IN EUROPEAN UNION’S VESSELS.

We may now draw a main conclusion from the above, which is that Seamen nationals of a MS of EC - European Union Seamen - are entitled to ask employment in Greek ships, and on Greek Coastal Passenger Ships as well, without any discrimination, and they will enjoy equal rights as well as equal obligations. These seamen coming from a MS other than Greece should be equally treated as Greeks (Greek passbook, application of Greek penal and disciplinary code etc).

The above can be accomplished as follows:

1 First a shipowner (employer) must be found and secured, and thus a work and stay permit would not be required. Otherwise a MS seaman must settle in Greece i.e. have a domicile in Greece (a vessel is not considered as consisting a domicile);

14 As this may be known Greek Coastal Passenger ships are obliged by Greek law to employ only Greek nationals.
(2) A MS seaman must accept the terms and conditions of the collective Agreement in force that specifies employment and wages of the Crew employed (signed on) on Greek Passenger Coastal Ships;

(3) Educational titles must be recognised/approved.

The above three conditions had, so far, no space of implementation as according to our research, no seaman of the European Union has decided to sign on a Greek Coastal Passenger Ship or other type of ship in this respect.

This is so, as the Greek Shipowner will most probably prefer a European Union seaman to a Greek, for all ranks of Crew, provided his wage is equal to that of a Greek seaman.

Is it possible that a European Union seaman accepts the terms and conditions of the Greek seamen collective Agreement as far wages and other benefits are concerned (insurance terms, leaves etc)? We will look next for a while into the above third condition of the title recognition.

Seamen’s title recognition in E.C.

Greek legislation has not so far been harmonised with the EEC directive 89/48, neither with the complementary Council directive 92/51 (18/6/92), referring to a general process of recognising professional education.

A seaman’s profession, both that of Officers and that of Ratings, can be classified to the professions for which European Union has not as yet specified the minimum required standard levels. As a result of the above, a MS can specify the required minimum standards of its seaman with a view of securing a certain quality of professional services that are provided in that MS Country.

Especially directive 92/51 of EEC Council refers at the preamble to what we think applies directly to the seaman profession:

(a) There is the need to specify in legal form the recognition of the technical skills that are based on experience that has been obtained in another MS;

(b) to institute a simpler mechanism for such cases, where in one MS of reception, for the exercise of one legally accepted profession, is required either education of a very short duration or certain personal qualifications or only a general education.\(^\text{15}\)

\(^{15}\)According to a work survey carried in Greek shipping in 1990 in a total of 26304 Greek seamen that have finished their general education, 52.6% were graduates of high school and 47.4% were graduates of the primary education. Also, among the 10711 Greek seamen being officers, the 6950 were graduates of special cadets schools, of Public & Private nature as well as of private technical lyceums or schools. See Marine Labour Survey, 1990, Table 17, p. 26, Athens
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As said there is a need for the recognition of qualifications which have been obtained through only professional experience on a MS. This experience has not so far legally be recognised for certain professions. There is also a need to acquire the opinion of certain professional unions and of certain educational institutions as well as of the institutions of professional education. There is also the need to secure the proper participation of the above institutions in the decision taking procedure.  

7 CONCLUSIONS FROM THE SOCIOLOGICAL POINT OF VIEW.

The concept of the Single European Market as a space without borders and where the abolition of any obstacles to the mobility and free movement of persons and services will be removed, creates and will create a lot of problems - in our opinion - of special organisational and functional type in the Labour Sector of the Single Market. Beyond the matters of Supply and Demand (see next section), and factors and conditions that shape and influence the mobility of Human Capital, there is the sociological and psychological dimension which calls for working people to become part of the single European Market.

With special reference to marine labour profession, which has so many special characteristics indeed one may note that the marine profession is more a way of life than a profession with the every day meaning of the later term.

A crew member of a ship does not simply work on a vessel, he lives in the vessel for the time he has signed on. The duration of work on a vessel is a determinant factor for the degree of adaptation of the crew member to the profession. A long time stay on a ocean going vessel shapes a different behaviour in comparison with a work on vessels of short sea shipping (coastal ships), in which case the crew member has not been separated from his family and his place of domicile.

In all cases of marine labour work, the social organisation on a vessel is drastically different from all other professional social organisations we may know. Life on ship has its own regulations and basically has a strict hierarchical structure.

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and way of functioning. The fact that a person (seaman) on a ship works and lives in the same place, that he has to stay on the ship and after his work has been finished, is one of the basic characteristics that influence not only the professional behaviour, but also the human behaviour of the seaman. Moreover, the above shapes also the opinion and belief for the profession.

There is a phycological - sentimental effect on these people (seamen) that have to leave from their familiar places and these persons try to create place- antidote of equal familiarity with that they have created at shore.

The heterogeneity, however, of the seaman social group will create- in our opinion- many problems and difficulties. We are concerned about the possibility of coexistence (parallel life) and cohesion of elements that show, as crew members, a high degree of heterogeneity\(^\text{18}\).

We may accept in effect that crew's country of origin and level of education certainly play a basic role to adaptation, cooperation and fit of a person into a crew group, but these factors cannot seen as factors providing solutions to every problem.

The subject of "nationality" of a person has a great social and sociological importance in every level of social organisation. Every person is a member of a society in which he was born, grown up and in which he "belongs". The social inheritance of a person is transfered through person's process of socialisation which results for the person to acquire a civilisational identity. There is no person or people without having a civilisational identity, which means in simple words that there is no specific way of life without a certain language as a code of communication, without a specific behaviour which is determined by the social group from which one comes from. Every person "belongs to" and his place of origin determines his degree of communication. We see that there is something inevitable with the different civilisational origin of crew members for many problems to be created. These problems cannot be classified on bases of quality alone (educated or not, European or not).

A Greek seaman signing on a vessel belonging to Greek Passenger Coastal Shipping feels like to be in his own particular place. Everybody speaks the same language, has the same tradition, knows the Greek ports and Greek waters, has the same way of living as most of the passengers have, he will return to his home and his family at time of his leave. A seaman, however, coming from a MS of the European Union will have none of the above characteristics though in

\(^{18}\)Experience of seamen signed on ocean going vessels with reference to foreign crew was bad. See A. Corres up.cit. p. 172. We cannot accuse differences in races or education as responsible factors (reference has been made for people coming from Asia) for a bad behaviour of ratings in Greek Ocean Going Shipping.

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legal and institutional terms he will be a "Greek". A foreign person will remain foreign in his own conscience and in the conscience of his Greek colleagues.

The Single European Market and the abolition of all nationality discriminations does not mean - in our opinion - in any case that one can abolish social origin and civilisational inheritance, decisive factors which in effect mean a way of life19.

8 THE ECONOMIC IMPACT OF THE FREE MARINE LABOUR MOBILITY IN GREECE.

The sociological analysis which has been so far seen, concluded, that two foreign people can never be the same and one cannot be considered as equal to the other in all respects, despite laws and regulations. Here, however, we have to stress it, that no one ever meant that the single European Market will invent a process by which nationals of the European Union will be somehow made homogeneous. What is exactly meant is the establishment of a degree of labour mobility, so that supply and Demand of labour is equalised in every single market of European Union. This fact would harmonise wage levels everywhere, though wages cannot in theory be reduced below a certain minimum. In order to equalise labour demand and supply and establish equal wages for equal amount and quality of labour services, one must have mobility in all respects.

The efforts of European Union should be to the above direction i.e. establish the highest possible degree of mobility of labour within E.C. The above means that there should be a European network informing about labour vacancies. So, we need a system of information for labour demand within E.C20. We may argue here that a kind of discrimination is possible to come from imperfections of information in the labour market21.

Moveover, the problem in our opinion is one based on the theory of equalizing differences22.

19There remains to be determined the mechanismy through which the cohesion and cooperation of people at places of work will be achieved in such a way that nationality cannot provide an obstacle for the free mobility and living of working people in EC, where also the civilisational models will not be disorganised but will be preserved.

20See Green Book and especially efforts through EURES.


22This theory is rooted into the writings of Adam Smith (see A. Smith,(1776), The Wealth of Nations, Chapter XI). See also R.F. Elliott op.cit p. 313.
This theory stresses the fact that equalizing tendencies of competition in the labour market is conditional on perfect mobility and on perfect knowledge. The theory of net advantages advanced the idea that competition equalizes the whole of the money and non-money advantages and disadvantages of different employments within a labour market and over the long run over wide geographical areas within which there is labour mobility.

The advantages and disadvantages of various jobs tend to equality. Dangerous and unpleasant jobs attract higher pay, jobs with better pension and health insurance arrangements have lower pay. Persons, however do not have the information required to evaluate the relative advantages of different jobs and these are discovered by experience. This means that there are enough transaction costs related to changing jobs and their experience cannot be obtained, ocean-going shipping is a sector where wage rates may be established and remain above the market clearing level depending on the state of the freight market (it has been calculated that actual crew wages can be 20% higher than contractual wages if freight market is good and crew labour demand higher than supply).

As this is known A. Smith’s approach involves implicitly a set of shadow prices for each of the non-money aspects of jobs. Let us have a desirable market good, A. and an undesirable good B. Good B may incorporate some characteristics of having a job in Greek Coastal Passenger Shipping. Thus $U = f(A, B)^{24}$. A seaman’s preferences can be represented by a number of convex indifference curves drawn in the goods space as shown in Figure 1.

Seamen’s preference will be to move to the left hand direction, as higher levels of utility result from consumption of more of the desirable good and less of the undesirable good. The conclusion is that seamen accept to work in a job with unpleasant characteristics only it they are compensated by larger amounts of A. Thus $OB_0$ should equal $DW$. Suppose that the competitively determined wage for jobs with displeasure $OB_1 = OW_1$ and that the competitive wage for jobs involving exposure to the next lowest level of displeasure $OB_0 = OW_0$. Then $OW_1 - OW_0$ represents the implicit price that is paid in the labour market for exposure to an additional amount of displeasure equal to $OB_1 - OB_0$. In this particular case the increment to the wage $OV_1 - OV_0 >$ the increment to consumption goods $DA$, which is required by the individual to compensate for the increased displeasure. A seaman would thus be willing to work in the job with displeasure level $OB_1$ for all $OW > DA$. Conversely, if $DW < DA$, the price would be too low, and the individual would not be prepared to undertake the job involving exposure to displeasure level $OB_1$.

---

23 See Elliott op.cit p. 352.
9 FINAL CONCLUSIONS

As it is shown above real free mobility in Greek passenger coastal shipping is not possible to happen for sociological and economic reasons.

And this despite the contents of the Green Book\textsuperscript{25} where is written that the free mobility of persons is considered as one of the four "liberties" of the Treaty of Rome (article 3), but soon after is written that is the economic activity which is the basic element in this process (articles 48-66). Article 8A of the Treaty for the European Union has established the right of movement and settlement freely in any M.S. of any citizen of European Union.

The interesting thing is that only the Single Market program understood the real importance of the problem, for it (the Council) extended the right of stay to all citizens of M.S. of European Union regardless of their economic activity provided they have secured Social Security (Medical and Hospital care) and adequate means of living. The above is extended and to the job- seekers which have strong possibility to be employed (social security is not secured as yet for this people).

\textsuperscript{25}European Social Policy: Green Book, Commission, Com (93/ 551 in Greek.
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The European Court has also established what was an objective of the Treaty of Rome for any citizen of European Union to exercise an economic activity in any M.S. without any bad discrimination and also for the employment in the Public Sector, the right of the M.S. has been restricted to those cases where an appointment has to do with exercising public power and responsibility in connection with safekeeping of the general interests of the State.

The core problem of all the above is of course, the mutual recognition of certain diplomas and certificates as well as of certain professional specialisations, in which in our opinion must also fall the crew profession, in M.S. of the European Union. Unfortunately, as this is written in the Green Book, the above effort i.e. to establish a real and essential mutual recognition and equivalence of the professional qualifications at all levels across whole European Union, should constitute an urgent political priority. This means that an essential element of free mobility is lacking and this will be so for many years to come. The right to stay is something that is related to the right of work. The right to stay is related to the right of entry.

As it is also written in the Green Book for the last three years the Council discussed the Commission’s proposals for improving the free mobility of working people without being in a position to find acceptable agreement.

Working people wishing to move for work to another M.S. usually face rigid administrative processes, where the administration ignores the rights of the European citizen.

Very important, for labour mobility is as mentioned, the network EURES, which is responsible for the exchange of information about offered work positions and applications for employment in all M.S. This network is targeted to provide an exchange of information on work conditions and living conditions in all M.S.

Greek Passenger Coastal shipping is regulated in two instances by the Cabotage Council Regulation: (a) as far as the liberation of cabotage is concerned and (b) the legislation that will apply to manning.

The Council Regulation which has been issued on 7th December 1992, tried to implement the principle of the free circulation of services in the Sea Transport in the internal (waters) of M.S. (internal sea transport - cabotage). The Regulation has been based on twelve reasons and one referred to the need of the establish-

---

26Especially, professions and specialisations, that are not governed by regulations.


28Reg. (EEC) No 3577/92 of 7/12/92 (cabotage)
Impact on Greek Passenger Coastal Shipping of free Movement of Labour

ment of the Single Market. The Single Market should contain, as argued, a space where the free circulation of goods, persons, services and capital should be secured. Exceptions then were introduced so as to avoid distortion of competition, to establish transitional periods, and to respect the fact that certain M.S. have different development levels. The possibility has also been legislated for the Government of a M.S. to appoint an E.C. shipowner in a public service (most probably this introduces a treatment of the innumerative cabotage lines). The regulation also has included action in case of emergency (market disturbances, emergency situations).

The strange fact of the cabotage regulation is that although the free circulation of services in sea transport inside a M.S. (internal sea transport - cabotage) for E.C. shipowners, the ships of which are registered in a M.S. and fly that M.S's flag, has been put in force since 1st January 1993, this is not so.

And this is not so for the above ships have to fulfil all preconditions required for them to offer internal transportation in a certain M.S. (including ships under EUROS) only from 1st January 1997 (i.e. four years preparation period).

Regulation had also defined certain terms like that of "E.C. Shipowners" without any discrimination. The regulation cares also about a serious disturbance that may take place like a permanent surplus of supply, a threat to the economic stability and viability of a substantial number of E.C. shipowners. All the above sound as restricting free, pure, full and perfect competition...

As far as the free marine labour mobility is concerned - which is our main theme - the regulation provides differently for different ships, as shown in Table I.

Despite the above table, cabotage is not in force before certain dates come, as they are specified by the regulation shown in Table II. For Greece cabotage between island ports for regular lines of passenger transport and short crossing and for vessels below 650 GT is free on and after 2nd January 2004.

Moreover for establishing EUROS discussions that have taken place indicate that manning for cabotage will be 100% in accordance with the legislation of the receiving state.

So, the present regulation will be invalid in cases where manning is treated differently for EUROS ships.

We may therefore conclude that due to the lack of a system that will: (a) recognise the professional and educational diplomas and certificates in E.C., (b) provide the timely information for job vacancies, over E.C., (c) lessen the inability of a person to be present in time (due to distance) to undertake a job, (d) offset the existing differences in wages and working conditions between vessels owned by various E.C. shipowners, (e) offset lack of a common lan-
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<table>
<thead>
<tr>
<th>Type of ships</th>
<th>Manning</th>
<th>Greek passenger coastal shipping</th>
<th>Date</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Vessels in cabotage between continental ports &amp; in regular (lines) cruises.</td>
<td>Flag state</td>
<td>Flag state</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vessels below 650 GT</td>
<td>Recieving state</td>
<td>Greece</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Vessels in cabotage between ports in islands</td>
<td>Recieving state</td>
<td>Greece</td>
<td>The commision will examine the economic &amp; social impact of the liberation of cabotage. Report is due before 1/1/97 to the council*</td>
<td></td>
</tr>
<tr>
<td>3. Commercial vessels larger than 650 GT in cabotage between islands ports**</td>
<td>Flag state</td>
<td>Flag state</td>
<td>1/1/1999</td>
<td></td>
</tr>
</tbody>
</table>

* On the basis of the above report, the Commission must submit to the Council, a proposal that may include modifications to the provisions referring to manning and to nationality, so that the final system to be approved by the Council in time but before 1/1/1999.

** When the relevant voyage comes first or follows a voyage to or from another state.

(Source: EEC Reg. op. cit.)

Table I: Manning on basis of regulation 3577/92

guage and other sociological constrains analysed above, the marine labour mobility is so far theoretical.

The only possibility of free marine labour mobility that we can see in our waters is when cabotage is fully established and E.C. shipowners come to run RoRo transportation in Aegean Sea. There, they may compete for Greek nationality crew, provided also that quality of services is maintained. This is inevitable for if fares continue to be regulated as is now the case, E.C. shipowners must have a way to compete their Greek competitors not only on quality of services, but also on service costs. Another bases of competition is the ability fo a shipowner to absorb losses (and for how long) till his competitor has vanished.
Impact on Greek Passenger Coastal Shipping of free Movement of Labour

<table>
<thead>
<tr>
<th>S.N.</th>
<th>Actions</th>
<th>Dates</th>
<th>Countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Cruising services</td>
<td>2/1/1995</td>
<td>Mediterranean, and along Spanish, Portuguese and French coasts</td>
</tr>
<tr>
<td>2.</td>
<td>Transport of strategic goods (oil, oil products, water)</td>
<td>2/1/1997</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Regular lines of passenger transportation and short crossings</td>
<td>2/1/1999</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Cabotage between islands ports</td>
<td>2/1/1999</td>
<td>Mediterranean, Canary islands, Azores, Madeira, theouta, Melilia, French islands along Atlantic coast and French overseas parts</td>
</tr>
<tr>
<td>6.</td>
<td>Cabotage between islands ports for regular lines of passenger transport and short crossings and vessels below 650 GT</td>
<td>2/1/2004</td>
<td>Greece</td>
</tr>
</tbody>
</table>

(Source: Regulations 3577/92)

Table II: Cabotage timetable

10 POLICY RECOMMENDATIONS

Greece should be concerned with the improvement of the quality of services provided to RoRo passengers on and after 2/1/2004 and thus "permit" better vessels to come freely into cabotage transportation.

As for the ownership of the vessels to come and their flags, one cannot pre-estimate. But despite ownership and flag, demand for Greek crew should change as: (1) transportation needs will rise, (2) vessel’s size will increase, (3) speed may come up as a basic choice element on part of the passenger.

Competition among shipowners will most probably increase wages, and thus Greek crew will be attracted from other shipping sectors (ocean going, Mediterranean).

Differences in crew wages among E.C. vessels is not expected to vanish, so non Greek crew is not expected to come to Greek cabotage shipping, unless paid their "home" wages. This will count on cost.
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The above thoughts are in line with the existence of some kind of fare regulation.

If fares are freely formulated by supply and demand, certain Greek shipowners will most probably vanish under the competition from non-Greek E.C. shipowners, but this does not mean that Greek crew demand will vanish, too.

The main, thus policy recommendation for the Greek State is to prepare as many Greek people as they wish for cabotage crew at the standards of our European Competitors. And this is so for while some Greek cabotage shipowners may vanish after 2/1/2004, demand for Greek crew may rise. This demand will be satisfied at the expense of Greek crew found in Ocean going and Mediterranean Ships. This, however must be faced from now.
Impact on Greek Passenger Coastal Shipping of free Movement of Labour

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Section IV - Shortsea Shipping Case Studies

FAST SELF-LOADING AND UNLOADING UNITLOAD SHIPSYSTEMS FOR COASTAL AND SHORTSEA SHIPPING POTENTIAL IN NORTH WEST EUROPE

By A. Sjöbris, N. Wijnolst, C. Peeters

Paper will be added later
COMPETIVENESS OF SHORTSEA SHIPPING PORTS:
THE CASE OF ZEEBRUGGE

By L. Maertens

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COMPETIVENESS OF SHORTSEA SHIPPING PORTS: THE CASE OF ZEEBRUGGE

1 INTRODUCTION

1.1 ENVIRONMENT FRIENDLY TRAFFIC

The ever increasing demand for transport services has led to congestion of the road network. Overcoming this congestion by expansion of the road infrastructure is not possible in most cases. In some European countries (e.g. Belgium and the Netherlands) the road network has reached a point of saturation. Moreover, road haulage is increasingly met with social disapproval because of the burden it puts on the environment (exhaust gasses, transport of hazardous goods).

The rail mode faces problems of an entirely different nature. It is more environment-friendly than road haulage and rail-infrastructure could perhaps cope more easily with additional traffic. Unfortunately, the equipment and facilities are not always adapted to modern cargo carrying units (e.g. standard-size containers). The rail mode, in much the same way as shortsea shipping (SSS), is confronted with high break-even volumes of traffic. Consequently, rail operators will only envisage investments in equipment and facilities if demand for rail services is relatively high. Moreover, most rail companies are still government controlled, which leads to an additional disadvantage given that these companies are often less customer oriented and less flexible.

In view of the above, SSS and inland navigation could increase their market share in spite of a number of unfavorable characteristics, which include:

* Long transit time as compared to road or rail traffic;
* Inability to provide door-to-door services;
* Ill adapted to customer-specific needs.

In order to shift traffic from the road or the rail mode towards SSS (or inland navigation), new policies are required to ensure cost efficiency and competitiveness.

1.2 EUROPEAN TRANSPORT POLICY

The European Commission is one of the policy making institutions that has understood the great need for change in the transport environment, partly
Competitiveness of Shortsea Shipping ports: The Case of Zeebrugge

because it has fathered some of the most important initiatives that will affect the transport situation in the near future. The demand for transport services within the European Union (EU) is expected to rise substantially. Forecasts of traffic growth within the EU over the next 10 years vary between 25% and 45%.

The liberalization of East-West relations and the development of the EFTA will also affect the demand for transport services, but the quantitative evaluation of this increased demand varies considerably depending upon the forecasting institution.

The European Commission's prime objective with regard to transport policy is to investigate alternatives which could enhance a smooth traffic flow and relieve the ecological burden. SSS, railway- and intermodal transport constitute some of the avenues the European Commission seeks to explore. These transport modes meet the objectives put forward by the Commission. Several shortcomings of the road mode favor the modes mentioned above, to the extent that they can alleviate some of the bottlenecks in the European road transport system, hence reducing congestion and pollution. A general policy framework concerning the transport of goods and passengers has been published by the European Commission in various publications during the last few years.

The most important publications are:

* COM(90) 218 final, June 27, 1990: Green Paper on the Urban Environment;
* COM(92) 231 final, Brussels June 11, 1992: Guidelines for the development of a European Transport Network;

1 The study: Welchen Beitrag kann die Seeschiffahrt zur Bewältigung der Transportaufgaben im EG-Binnenmarkt leisten?, conducted by the INSTITUT FUR SEEVERKEHRS-WIRTSCHAFT UND LOGISTIK, estimates the combined effects of the Single Market Initiative, the unification of East- and West-Germany and the liberalization of the East-West relations. The average yearly growth of demand for transport services in the European area, is expected to approximate 7.8% until the year 2000.

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* 1993: Trans European Networks: Towards a Master Plan for the Road Network and Road Traffic.

The development of different Trans-European-Networks (TENs) which include the different modes of transport performs an important role in the implementation of the Commission’s program.

The terms and principles of the TENs are expressed in the Treaty of Maastricht (Title XII and Article 129 b-d and Title XIV and Article 130 a-e) and the Presidency of the European Council in Edinburgh on 11/12 December 1992 (Conclusion, part C, Annex 3). In general, the main principles include:

* The increase of cohesion among Member States;
* The improvement of mobility;
* The facilitation of trade.

As a first step, individual working group were set up within DG VII (the Union’s Directorate General for Transport of the European Commission) in order to develop Trans-European-Networks for the different modes, namely road haulage, trains, shortsea shipping, inland waterways and air transport. The European Commission also installed other working groups related to ports and the creation of networks for energy transmission and telecommunications. The Commission’s objective was to coordinate the efforts of Member States in making the traffic of persons and commodities throughout the Union more efficient.

2 MARKET POSITION OF THE PORT OF ZEEBRUGGE

Zeebrugge can be situated among the medium sized to large ports in the range Hamburg-Le Havre with a total volume of 33.4 million tons and a market share of 4.9%. During the last decade, the port of Zeebrugge showed an average annual growth of 10.8%, while the average growth of the relevant range was 1.5%. The port of Zeebrugge is particularly important for European shortsea and feeder traffic. In the Hamburg-Le Havre range, the port of Zeebrugge has become a dominant player for ro/ro traffic, container traffic, dry-bulk and general cargo.

In the Hamburg-Le Havre range, the port is the market leader for ro/ro traffic. The different ports in the Hamburg-Le Havre range grew on average with 7.5% per year, while the port of Zeebrugge had an average annual growth of 10.5%. Zeebrugge is also market leader for ro/ro-traffic to and from Great Britain with an average market share of 30% and a total of 769,000 units in 1993, see Figure 1.
During the last four years, the following traffic volumes were recorded in shortsea trade, see Table I.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Skand. + Baltic</td>
<td>0.3</td>
<td>0.3</td>
<td>0.7</td>
<td>0.7</td>
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<td>o.w. Norway</td>
<td>0.1</td>
<td>0.2</td>
<td>0.5</td>
<td>0.6</td>
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<tr>
<td>Range</td>
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<td>1.3</td>
<td>1.6</td>
</tr>
<tr>
<td>o.w. Belgium</td>
<td>0.6</td>
<td>0.6</td>
<td>0.6</td>
<td>0.6</td>
</tr>
<tr>
<td>Netherlands</td>
<td>0.4</td>
<td>0.4</td>
<td>0.5</td>
<td>0.7</td>
</tr>
<tr>
<td>Germany</td>
<td>0.0</td>
<td>0.0</td>
<td>1.3</td>
<td>0.3</td>
</tr>
<tr>
<td>UK + Ireland</td>
<td>15.5</td>
<td>15.9</td>
<td>16.1</td>
<td>16.8</td>
</tr>
<tr>
<td>Iberia</td>
<td>nr</td>
<td>nr</td>
<td>nr</td>
<td>nr</td>
</tr>
<tr>
<td>Mediterrania</td>
<td>3.1</td>
<td>3.3</td>
<td>3.7</td>
<td>3.4</td>
</tr>
<tr>
<td>o.w. Algeria</td>
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<td>3.1</td>
<td>3.4</td>
<td>3.1</td>
</tr>
<tr>
<td>Middle East</td>
<td>0.1</td>
<td>0.1</td>
<td>0.2</td>
<td>0.3</td>
</tr>
<tr>
<td>Other</td>
<td>1.4</td>
<td>1.5</td>
<td>1.5</td>
<td>1.6</td>
</tr>
</tbody>
</table>

Table I: Zeebrugge Traffic volumes per corridor, 1990-1993 (mln tons)
Shortsea traffic in the main continental ports is of major importance and constitutes between 20% and 40% of total traffic volumes in the respective ports. For the port of Zeebrugge, this traffic is even more important with a total of 76.6% of total maritime traffic, see Table II. The numbers in Table II are for the last known year and include both intra-European traffic and feeder traffic (transshipment traffic). Transshipment in the port of Zeebrugge totals approximately 12% of total traffic with a volume of 3.6 million tons. Transshipment in the other ports in the Hamburg-Le Havre range varies between 8% (Bremen) and 19% (Antwerp).

The port of Zeebrugge is particularly interesting to study because it is characterized by several strengths which are discussed briefly.

* Zeebrugge offers regular services in relation to British destinations, spread from South to North England and serves eight different ports: Dover in the South, Purfleet and Dartford on the Thames (London), Harwich, Felixstowe in the East and finally, Immingham, Hull and Middlesbrough in the North;
* The port offers, on average, one hour sailings to and from Great Britain; and weekly sailings to the Scandinavian ports;
* Four major categories of shortsea shipping services are available, combined passenger and freight, multi-user freight, dedicated freight and finally industrial inter-company traffic.

<table>
<thead>
<tr>
<th>Skand. + Balt</th>
<th>Le Havre</th>
<th>Zeebrugge</th>
<th>Antwerpen</th>
<th>Rotterdam</th>
<th>Bremen</th>
<th>Hamburg</th>
</tr>
</thead>
<tbody>
<tr>
<td>H-LH range</td>
<td>4.3</td>
<td>0.7</td>
<td>11.0</td>
<td>25.8</td>
<td>7.0</td>
<td>18.2</td>
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<tr>
<td>UK + IR</td>
<td>7.6</td>
<td>16.8</td>
<td>8.2</td>
<td>44.2</td>
<td>2.1</td>
<td>7.3</td>
</tr>
<tr>
<td>Iberia</td>
<td>0.7</td>
<td>3.4</td>
<td>2.1</td>
<td>2.4</td>
<td>0.5</td>
<td>2.3</td>
</tr>
<tr>
<td>Medit.</td>
<td>-</td>
<td>1.6</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Other</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>12.6</td>
<td>24.1</td>
<td>21.3</td>
<td>72.4</td>
<td>9.6</td>
<td>27.8</td>
</tr>
<tr>
<td><strong>% of total</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>port traffic</strong></td>
<td>23.3</td>
<td>76.6</td>
<td>21.2</td>
<td>25.0</td>
<td>31.4</td>
<td>42.9</td>
</tr>
</tbody>
</table>

Table II: Shortsea Shipping Corridor relations (mln. tons, last known year)

Zeebrugge is also important as a container port. The containers are generated mainly by shortsea and feeder traffic. Shortsea lo/lo-operations handled 84,000
Competiveness of Shortsea Shipping ports: The Case of Zeebrugge

TEU in 1993 but experience competition from to ro/ro-services which handled an extra 123,000 TEU.

Container feeder services include traditional feeder services to Britain and Ireland and to other deepsea ports such as Rotterdam and Hamburg. In addition, several Rhine terminals are served twice a week by sea-going barges. The total volume of this barge services amounted to more than 41,000 TEU in 1993.

In addition to traditional feeder services, Zeebrugge also had inter-company traffic for Ford Motor Company with a volume of 30,000 TEU for 1993.

Given the excellent performance of the port of Zeebrugge for container - and ro/ro services, the question arises what needs to be done to maintain this market leadership position and even to improve this position. In other words, what strategies can be identified that contribute to improve the competitive advantage of the port of Zeebrugge in the relevant range.

3 COMPETITIVE STRATEGIES FOR THE PORT OF ZEEBRUGGE

3.1 INTRODUCTION

The port of Zeebrugge is currently the market leader for shortsea ro/ro and container traffic in the Hamburg Le Havre range. The success of the port of Zeebrugge is reflected in continuous growth in shortsea shipping traffic volumes, showing an average annual growth which is higher than the average in the range.

Expectations as regards future trends are therefore positive, specifically on shortsea shipping traffic that is oriented to the north and the Iberian Peninsula. It has been suggested that future traffic volumes for Scandinavian trade may reach 2 million tons per year very soon and could eventually double to 4 million tons. Traffic to and from the Iberian Peninsula will develop very shortly with an estimated 0.5 to 1 million tons per year. For the British market, average growth rates of 7% have been observed, despite low economic performance in the U.K..

Therefore, expectations are also high and it is suggested that this market will show substantial growth again. Finally, there are indications that feeder services will also show further growth, as Zeebrugge is expected to become one of the main hub container ports in Europe.


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In order to meet the increasing demand by customers for better services, substantial investments are done by the port of Zeebrugge. Investments have been made both to increase vessel turn around speed under strict time schedules, and to benefit from economies of scale in view of the trend of increasing vessel capacity for shortsea shipping\(^3\).

### 3.2 THE IMPACT OF THE CHANNEL TUNNEL

Several events in the near future may have a major impact on existing traffic flows in the European Union. The port of Zeebrugge will also undergo changes as a consequence of these circumstances. In this chapter, the potential impact of the Channel Tunnel will be evaluated.

The Tunnel has two components:

- The shuttle, which as a matter of fact, is just a new link competing with existing ferry connections;
- The city-to-city rail intermodal service, which is a new mode.

The shuttle will reduce the competitiveness of Dover and Calais (as a seaport) however without in road miles. This service is the innovative element of the Tunnel as it is a true alternative viz. the shipping industry. Especially for long distance traffic a switch from road haulage to combined rail traffic is expected to occur.

Thus, the intermodal service may take rail container traffic for Italy and East Europe, reducing the cargo base of the container carriers. In general, the Tunnel represents a large supply-side injection into the market, which will inevitably reduce prices and increase the pressure on the margins of all other modes.

The switch from road to rail will be favoured by different market elements and notional and EU environmental policies. Continental restrictions on Sunday driving have already increased the costs of long-distance haulage, and the UK government is examining ways of restricting road traffic. Measures such as a carbon tax would not have a significant effect. Even a doubling of fuel price and duty in the UK would only increase road haulage rates by one sixth. Motorway tolls, or a high annual taxes, could have more effect. Congestion may have its own deteriorating effect on service quality and would affect trailers moving

\(^3\)Most studies set the dividing line between the SSS and the deepsea fleet at 10,000 DWT (or 6,000 GTI, see Policy Research Corporation N.V., *Analysis of the Competitive position of Short Sea Shipping: Development of Policy Measures*, Study co-financed by the European Commission, DG VII and the Department of the Environment and Infrastructure, Ministry of the Flemish Community, Flanders, August 1993, p I.9.
Competitiveness of Shortsea Shipping ports: The Case of Zeebrugge

through Kent and around London. Generally, physical restrictions on road transport could affect service quality adversely in the future.

SSS was recognized relatively late by the EU as a potential joint contributor, with intermodal transport, to the solution of the environmental problems caused by road freight, and the UK Government has lagged behind the EU. Most recently the UK Minister of Transport has begun consultations on a 44 ton concession for intermodal transport, which would allow intermodal operators to compete on level terms with TIR operators as far as payload weight is concerned (otherwise the combination of swap-body and chassis weighs more than a trailer).

This corresponds with EU practice in France, Germany, and Italy, where the concession is a 40 ton road limit, whereas the proposed UK limit will be 38 tons for both semitrailer and drawbar operations.

Several studies have estimated the potential impact of the Channel Tunnel on shortsea shipping from and to the U.K. Although an accurate assessment of this impact is impossible, it is expected that accompanied trailers will be affected more than unaccompanied traffic, especially in a first stage of the operations. It is also expected that the effects of combined transport (intermodal traffic) will be much stronger on longer distances than on the short distances. For that reason, it is expected that the port of Zeebrugge will be less affected by the opening of the Tunnel than other ports which are located closer to the Tunnel. In addition, Zeebrugge is market leader in ro/ro and shortsea shipping container traffic with a large distribution of U.K. ports from the South (Dover) to the North (Hull).

The impact of the Channel Tunnel on the northern ports of the U.K. is expected to be less important and for the port of Zeebrugge, the share of shortsea shipping to the north of the U.K. is continuously rising. The port also possesses a balanced distribution between accompanied - and unaccompanied traffic, is centrally located and has a large hinterland that is spread over Continental Europe. Therefore, expectations are that the impact of the Channel Tunnel will be predominantly on accompanied traffic while unaccompanied traffic might only feel an impact on long distance traffic.

The new strategy of Ford Motor Company that will be in effect once the Channel Tunnel will be operational and that includes shifting segments of its traffic from road/shortsea shipping (via Zeebrugge) to railway tunnel traffic seems to confirm this evaluation. Early this year, Ford announced that it will shift its long distance traffic between Valencia (Spain) and Dagenham (U.K.) to the rail mode.

4e.g. The Channel Tunnel: Prospects for users, investors and competitors, Drewry Business Publications, 1993.

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This traffic involves the transport of spare parts which are at present transported to Zeebrugge and then shipped to the U.K..

Once the Channel Tunnel will be operational; these volumes will be transferred to railway and sent to the U.K. via the Channel Tunnel. However, the shorter connections, on the one hand between Dagenham and Genk (Belgium) and on the other hand between Dagenham and Keulen (Germany) remain unaffected and will continue to use the port of Zeebrugge. Ford concluded that a shift from the present mode to the railway mode would not contribute to gain competitive advantage.

4 STRATEGIES FOR COMPETITIVE ADVANTAGE

The opening of the Channel Tunnel is not the only major evolution in the market that will affect the competitive position of shortsea shipping.

The most important other elements are:

* The recognition by public policy makers of shortsea shipping as an alternative for road haulage;
* The objective of public policy makers to reduce road haulage substantially in order to fight environmental pollution and congestion;
* The introduction of innovative techniques that will increase the competitive position of shortsea shipping;
* The expected increase of commercial traffic in the European Union.

All these elements might also affect the port of Zeebrugge and require the development of a strategic plan of action for the port, both in the short term and in the long term. Such a plan will ensure that Zeebrugge will maintain its leadership position and will create new markets.

This plan may build upon the following elements:

* Improvements in port infrastructure and superstructure will contribute to meeting the requirements of innovations in shortsea shipping, both in ship designs and transhipment methods. This will allow an even faster turn-around time making the port more attractive for fast cargo;
* An increase in the capacity of the port will allow to meet the new developments in shortsea shipping regarding economies of scale;
* Total transit time will be reduced by making hinterland connections more efficient;
* New potential markets should be entered, e.g. the Mediterranean market, and promotion activities should be developed on those corridors with a high development potential.
INTRODUCTION TO THE CORRIDOR-STUDY

By T. Kelchtermans

Paper will be added later
THE FUTURE OF EUROPEAN POLICIES FOR SHORTSEA SHIPPING

By C. Peeters, A. Verbeke and E. Declercq

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1 INTRODUCTION

This paper contains a detailed set of policy recommendations to the European Commission in the area of Short Sea Shipping (SSS). These policy recommendations result from a recent in depth economic and managerial analysis of various important traffic corridors in the European Union (E.U.) and a number of neighbouring countries.

Two complementary corridor studies on SSS, initiated by the Directorate General for Transport (DG VII), Commission of the European Union, were undertaken in the period 1992-1993. The first study was executed by Policy Research Corporation N.V. (Belgium)1. This study analyzed the competitive position of SSS in the following corridors:

*Benelux/Germany - Nordic Countries/Baltic Sea;
*Benelux/Germany - UK/Ireland;
*Benelux/Germany - Black Sea Area;
*UK/Ireland - Italy/Greece.

The second study was undertaken by an international consortium led by l' Institut Français de la Mer (France)2 and analyzed the following corridors:

*Spain/Portugal - UK;
*Spain/Portugal - Germany;
*Spain/Portugal - Greece;
*Italy - Black Sea Area.

The present paper focuses on the 10 government recommendations for European SSS policy contained in the former study. However, the link with the complementary policy suggestions formulated in the latter study is made whenever possible.


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In the second section of this paper, a large number of requirements is listed that must be satisfied to improve the position of SSS in Europe. These requirements follow directly from the two studies mentioned above.

In the third section, the 10 detailed policy recommendations to the E.U. for European SSS policy, developed in the report of Policy Research are described, given that they are in broad accordance with the 24 proposals of Institut Français de la Mer and associates, and primarily constitute an elaboration of those requirements that have particular relevance for policy matters at the level of the E.U.

2 REQUIREMENTS TO IMPROVE THE COMPETITIVE POSITION OF SSS.

The various requirements identified in both reports can be positioned according to their primary link with a specific element contained in Table I: Critical external and internal factors for SSS - competitiveness. Some of these requirements, when translated into policy recommendations, may obviously have a major impact on several elements contained in this table as will become clear in the next section, but in this section only the element with which the most direct link exists is taken into account.

2.1 REQUIREMENTS RELATED TO MARKET FACTORS

Both Institut Français de la Mer and associates and Policy Research have argued that more reliable market data are required on European SSS, as a precondition for potential transfers of traffic. This requirement has been transformed into Policy Recommendation 1 to the E.U., see the next section.

Institut Français de la Mer and associates have also argued that a formal identification should take place of ports that can strengthen the regional market potential of SSS through a concentration of traffic (which would in turn improve the reliability and frequency characteristics of SSS). In addition, those ports should be identified which can aid in the development of SSS for specific types of cargoes. This proposal is obviously directed primarily to shipping companies and the ports themselves. As regards the latter, this requirement was also identified by Policy Research and it has been translated into Policy Recommendation 2 to the E.U. in the next section, albeit as a measure meant to improve the internal and external (port related) technical factors of SSS rather than its market potential per se.
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VI. Other

*A high score for alternative transport modes in fact reflects an unfavourable environmental factor for SSS.*

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Table I: Critical external and internal factors for SSS-competitiveness
2.2 COMPETITIVE FACTORS

As regards the internal strengths of SSS, the total cost structure of this mode could be substantially improved, through financial incentives for newbuilding and rebuilding. This requirement, identified by Policy Research was translated into Policy Recommendation 5 to the E.U., see the next section. In addition, l' Institut Français de la Mer and associates have argued that SSS - operators should be faced with only those port costs they created and not with imperfect approximations of these costs. Furthermore, they have proposed that the use of port services for loading/unloading should be associated with fixed prices for specific port activities (e.g. a fixed price for loading a container).

In the area of total service quality, the internal strengths of SSS could be improved through the introduction of a so-called "combined bill of lading", that would allow multiple inland terminal calls from port to port, to the extent that this bill of lading could be linked to a single administrative document, (equivalent to the one that exists in the road haulage sector). This would allow to avoid, e.g. customs or health regulation controls. Although a simplification of administrative procedures would undoubtedly facilitate the functioning of SSS in the E.U., this element was not included as one of the ten main policy recommendations to the E.U., as purely administrative improvements cannot be expected to substantially alter the relative competitive position of the various modes, but this measure is implicitly taken into account in Policy Recommendation 10 of the next section, which proposes a strong intra-E.U. coordination of all policy initiatives, including administrative ones (see also infra).

The internal time characteristics of SSS can be ameliorated through a stronger coordination between SSS activities and specific port activities related to e.g. transit, storage or logistics.

As regards internal frequency and reliability characteristics, l' Institut Français de la Mer and associates suggested that existing liner shipping companies should coordinate their activities in terms of, e.g. time tables and itineraries. In addition, SSS operations should also make use of the feedering services provided by the very large shipping companies and the feedering services that link large E.U. ports with the final destinations of the cargo.

In order to provide a better integration of SSS in door-to-door intermodal transport chains, it was proposed by l' Institut Français de la Mer and associates to develop a network of multimodal nodal points that would improve the viability of SSS, through a concentration of traffic for, e.g. redistribution or groupage. A similar view was adopted by Policy Research, which also emphasised the need to stimulate the development of multimodal terminals, see Policy Recommendation 6 in the next section.
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2.3 FINANCIAL FACTORS

As regards purely financial factors, no specific requirements were identified. The view adopted here is that market forces should prevail and that no major problems exist as regards the financial structure or profitability of SSS-operators in general.

2.4 TECHNICAL FACTORS

The environmental attractiveness of SSS could improve substantially if specific investments were performed in port infra- and superstructure in the Cohesion Fund Countries and Eastern Europe, as suggested in Policy Recommendation 7 in the next section. L' Institut Français de la Mer and associates have also suggested the development of inexpensive, standardised loading/unloading equipment in small and medium-sized ports. They also identified the requirement to ameliorate the infra- and superstructures of inland ports, which is consistent with the policy recommendation regarding multimodal inland terminals (see supra).

The requirement to increase the use of EDI and related systems was identified by both L' Institut Français de la Mer and associates and Policy Research; this issue is discussed in more detail in the next section as Policy Recommendation 3.

The external environment of SSS would obviously be much more attractive if the technical integration with other elements in the chain, e.g. as regards EDI, would be organized by the ports involved on specific routes themselves. Here, Policy Research identified the requirement to create "port-pairs" as traffic development champions, see Policy Recommendation 2 in the next section.

Finally, both L' Institut Français de la Mer and associates and Policy Research emphasized the requirement of improved internal strengths of SSS as regards integration in an intermodal transport chain. Whereas L' Institut Français de la Mer and associates focused primarily on the need to unitize cargo, e.g. through increased containerisation, Policy Research also drew attention to the need for innovative vessel designs in SSS, as explained in Policy Recommendation 4 in the next section.

2.5 SOCIO-POLITICAL FACTORS

Various important requirements were identified in the area of socio-political factors. Both L' Institut Français de la Mer and associates and Policy Research view a better promotion of SSS as crucial to the facilitation of interactions with major stakeholders. They are also in favour of a formal strategic plan for SSS
across corridors. In Policy Recommendation 9 of the next section, a new institutional structure is proposed to organise promotion and strategic planning activities.

In terms of regulation, the two consultants agreed that external costs should be taken into account when comparing the total cost structure of alternative modes; this requirement was translated into Policy Recommendation 8 to the E.U. in the next section.

L'Institut Français de la Mer and associates have suggested various other regulatory changes aimed to stimulate SSS, including the harmonisation of regulations regarding, e.g. flag requirements, safety requirements, the status of vessels registered under second registers of Member States, liability rules etc.. They have also proposed to provide the most favourable conditions to SSS as regards energy costs (in particular in the ports) and the unambiguous, full exemption of SSS traffic from value added taxes.

In this context, Policy Research has adopted a somewhat institutional perspective, arguing that all proposals and actions regarding SSS at the E.U. level such as the ones proposed by l' Institut Français de la Mer and associates should be the subject of formal coordination and strategic actions by a new organizing agency, see Policy Recommendations 9 and 10.

2.6 OTHER

L'Institution Français de la Mer and associates have identified the need to ameliorate the accessibility of a number of inland navigation waterways for SSS-vessels. This has been taken into account in Policy Recommendation 4 regarding the stimulation of the use of sea-river ships. In addition, they have argued that SSS-operators should benefit from the same advantages as inland navigation vessels, e.g. as regards exemptions from pilotage in ports.

3 TEN SSS-POLICY RECOMMENDATIONS TO THE E.U.

Given the requirements that need to be satisfied to improve the competitive position of SSS in Europe, as described in the previous section, the present section contains concrete policy recommendations to the E.U.. Although the research methodologies used by l' Institut Français de la Mer and associates on the one hand and by Policy Research on the other hand are somewhat diverging and reflect the core capabilities of each consultant, the previous section has demonstrated that a high level of complementarity exists as regards the requirements identified by the two consultants. Hence, the policy recommendations
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included in this section constitute a logical extension of the requirements identified in the previous section.

3.1 POLICY RECOMMENDATION 1: CREATION OF RELIABLE MARKET DATA ON EUROPEAN SSS.

As regards market data on SSS, it should be recognized that it is very difficult at present to assess the exact market size of specific traffic flows on specific routes and thus the market power of alternative transport modes.

An important problem in the analysis of existing cargo flows and in assessing the market potential of SSS, is the lack of reliability and correspondence of the available statistical data. Many data bases exist that contain shipping information; e.g. Eurostat’s data base on external trade by mode of transport, Lloyd’s Maritime Information Services, the Dutch BTS system or port data bases such as APICS in Antwerp.

For a number of reasons the comparison of SSS flows derived from different data bases is very difficult:

* SSS is not defined in an unambiguous fashion; hence, depending upon the definition used in an analysis, flows may vary considerably;
* When analyses are based upon external trade data, definitions of import and export may vary considerably depending upon the reporting statistical agency;
* Cargo flows are often disaggregated into classifications of goods in order to appraise the importance of particular categories of goods. Unfortunately, many such classifications exist, e.g. SITC\(^3\), NSTR\(^4\), CN\(^5\), etc., all of which are different in one or more aspects from the others. Cargo flows based upon different data bases using different goods classifications are therefore hardly comparable.

Eurostat data constitute the most valid European statistics presently available. The Eurostat data base provides up-to-date information on external trade of the E.U. member states: data is available from 1989 onwards. As the Eurostat data base is restricted to national statistics on the 12 E.U. member states, it faces limitations for studies of a much smaller scope (e.g. individual routes or interregional flows) or for individual SSS operators who want, e.g. to forecast future

\(^3\)Standard International Trade Classification of the United Nations Organization.

\(^4\)Standard Goods Classification for Transport Statistics.

\(^5\)Combined Nomenclature, since 1 January 1988 the statistical nomenclature of the E.U.
traffic demand in a certain region or transport relation. The Eurostat external trade database does not supply port or regional statistics and data on non-E.U. member states can only be compiled through the import data of the 12 reporting countries. Such demands would have to be met by national or port data bases, to the extent that they exist. Here, the above mentioned problems with regard to data comparison come into play: a statistic in one national or port data base does not necessarily mean the same thing in another one. To avoid such inconsistencies between data from different data bases, it is suggested that a data base be created which provides detailed information with regard to SSS. The need for detailed SSS statistics has often been observed by both researchers and policymakers. In a paper, included in N. WIJNOLST, C. PEETERS AND P. LIEBMAN, European Shortsea Shipping, Proceedings from the First European Roundtable Conference on Shortsea Shipping, 26-27 November 1992 at the Technical University of Delft, The Netherlands, Lloyd's of London and New York, 1993, it was demonstrated, through the use of a hierarchic decision model, that the shipping market in general expects the greatest contribution to an improvement of the SSS trade from the processing of relevant statistics.

Hence, the first policy recommendation is that the existing Eurostat data base should be expanded to non-E.U. member states such as the EFTA and East-European countries. In addition, port statistics should be included in the data base so as to provide a means to create origin/destination matrices on a port-to-port basis. Initially, these port statistics could be limited to a country's most important ports (mainports). As regards the role of small ports in the development of SSS and multimodal transport, it is suggested that these ports' statistics should be included in a further stage of the data base development.

As the current Eurostat data base on external trade by mode of transport is limited to import and export data, throughput - an important cargo flow in countries such as Belgium or the Netherlands - is either lost or needs to be compiled from other data bases. Here again, problems related to inconsistent data arise. Therefore, it is suggested that data on throughput by mode of transport and goods in customs warehouses be collected. Hence, the data base should cover the full spectrum of cargo transported in a certain country or on a certain transport relation, specified by mode of transport and by category of goods.

It should be recognized that the compilation of such a data base is a difficult undertaking. However, all the data mentioned above are currently available from various sources: national statistics offices, ports, UN, O.E.C.D, etc.. The problem is not so much the availability of data but rather the lack of cor-

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respondence among data from different sources. Consequently, priority should be given to the establishment of internationally accepted procedures and definitions (import, export, goods classifications, etc.) for data collection. In order to convert data of previous years into a standard classification, an additional set of transformation procedures will need to be developed. The creation of reliable data on the SSS-market may improve both the environmental attractiveness of SSS as perceived by customers and strategic planning by SSS-operators themselves.

3.2 POLICY RECOMMENDATION 2: CREATION OF "PORT-PAIRS" AS "SSS-TRAFFIC DEVELOPMENT CHAMPIONS".

An important paradox exists as regards the improvement of internal technical factors for SSS. It has been called the 'Delft Paradox' by a number of European SSS-insiders. At the research conference on SSS at the University of Delft which was mentioned above, several experts explained the need to achieve scale economies in terms of larger SSS-vessels, higher capital investments in ports and a concentration of traffic flows on a few routes within major corridors. Simultaneously, a number of other experts expressed their concerns regarding the hinterland transportation problems that would arise from a concentration of SSS-traffic based on scale economies in a limited number of ports and the fact that such a concentration would reduce the possibilities of SSS to improve on its major weakness, namely its time, frequency and reliability characteristics vis-à-vis the road mode. In fact, this second view is shared implicitly in the E.U.'s White Paper on "The Future Development of the Common Transport Policy - A Global Approach to the Construction of a Community Framework for Sustainable Mobility". A reduction of the market power of the road mode in favour of SSS will only occur if SSS can build upon the existing pool of small ports in Europe.

Hence, the policy recommendation to the E.U. is that all seaports in the E.U. should in principle be viewed as transboarding points that can assist in the development of SSS. No attempt should be undertaken, for example, within the context of developing Trans European Networks, to select a limited number of ports as potential catalysts for large scale SSS-development, as this would likely lead to new bottlenecks in hinterland transportation and a reduction of door-to-door transportation capabilities. The development of SSS on smaller scale routes requires "SSS traffic development champions".

Unfortunately many informal meetings held with a variety of business level policy makers, whether from the shipping or port sector, led to the conclusion that neither individual small shipping operators, nor individual small ports have the capabilities and/or entrepreneurial drive to generate such developments. Small shipping companies are mostly interested only in the shipping part of the business, from port to port, and not in creating door-to-door transport chains. In
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contrast, most port authorities are primarily interested in providing services demanded by their own port customers, not in providing new international door-to-door transport services to be "sold" to commercial or industrial customers who presently use a transport option with a stronger involvement of alternative modes.

The policy recommendation in this respect is that the E.U. should stimulate the development of "Port-Pairs" which should act as "SSS-traffic development champions" on a specific route. Hence, it is suggested here that, e.g. feasibility studies or other research projects supported by the E.U. to stimulate SSS on specific routes should be funded in cases were two (or more) port authorities are involved at the outset of the project.

An example of a potential project that could fit in this area is the so-called "Baltic By-Pass" project that is promoted by a consortium including the Associated British Ports Goole (UK) and the Port of Rostock (Germany). The pilot project "Sealink" launched by the Commission and involving four ports in Germany (Rostock and Lübeck), Italy (Brindisi) and Greece (Patras) should also be viewed in this context. The main advantage of ports functioning as a pair is that cooperation between them can rapidly be established, e.g. in terms of coordinating EDI-proposals, identifying potential cargo flows and providing "dual" incentives to shipping companies and shippers to consider the proposed SSS-route. In fact, each "port-pair" should provide the services that can normally only be offered by large mainports and/or large shipping companies. In practice their activities should lead to the attraction of sufficiently large cargo flows on "thin" routes to make services possible between the two (or more) ports.

In practice, this recommendation does not hold primarily for dry bulk, which is mostly well organized already, given the concentration that often exists at the suppliers' side. It is not meant for ro/ro traffic either, which is already well-established on main routes and which mostly requires large and stable traffic flows with high frequency to be commercially viable. It does seem appropriate, however, for general cargo transportation. Here, both supply and demand are often very dispersed, but precisely given the challenge to generate reliable door-to-door services which far exceed a single port to port route, this constitutes a largely untapped area for policy actions.

Given that it was suggested above that a "port-pair" should act as the initiator of new SSS-routes for specific types of cargo, the first task of each port should not be to substitute for activities, which are normally executed by a variety of business firms such as shipping companies, stevedoring companies, hinterland transportation operators etc. but to set up a local consortium of interested partners. The local consortium at each end could then form an international, intermodal network. The first function of this network should probably always be to set up an appropriate EDI system with standard messages related to
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enquiry, offer, acceptance and confirmation of transportation services, thus linking in an appropriate way the different economic actors involved in international transportation, e.g. cargo owners, export agents, export hauliers, shipping companies, counterpart agents (import), import hauliers, receivers of goods, financial institutions, etc.

The main problem here is obviously related to the nature of the data included in the system: none of the actors mentioned above would agree to provide information deemed confidential to the system, e.g. related to real freight rates. In any case, in the UK the development of a full EDI consignment tracking system could probably be operationalized in the short run, through the use of the excess capacity of the UK and Irish customs clearance system, which has arisen as a result of the European Single Market. The identification and stimulation of "port-pairs" to act as "SSS-traffic development champions", e.g. through E.U. support for feasibility studies for specific routes will lead to an impact on technical factors, both in terms of environmental attractiveness (given the improved availability of EDI and network systems in ports) and internal strength (given the improved technical compatibility of SSS-vessels in an intermodal transport chain, and their better access to - and use of - EDI and network systems).

3.3 POLICY RECOMMENDATION 3: CREATION OF HOMOGENEOUS EDI-STANDARDS THROUGH AN EDI-DEVELOPMENT PACKAGE FOR PORTS AND MULTIMODAL OPERATORS

Most of SSS's traffic potential is related to its possible role in a multimodal transport chain. The extent to which SSS will be able to exploit this opportunity depends largely on its ability to link itself to other transport modes. It is generally accepted by researchers and policymakers that Electronic Data Interchange (EDI) has a crucial task in the scheduling and linkage of different modes. Consequently, attention should be devoted to the creation of an European EDI network. Currently, a number of projects on EDI are being carried out, some of them under the auspices of the E.U. (e.g. the Arcantel platform).

One should keep in mind that there are several aspects to the current EDI experiments numerous ports are undertaking. On the one hand, such experiments imply that port authorities acknowledge the contribution of EDI to intermodalism and are aware of the importance of adequately linking one mode to another. On the other hand, the various independent projects may generate different de facto EDI-standards, and pose various problems for the linkage of distinctive regional EDI-networks into one national or European network in the future.

Consequently, the policy recommendation for the E.U. is to develop a support program, through which information and possibly financial and staff resources would be allocated to ports envisaging EDI projects. This implies that the E.U. should create an EDI-development package for ports, possibly including a train-
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ing scheme for specialized EDI personnel. These EDI specialists should be made conscious of the E.U.'s policy purposes, requirements and standards with regard to EDI and should implement these in the port network.

To the extent that EDI-development would be implemented by "port-pairs" and local consortia as already suggested, the internal strengths of SSS could be improved through the support of EDI specialists to companies offering intermodal services, especially those engaged in SSS. This could bring about a shift in the perception of EDI by the staff of the relevant companies: EDI would increasingly be appreciated as accessible, useful, even necessary. This incorporation of EDI in the company culture of SSS-firms is probably a vital cornerstone to the future success of intermodal transport.

As valuable as EDI may be, it is not a miracle cure. EDI enhances the intermodal flow of cargo, but does not provide the ability to react to unforeseen situations. It does not supply real-time feedback loops to shipper, mode operator or customer. For example, production techniques based upon the JIT-philosophy require the timely arrival of ordered components. In case the intermodal scheduling is inaccurate, alternative routings need to be available so as to ensure the arrival of the parts. Numerous other reasons exist that require flexibility of the transport system, e.g. transport of high value goods, goods prone to putrefaction, live animals, etc.. In this respect, road haulage in general has a superior ability to adapt to unforeseen situations. Although SSS can never achieve the same level of adaptability, it should be able to attract additional traffic by implementing a real-time information system.

A real-time information system implies that the customer, the shipper and the mode operator are at all times informed of the location of the cargo. This could be achieved through the use of, e.g. an electronic tracking system whereby each container or cargo unit would be equipped with a microwave signalling device which is registered at regular time intervals and/or at border crossings, port calls, transboarding operations, etc.. This information would be sent to the interested parties via a network or via satellite. Such a system would greatly improve the level of service of SSS; moreover, it could contribute to eliminating at least partially one of the weaknesses of SSS, namely its reliability. Nonetheless, it should be emphasized that the costs of such a system should be carefully weighted against the expected benefits. The creation of homogeneous EDI-standards across corridors, countries and transport modes, should improve the total service quality of SSS and its integration in door-to-door intermodal transport chains. Hence, the competitive position of SSS would be improved. Simultaneously, the technical capabilities of SSS would also improve, in terms of technical integration in intermodal transport chains. Given that ports would also be supported in implementing EDI standards, the environmental attractiveness of SSS would also increase, as regards competitive and technical factors.
3.4 POLICY RECOMMENDATION 4: STIMULATION OF DIFFUSION OF "ENTRY BARRIER ELIMINATING" SSS VESSEL DESIGNS

The report of Policy Research emphasized the potential of new types of vessels to make SSS competitive in terms of total service quality, time characteristics, frequency and reliability characteristics. The potential of 4 different types of SSS-vessels was demonstrated, each of them capable of substantially improving the competitive position of SSS vis-a-vis alternative transport modes. Hence, these 4 types could be called "entry barrier eliminating" (EBE) SSS-vessels. A distinction was made among fast cargo ships, sea river ships, selfunloading bulk carriers and selfunloading and loading unitload ships.

As regards the first category of EBE-vessels, namely fast ships, it appeared that many routes are viable, especially from the UK, but traditional operators may not be sufficiently entrepreneurial to enter into this market. Hence, operators of fast ships will mostly be newcomers in shipping.

Their competitive advantages will be that new services can be started without delay (as no new infrastructure is required), with a frequency and reliability that equals the quality of road transport. However, fast ships can only function efficiently when EDI-network systems are present and port terminals are available with advanced handling technology. What is required to create a diffusion of fast vessel technology is to:

* Stimulate and co-finance research into the technological development of light structures for fast ships;
* Stimulate the development of light weight intermodal unitloads for road, rail and sea;
* Develop flexible, automated cargo handling/transfer terminals in ports;
* Develop vessel traffic control systems and advanced shipboard navigation and operation systems;
* Eengage in the early development of technical standards that will increase the long term competitive position of the manufacturing industry in Europe.

The potential of the second category of vessels, namely sea-river ships, was demonstrated through a chemical tanker case study. Although this type of vessel is already widely used in the North of Europe (between the UK, Benelux, Germany, the Nordic countries and Poland and the other East European countries on the Baltic Sea), a new opportunity is the major new North-South corridor connecting the Baltic Sea and the Mediterranean Sea via the Volga-Don rivers and canals and the Black Sea. Sea-river vessels can operate 220 days of the year (the rest of the year, the rivers are frozen) on this 3000 km long system from St. Petersburg to Rostow. The potential of this route is enormous because of the availability of a large fleet of unemployed Russian and Ukranian
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sea-river vessels, the low running and voyage costs of these ships, and the fact that the sailing time from the Baltic to the Mediterranean is short.

In order to further develop the use of sea-river ships, it is necessary to provide dimensions to the river and canal systems in Europe along common standards so as to facilitate the design of ships, a work that is already initiated by PIANC.

The third ship category, selfunloading bulk carriers are especially competitive on shorter routes (below 2000 nautical miles), which covers most of the dry bulk corridors in Europe, and the North-African countries around the Mediterranean. The closure of many coalmines in Germany and the UK, will increase transhipment and distribution flows. These represent an opportunity for selfunloading bulk carriers. The major opportunity comes from the development of low cost, flexible discharge systems onboard small bulk carriers. The reduction of the handling costs will not only reduce the overall freight bill, but will induce the development of new trade flows to and from small ports in Europe and of low value commodities, that could not be shipped in an economically viable way until now. These bulk carriers which range from 2,000-7,000 dwt, will not dramatically change the existing corridors, but will contribute to a dispersion of the corridors.

Corridors suggest large flows of goods, and economies of scale because of this large volume. A complete different perspective is the achievement of a network of hundreds of small routes, dispersed over Europe. As a result of the very low seaborne transport cost, each small port could become competitive in its own right. The technological innovation in small ship selfunloading technology at low capital costs, could be the trigger to achieve this objective, which is also in line with Policy Recommendation 2.

Finally, automated unitload ships represent the fourth category of EBE-vessels. The use of such ships could create the same economies for small coastal ports in Europe as described above for selfunloading bulk carriers. The development of these ships could alter the competitive advantage of SSS vis-à-vis road transport, particularly in countries with a long coastline, such as the Nordic countries and Italy. An efficient, low cost unitload shipping system could alter dramatically the transport corridor between Benelux/Germany and the Nordic and Baltic countries. A unitload based on the maritime container and the stackable swapbody could become the backbone of an alternative system that would substitute for long distance road transport in Europe. Its development should therefore be actively stimulated.

The stimulation of EBE vessel designs may have a substantial impact on the market share of SSS on many routes and the internal competitive, financial and technical factors faced by SSS-operators. Given the higher overall service quality that can be expected from these vessels, improved relationships may result with customers.
3.5 POLICY RECOMMENDATION 5: STIMULATION OF NEWBUILDING AND REBUILDING OF SSS-VESSELS

The 7th Directive (90/684/EE.U.) of December 21st 1990 (O.J. L 380/27) on shipbuilding support created a situation where support for small vessels with a contract price lower than 10 million E.U.U is severely limited as compared to larger vessels. In addition, this same directive only foresees support to vessels with a metal casco. As a result, small SSS-vessels and innovative SSS-ships with a non-metal hull (e.g. polyester-GRP) are virtually excluded from government support measures. Hence, it is proposed here to eliminate the words 'with a metal casco' in Article 1 of the 7th Directive. As a result, it would become possible to provide support for newbuildings of SSS-vessels with a non-metal casco.

In addition, the present limits on financial support for small vessels could be altered in the case of 'innovative' SSS-vessels, more specifically the so-called 'EBE' vessels described in Policy Recommendation 4. This change of the Directive on E.U.-support to shipbuilding in favour of SSS-vessels, will primarily influence the internal competitive, financial and technical strengths of SSS.

3.6 POLICY RECOMMENDATION 6: STIMULATION OF MULTIMODAL INLAND PORT TERMINAL EXPANSION

Policy recommendation 4 included the suggestion to stimulate the use of sea-river vessels in order to improve the competitive position of SSS in terms of, e.g. time, frequency and reliability characteristics and integration potential in a multimodal transport chain. The external complement of this recommendation that aimed to increase the internal strength of SSS-operators is the development of "state of the art" multimodal inland port terminals.

The further development of such terminals, especially in the Benelux and Germany, could greatly enhance the combined attractiveness of inland navigation and SSS. Hence, the E.U. should stimulate the development of multimodal port terminal projects, which should be eligible for the "common interest" status in the port network.

Policy Research recently developed a new methodology for the optimal location selection of multimodal terminals in the Flanders area (Belgium)\(^7\), based upon a

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\(^7\)Policy Research Corporation N.V., Onderzoek naar de mogelijkheden voor het inplanten van multimodale terminals in het Vlaams Gewest, Studie in opdracht van het Vlaams Gewest, Departement Leefmilieu en Infrastructuur; Administratie Waterinfrastructuur en Zeewezen, May 1993. An English summary of this study is available: Flanders: the optimal location for multimodal inland navigation terminals. Summary of the study, commissioned by the Ministry of the Flemish Com
variety of qualitative and logistical parameters. The qualitative parameters include criteria such as the physical characteristics of the different sites, their quality and capacity, the possibilities for expansion, the environmental impact, etc. The logistical parameters include technical determinants (transport costs, centrality), site specific determinants (public infrastructure facilities and waste disposal) and market specific determinants (customer base and potential demand growth).

A paradoxical side-effect resulting from the development of multimodal terminals may be the need to create strategic alliances with alternative (in this case complementary) transport modes, especially road transportation. Such alliances may benefit road hauliers, given that some of their core business is now threatened by increased competition, congestion and unfavourable government regulations. A redefinition of corporate strategies will likely include the assessment of possibilities for intermodal cooperation. It is self-evident that the availability of well-equipped multimodal terminals may induce road haulage firms to search for ways to cooperate with SSS-operators. In this context of strategic coordination, it is also suggested that these multimodal terminals should be eligible for government support through an extension of the concept of combined transport as defined by the E.U. to include multimodal transport involving SSS. At present combined transport is still defined primarily in terms of road or rail transportation whereby, e.g. a truck or container (20 ft or larger) may use different transport modes, see Council Directive 92/106 of December 7th, 1992 (O.J. L 368/38). Hence, multimodal transport of, e.g. general cargo or goods that are repackaged in a terminal is excluded from this definition. To allow government support for multimodal transport, Council Regulations 1107/70 of June 4th, 1970 (O.J. L 130/1) and 3578/92 of December 7th, 1992 (O.J. L 364/11) should be altered in order to include multimodal transport involving SSS.

Hence, support would become available for:

* Investments in infrastructure;
* Investments in fixed and mobile assets for transboarding;
* Investments in vessels or rolling stock used exclusively for multimodal transport.

The improvement of multimodal inland port terminals is especially important as various case studies have convincingly demonstrated that often there is not just a simple choice between on the one hand SSS and on the other hand road transportation. The choice is mostly one between a "lower" or "higher" use of SSS. In this context, multimodal inland port terminals may contribute to im-

munity, Department of the Environment and Infrastructure, Administration for Water Infrastructure and Maritime Transport, June 1993.
proving the competitiveness of the "higher use of SSS"-options, given the lengthening of the SSS-voyages without transboarding.

3.7 POLICY RECOMMENDATION 7: STIMULATION OF PORT DEVELOPMENTS IN COHESION FUND COUNTRIES AND EASTERN EUROPE

The four Cohesion Fund countries (Greece, Ireland, Portugal and Spain) with a per capita GNP of less than 90% of the Community average are eligible for support to infrastructural projects. The Member States Group on Ports and Maritime Transport, set up in the context of the formation of Trans-European Networks, has developed operational criteria to be fulfilled by these Cohesion Fund countries when submitting port projects. One of the criteria to be satisfied in this context is the use of environment friendly transport modes for project related traffic, with a focus on SSS at the maritime side.

In the Member States Group on Ports and Maritime Transport it was argued that financial support for port infrastructural projects, even within the framework of the Cohesion Fund could lead to distortions of competition, given that the Cohesion Fund leads to funding of, e.g. 85% of the cost of a project. However a "Formula" was developed, including various criteria, such as each project's financial and/or socio-economic return, the application of which should avoid distortions of competition.

Hence, the E.U. should further stimulate the submission of SSS-related port projects for Cohesion Fund support as this constitutes a unique opportunity to achieve both a stronger economic development and a reduction of negative external effects in the relevant Member States.

It was also suggested that insufficient port infra- and superstructure in various Baltic states is responsible for slow SSS-growth. In these nations, support for, e.g. feasibility studies and port master plans should also be focussed on SSS-development with the E.U.. In meetings with Eastern European countries, E.U. officials should perhaps not try to discourage the growth of road transport networks in these nations, but they should at least focus the attention of public policy makers on the negative external effects associated with road transportation and on the benefits and opportunities associated with SSS. The impact of this policy recommendation is primarily in the area of technical factors that will improve the environmental alternatives of SSS.

3.8 POLICY RECOMMENDATION 8: INTERNALIZATION OF EXTERNAL COSTS CREATED BY THE VARIOUS TRANSPORT MODES

The need for internalization of external costs created by the various transport modes has since long been recognized at the E.U. level. It constitutes a building
block of the White Paper on "The Future Development of the Common Transport Policy: A Global Approach to the Construction of a Community Framework for Sustainable Mobility". The road transportation sector still does not pay fully for the external costs it generates. Unfortunately it is not evident that, e.g. higher fuel taxes would lead to substantial shifts in traffic.

A number of other case studies demonstrated that at present SSS is often not chosen in spite of a lower cost to the shipper as compared to the road mode. In other words, customers are often prepared to pay a higher price for the road mode given its time characteristics, flexibility, reliability, etc.. Hence, in contrast with conventional economic theory, it is suggested here that the road mode should be regulated in those areas that constitute the major weaknesses of SSS. For example restrictive measures, such as the prohibition of road transport during week-ends may substantially affect the competitive position of SSS, given that its time characteristics constitute one of its major weaknesses, vis-à-vis the road mode. In general terms, the E.U. should act as a driving force to achieve a consensus among Member States as to homogeneous measures aimed to reduce the attractiveness of the road mode, but which are different from mere tax increases.

3.9 POLICY RECOMMENDATION 9: CREATION OF THE "EUROPEAN SSS - PROMOTION SERVICE" (ESPS)

SSS has remained a relatively "unknown" sector for many potential customers and interested parties, especially in the area of general cargo transportation. It is suggested here, that only a new organizational structure would contribute substantially to ameliorating this situation. Hence, the "European SSS-Promotion Service" (ESPS) should be established as a non-profit organization, with 4 main goals:

1. Stimulation of alliances among SSS-operators on specific routes, in terms of both groupage and marketing, in order to improve the total service quality of SSS vis-à-vis other modes;

2. Stimulation of cooperation with other modes in order to improve the intermodal capabilities of SSS, especially in the area of EDI and VTS;

3. Stimulation of innovation, especially in vessel design to overcome existing competitive and technical weaknesses of SSS. This third goal is very important as many SSS-operators and representative organizations are conservative in terms of adopting innovations; this attitude may sometimes be beneficial to the sector as regards, e.g., safety standards, but it is detrimental to the diffusion of innovations. Hence, it is very important that the ESPS should act as a catalyst for the diffusion of knowledge on
innovations among the many conservative and individualistic actors in the SSS-sector;

4. Strategic interaction with public and business level policy makers to implement the general policy measures described in the other sections of this chapter as well as specific policy measures for specific routes. The ESPS could perform a key role in the intra-E.U. coordination of activities related to SSS and act as the main coordinating body in this area, see also Policy Recommendation 10.

It is proposed here that the board of directors of the ESPS should consist of a representative of DG VII (chair) and representatives of (a) the sector itself; (b) the various E.U.-Member States; (c) (potential) SSS-users; (d) regional branches of the ESPS.

The regional branches could be set up per Member State or SSS-route. In addition, ad hoc commissions could be established to stimulate specific external or internal factors related to SSS. In order to allow an effective functioning of the ESPS, especially as regards continuity in its actions, a Central office should be set up. The Central office of the ESPS should consist of a staff with at least a general manager, an assistant and a secretary. It is suggested here that it could be funded for 50% by the E.U. and 50% by the Member States.

The financing of the regional branches could, e.g. be done for 25% by the E.U. and 75% by the Member States. Given the 4 goals of the ESPS mentioned above, the regional branches should focus primarily on goals 1 and 4. Goal 1 refers to the stimulation of cooperation within the SSS-mode, not to achieve industry collusion, but to strengthen the position of this mode vis-à-vis alternative modes. Goal 4 is related to promoting SSS within specific routes in particular Member States. In principle, the creation of the ESPS could contribute to an improvement of all external and internal factors related to SSS in function of the focus of its activities.

3.10 POLICY RECOMMENDATION 10: FORMAL INTRA-E.U. CO-ORDINATION OF SSS-SUPPORT MEASURES

Several projects in favour of SSS are presently being supported by the E.U. However, the danger of fragmentation is high in this respect. For example, in a recent paper, included in N. Wijnolst, C. Peeters and P. Liebman, op. cit. 1993,
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an overview was given of a number of E.U. supported projects in the area of coastal shipping and SSS\textsuperscript{8}.

This overview illustrated the variety of policy initiatives related to SSS. However, it is clear that as the number of these initiatives will increase, especially in the area of research, formal coordination is required to avoid duplication and the development of contradictory policy options.

Seven major areas of research were identified to be supported by the E.U., where overlapping efforts should be avoided:

1. Research related to SSS-data, as discussed in Policy Recommendation 1;

2. Research related to SSS-feasibility studies for specific routes, as discussed in Policy Recommendation 2;

3. Research in the area of EDI and Vessel Traffic Control Systems in terms of the requirements discussed in Policy Recommendation 3;

4. Research and multidisciplinary evaluations regarding innovative shiptypes such as the ones discussed in Policy Recommendation 4;

5. Research aimed to identify and establish multimodal SSS-terminals in Europe, including inland terminals, as discussed in Policy Recommendation 6;

6. Research on potential improvements of port efficiency in Eastern Europe and the Cohesion Fund countries, as suggested in Policy Recommendation 7;

7. Research related to an efficient functioning of the European SSS Promotion Service (ESPS), the establishment of which was proposed in Policy Recommendation 9. More specifically, an operational marketing strategy and marketing plan should be developed for the ESPS. In addition, software should be developed for cost comparisons and investment analysis of SSS-projects.

This policy recommendation will also lead to an amelioration of the situation of SSS as regards all internal and external parameters.

4 CONCLUSIONS

The ten policy recommendations to the E.U. formulated in this paper result from in depth research into the internal strengths and weaknesses as well as the external opportunities and threats, which presently characterize SSS in a number of large European corridors.

It is important to realize that these policy recommendations should be adopted in their entirety in order to maximize the effectiveness of European SSS policies. Therefore, it may be appropriate to formulate a Masterplan for European SSS at the level of the European Commission. This Masterplan should include all the recommendations discussed in this paper and should address the problems of their implementation in practice. Here, the focus should be on the mobilisation of the required financial, human and other resources and the expected timing of the recommendations' adoption.
INSTITUTIONAL AND SOCIOECONOMIC ISSUES IN GREEK FERRY SERVICES

By S.G. Sturmey, G. Panagakos, H.N. Psaraftis

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INSTITUTIONAL AND SOCIOECONOMIC ISSUES IN GREEK FERRY SERVICES

ABSTRACT

This paper aims at presenting the main issues concerning institutional and socioeconomic problems in Greek coastal shipping. In particular, issues concerning the implementation of the EU Regulation on maritime cabotage are given emphasis and discussed throughout the paper. It is seen that many changes will have to take place to harmonize existing national legislation with the new regime that will take place in 2004.

1 INTRODUCTION

As a nation with small mainland and a plethora of islands, Greece depends essentially on its ferry services to maintain its economic, political and social cohesion. Without these ferry services, many of the inhabited islands would become uninhabited. In strictly economic terms, if the services are examined on a route by route basis, their maintenance cannot be justified. However, the route by route basis is not a correct way to examine the situation. The justification for maintaining the services, is based upon the following considerations:

* The economic value of the whole is almost certainly greater than the sum of the values of the parts and the loss to the vacation industry, particularly in social welfare, of the islands which cannot be served economically on a year round basis would be considerable;

* Many of the uneconomic islands are uneconomic because of lack of rational development, not because they are incapable of development;

* The influx of the island populations to Attica would worsen conditions in an already overcrowded area, which is approaching an environmental disaster, and would create economic costs which would be immense; and

* An integrated plan for the development of alternative centers of activity to the Athens/Piraeus agglomeration would also help the presently disadvantaged islands by reducing the transport costs of meeting their needs and rendering their exploitation viable.
Institutional and Socioeconomic Issues in Greek Ferry Services

The system by which the uneconomic services are supported is ingenious and enables assistance to be given without any state subvention. But:

* The system establishes monopolies in the service of popular islands to the detriment of the quality of service enjoyed;

* The ferry fleet has aged to the point where its ability to continue to serve the islands is becoming a matter of doubt; of the 71 mainline ferries in the fleet, 27 will reach the age of 35 years within the next ten years;

* Current practices are contrary to the letter and spirit of the EU Regulation on liberalizing maritime transport, and so must be changed; and

* The dual obligation placed on ferry owners, namely, to serve islands they don’t want to serve, and also islands they do want to serve, in accordance with the detailed terms of the Ministry and never in accordance with their own judgements, has held back the proper development of the Greek ferry fleet and leaves it vulnerable to a takeover by non-Greek EU shipping lines.

This paper is a product of a project on Greek coastal shipping sponsored by the Hellenic Industrial Development Bank (ETBA). Complete details can be found in Psaraftis (1993) and in a companion paper to this one (Psaraftis et al, 1994). It is organized as follows. Section 2 presents the institutional framework. Section 3 presents the socioeconomic issues. Finally, Section 4 presents a summary of the results and recommendations of this paper.

2 INSTITUTIONAL FRAMEWORK

2.1 GREEK LEGISLATION

Basic definitions: The Code of Marine Law defines "coastal" shipping as the transfer of passengers and cargo between Greek ports. Coastal shipping is reserved exclusively for ships flying the Greek flag. Only ships registered in one of the Greek registries can fly the Greek flag. Precondition for such registration is Greek nationality. According to the Code mentioned above, Greek nationality is granted to ships, the majority shares of which are owned by Greek nationals or Greek firms.

Ship types: Greek law defines the following ship types: A ship which can carry more than 12 passengers is a passenger ship. All non-passenger ships are cargo ships. Based on their employment, passenger ships are divided into liners which move passengers between certain ports (on pre-specified lines) and "tourist
ships" which execute round voyages. Tourist ships are further divided into professional tourist ships which move passengers on a freight basis (cruise ships or chartered yachts), and pleasure ships which are non-professional ones. Ships which are specifically designed and constructed for the carriage of vehicles are called "ferry boats". Ferries which in addition can carry more than 12 passengers are called "passenger-car ships", while those which are not "passenger-car ships" are called "cargo-car ships". Furthermore, ferries are divided into those of "closed type" if the entire main deck is covered by superstructure, and those of "open type" if the above condition is not met.

Age limits: With certain exceptions (passenger ships which carry up to 49 passengers and pleasure ships), Greek ships can only be registered as "passenger ships", if at the date of registration their age does not exceed the 20 years. Furthermore, Greek passenger ships are not allowed to serve the coastal liner trades if their age exceeds the limit of 35 years. It should be mentioned that the entry limit to the Greek passenger fleet (20 years) applies to all passenger ships, while the exit limit (35 years) concerns only the liner passenger vessels, meaning that cruise ships or ships employed on the Greece-Italy lines are not subject to the exit limit.

Cabotage: The right to transfer passengers between Greek ports belongs exclusively to liner Greek passenger ships. This does not apply to the drivers of professional vehicles, who can be transferred by Greek "cargo-car ships", as well. Direct transfer of passengers between Greek and foreign ports and vice-versa can also be executed by foreign-flag passenger ships, on the basis of reciprocity.

The right to carry cargo between Greek ports belongs exclusively to Greek cargo ships of up to 1,000 G.R.T. This limit does not apply to "cargo-car ships" employed between Greek ports. The use of Greek cargo ships of more than 1,000 G.R.T. is allowed for the carriage of certain commodities in bulk (cement, oil products, ores, etc.). The upper limit of cargo volume which can be carried by Greek passenger ships is 5 tones per shipper. Ships serving "thin lines" and the carriage of vehicles are exempt of this limitation. Direct carriage of cargo between Greek and foreign ports and vice versa can also be executed by foreign-flag cargo ships (with no limitation on tonnage), on the basis of reciprocity.

Entry into fleet: Shipowners willing to introduce a new vessel in the Greek coastal trade are obliged to place an application for a license (feasibility certificate) with the Ministry of Merchant Marine. Following discussions with the Consultative Committee¹, the Minister decides on the matter within 60 days.

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¹The Consultative Committee has 7 or 8 members depending on the subject to be discussed and is presided by the General Secretary of the Ministry of Merchant Marine. The Committee is formed by high-rank officers of the administration and a representative of the shipowners’ association. The members of the Committee are replaced every year.
Institutional and Socioeconomic Issues in Greek Ferry Services

Line types: The coastal network consists of a number of lines, which fall into one of the following categories:

Main lines: They originate in Piraeus and connect ports in different provinces.
Secondary lines: They originate in ports other than Piraeus and connect ports in different provinces.
Local lines: They connect ports in the same province. The connections between points of mainland Greece and the opposing islands, as well as the crossings of narrow strips of sea water (narrower than 3 nautical miles) are considered local lines.

Allocation of ships: The passenger-car ships of open type are only employed in sheltered waters and along distances of no more than 10 nautical miles. The minimum tonnage of ships employed on the longer routes of Piraeus-Corfu, Piraeus-Dodecanese, Piraeus-Crete and Piraeus-Chios-Mytilene is 1,700 G.R.T. The minimum required tonnage for the medium-distance connections of Piraeus, Samos and Piraeus-Eastern Cyclades is 1,000 G.R.T.

The allocation of ships to the lines of the network is a complicated process. For the main lines, the process involves the submission of applications by the interested ship operators for either the winter (months November through March), the summer (April through October), or the entire year, and the subsequent approval by the Minister of Merchant Marine (MMM) following discussions with the Consultative Committee. Prior to the submission of applications, the MMM has the right to determine (and he usually does) the following for each season of the year:

- The number and sequence of port calls on each line;
- The required number of round trips per week; and
- The schedules of the voyages.

The number of the ships to be employed on each main line is determined by historical data and projections on passenger and vehicle traffic volumes, the distances involved, as well as any other idiosyncrasy that each line may present.

The selection of ships to be employed on each main line for the winter season or the entire year is based on the technical characteristics (passenger and car capacity, age, speed and ability to call safely at the ports of the line) of the ships, the owners of which have expressed interest. Between ships of similar characteristics, those which have been built or converted by Greek shipyards and those which have been financed by Greek financial institutions are preferred.
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If the MMM has not exercised his right to determine the number and sequence of port calls, as well as the required number and scheduling of the round trips on each line, prior to the submission of applications by the ship operators, he maintains the right to modify the schedules proposed by the operators with respect to those matters. Furthermore, he should: (i) avoid simultaneous departures of more than one ships employed on the same line, unless such an arrangement is dictated by specific transport needs, and (ii) make sure that ships remain for at least six hours at the port of origin between consecutive voyages. If this is not possible, the Minister may force ships to spend one night per week at the port of origin.

After the winter season, ships on a yearly contract keep on duty only if the number of idle days during the last winter season was no more than 60 for the annual survey and usual repairs, or 90 for conversion, remodelling or re-engining. If the number of ships meeting this condition is not sufficient to cover the summer needs, additional ships are employed among those which have served the same line during the previous winter season with acceptable number of idle days. If even then the needs are not met, other ships may be employed.

Having in mind the high seasonality of the traffic volumes that characterizes the Greek coastal network, restrictions like the one mentioned above aim at securing the provision of adequate transport services during the low-revenue winter season. For the same reason, ships employed during a summer season are obliged to retain their crews hired during the following winter season (with the exception of the 60-90 day immobilization period), regardless of the winter-time ship employment status.

Similar procedures are followed for the allocation of ships to the secondary and local lines.

A basic characteristic of the way ships are allocated to the lines of the network is the ability of the MMM to determine the ports to be called on each line. In this way, shipowners who are willing to operate their ships between ports with acceptable levels of traffic are now forced to serve additionally and at no cost for the public budget, little islands with very low traffic volumes. In fact, a shipowner who has submitted application for a specific line cannot refuse an approved schedule if the MMM has added up to 2 extra port calls on each direction, and this addition results in an increase of the proposed round-trip distance by up to 10%. For the islands which cannot be served in this way, the law makers have provided a totally different procedure.

Thin lines: An extensive part of the Greek legislation on coastal shipping deals with the "thin lines" (the literal translation from Greek is "infertile lines"). The term concerns lines of very low traffic, which cannot be served profitably by independent operators. According to the Code of Marine Law, the Minister of Merchant Marine (MMM) has the right to sign contracts with Greek ship owners...
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operators in order to meet the sea transport needs of the country along "thin lines" by employing Greek passenger or cargo ships on a fixed schedule. The cost of such services is borne by the Greek government. There are three thin line categories: (i) main thin lines, which concern the transport of passengers and/or cargo, (ii) the mail thin lines, which concern the carriage of mail and (iii) the tourist thin lines, which relate to tourist needs. The thin line contracts result from public tenders. Details of the bidding and contacting process for each and every thin line category are determined by relevant ministerial decisions. For each thin line the sequence of the ports to be served, the desired number of round trips per week, the contract period (which cannot be extended beyond 5 years), as well as the technical requirements of the ships to be considered (tonnage, passenger and cargo capacity, speed, e.t.c.) are set prior to the tenders by the MMM, following discussions with the Consultative Committee.

Employment of other ship types: The procedures described above concern the passenger-car ships serving the coastal network. Cargo-car ships are allowed to be employed only after obtaining a relevant license by the MMM, which is issued if the new ship would not seriously affect the economic exploitation of the existing passenger-car and cargo-car ships on the line of interest.

The necessary procedure for the employment of Greek passenger ships between Greek and other Mediterranean ports is much simpler. The only requirement is a written statement to be submitted by the interested shipowner or his authorized agent to the Ministry of Merchant Marine at least 30 days prior to the inauguration of the new service. The statement must contain the detailed schedule of the new service.

Freight rates: Freight rates were set by the Greek legislation as early as in 1926. Since then, the law makers were trying to protect the users of coastal services from possible exploitation by the ship operators by determining upper limits to the freight rates. However, they also determined lower limits to the rates in an effort to protect ship operators from dumping practices. Furthermore, "...any direct or indirect partial or complete refund of the freight rate to the passenger or the shipper in the form of a grant or a commission ..." was considered illegal. Later on, the lower and upper limits to the freight rates were replaced by a single rate. Passenger and cargo rates on the main and secondary lines are determined by the MMM after consultation with the Consultative Committee. On the local lines, freight rates are determined by the local Port Authority and approved by the MMM. These rates are compulsory and any agreement setting higher or lower rates is forbidden. Fares paid on board are higher than the normal ones by 20%. Passenger-car ship operators of the main lines are allowed to offer discounts of up to 20% on the vehicle fares for round trip voyages. The vessel chartering rates of passenger ships are set freely.

Specific discounts are granted to certain categories of passengers and cargoes by ministerial decisions. In fact, shipowners and operators accuse the govern-
ment for making excessive use of that provision. Indicatively, it is mentioned that parliament members and their private cars, members of families with more than 3 children, the students, reporters, military personnel, the Ministry of Merchant Marine personnel, pensioner seamen, athletes, boy scouts, members of theatrical groups, as well as the agricultural products are granted discounts which range from 20 to 100%.

Economic incentives: On the other hand, marine companies owning and operating coastal ships are exempt from any tax, duty or other government fee. In addition, the Greek liner passenger ships are exempt from pilotage charges, and the same is true for Greek cargo ships of less than 1,000 G.R.T. A discount on the light dues is also granted to the Greek liners.

Number of passengers: The highest number of passengers, which can be carried at any given point of time by a passenger ship is determined by the Ministry of Merchant Marine based on the technical specifications of the vessel. High penalties are imposed on owners carrying more passengers than allowed. Exceptions to the rule are only permitted on occasions of extraordinary transport needs (i.e., due to a marine accident or due to massive transfer of voters during election periods). A 1974 law, which is still in force, goes in great length to determine the procedure of passenger number surveillance: "At the port of origin, every intermediate port of calling, and at the port of destination, prior to passenger embarkation/disembarkation, the ship master is obliged to assign a ship officer to every embarkation stairway of the ship who, together with a representative of the local Port Authority, are responsible for counting the disembarked and embarked passengers".

Composition of crew: Crew members are Greek registered seamen and officers holding the appropriate licenses. Crew composition is determined by a series of decrees and ministerial decisions. As a general rule, deck personnel is determined by the gross tonnage of the ship, the engine-room personnel by the total horsepower of the main engines, the radio personnel by the number of passengers and the area of navigation, the administration personnel by the number of passengers, the accommodation personnel by the number of passenger berths, and the kitchen personnel is determined by the ship’s gross tonnage.

Technical specifications: As with other ship types, the construction, outfitting, surveys and operation of coastal ships are determined by a number of international and national regulations. Among the international regulations, the avoidance of collision at sea convention, the SOLAS, MARPOL and the loading line and capacity determination conventions, as well as the technical specifications of the various classification societies are indicatively mentioned. There are national regulations on propulsion means, marine outfitting, safety means, firefighting equipment, telecommunications, cargo lifting devices, medical supplies, passenger accommodation, crew accommodation, carriage of special cargoes,
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shipbuilding, repair and conversion surveys, as well as the annual and periodic ship surveys. It should be mentioned, however, that the only reference to new-technology ships in the Greek legislation is a Presidential Decree of 1981 on the safety regulation of dynamically supported ships.

2.2 MARITIME LAW AND POLICY

As a number of the E.U., Greece is bound by the provisions of formal Regulations issued by the Council of Ministers. These Regulations, therefore, constitute a part of Greek law, breaches of which can lead to action by the Commission of the E.U. Some of these Regulations cover maritime transport. While only one Regulation, that on maritime cabotage, covers coastal shipping directly, the existence of the other instruments dealing with sea transport needs to be noted. In particular, they may be used as precedents in matters concerned with the application of the competition rules to maritime transport.

The Treaty of Rome, which in 1957 established the European Economic Community, contains a section dealing with transport. In one of the articles in this section it is stated: "The Council, acting by means of a unanimous vote, may decide whether, to what extend and by what procedure appropriate provisions might be adopted for sea and air transport". Until 1979, it was thought that sea transport could not be subject to the competition articles of the Treaty (specifically 85, 86 and 87) unless there was a unanimous decision of the Council of Ministers. In 1979 the Court of Justice ruled that the competition articles of the Treaty did apply to maritime transport.

The first Council regulation relating to maritime transport was issued in the same year. This was Council Regulation (EEC) No. 954/79 of 15 May, 1979, concerning the ratification by Member States of, or their accession to, the United Nations Convention on a Code of Conduct for Liner Conferences. This regulation does not affect coastal shipping, but it could cover the Adriatic ferry services between Italy and Greece if these came under the umbrella of a liner conference, or if the Commission perceived that a body akin to a liner conference had become active in the trade.

The preamble to this first Regulation proposed that "... the Commission will accordingly forward to the Council a proposal for a Regulation concerning the application of those rules (that is, those incorporated in the Regulation) to sea transport." (Our bracketed insertion). In fact, four regulations were issued on 22 December, 1986. The numbers and titles of these are:

- 4055/86, applying the principle of freedom to provide services to maritime transport between Member States and between Member States and third countries;
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- 4056/86, laying down detailed rules for the application of Articles 85 and 86 of the Treaty to maritime transport;

- 4057/86, on unfair pricing practices in maritime transport; and

- 4058/86, concerning coordinated action to safeguard free access to cargoes in ocean trades.

These four regulations constitute the first part of the common maritime transport policy of the E.U.

These four regulations have been described by the Commission as dealing with the external aspects of shipping. Further measures, it was claimed, would be needed if all aspects of the Union’s objectives in the field of maritime transport were to be met. In August, 1989, the Commission proposed a four part programme of what it called positive measures, namely:

* The establishment of a Union ship register (EUROS);
* The improvement of port-state control within the Union;
* A common definition of a Union shipowner; and
* The application of the freedom to provide services to maritime transport within Member States.

It will be noted how the title of the last item in the programme reflects the title of Regulation 4055/86, adopted in 1986. To date, this is the only part of the programme of positive measures to have culminated in a Regulation.

The full title of the Regulation is: Council Regulation (EEC) No 3577/92 applying the principle of freedom to provide services to maritime transport within Member States (maritime cabotage) and it is dated 7 December, 1992.

As is usual, the regulation is in two parts, namely, the preamble and the operative clauses. The preamble contains elements of the historical background, followed by clauses stating objectives to be achieved and generalities on the modalities for their application. Statements in the preamble are non-operational, but what is said there can often provide clues to the interpretation of operational provisions. The preamble is followed by the operational section, that is, the body of the Regulation.

There are two statements in the preamble which are of particular importance to Greece. Both of these are the result of pressures from the European Parliament and are fully reflected in appropriate operational provisions. One statement speaks of implementation being "gradual and not necessarily provided for in a uniform way for all services." The other states that "public services entailing certain rights and obligations for the shipowners concerned may be justified in
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order to ensure the adequacy of regular transport services to, from and between islands."

A detailed discussion of the entire Regulation is not necessary. Only articles 1, 4 and 6 should be highlighted here because of their importance to the future of Greek coastal shipping.

Article 1 gives freedom to provide maritime transport services within a Member State to all ships registered in, and flying the flag of, a Member State, EUROS included, as from 1 January, 1993. Article 6, however, grants exemptions from the implementation of the provisions of the regulation for certain countries. For reasons of socio-economic cohesion, the derogations for Greece are:

* For cruise services, until 1 January, 1995;
* For transport of strategic goods (oil, oil products and drinking water), until 1 January, 1997;
* Regular passenger and ferry services, until 1 January 1999; and
* For island cabotage and services by ships of less than 650 GRT, until 1 January, 2004.

Article 4 provides that a Member State "may conclude public service contracts with or impose public service obligations as a condition for the provision of services on shipping companies participating in regular services to, from and between islands". Such public service contracts shall be made on a non-discriminatory basis in respect of all Community shipowners. Taking article 4 in its entirety, all possible protection is provided for the maintenance of the Government policy of ensuring the provision of year round services to the islands for reasons of both social justice and territorial integrity.

3 SOCIOECONOMIC ISSUES

As stated earlier, for reasons "of socio-economic cohesion", a deferral of the full application of Council Regulation No. 3577/92 has been accorded to Greece until 1 January, 2004 "for regular passenger and ferry services and services provided by vessels less than 650 GRT". The ferry services, which are the concern of this part of the paper, are like Damocles. Unless the unimaginable happens and Greece should leave the Common Market, the sword will fall on schedule. Whether, in its fall it will kill the industry or whether it will simply make some noise as it hits the steel helmets of protection the industry has
forged for itself, depends on Greece. The EU has given Greece eleven years, of which one has already passed, to prepare itself in defence against the falling sword.

3.1 HOW THE SHIPPING OF OTHER MEMBER STATES MIGHT REACT

No attempt will be made to forecast in quantitative terms the extent to which the shipping of other Member States will invade Greek waters in 2004. The extent of this invasion will depend on two factors, the relative importance of which is difficult, if not impossible, to forecast.

The first factor is the extent of preparedness of the Greek ferry services to meet the challenges which may arise. This is a matter which is partly in the hands of shipowners themselves, but it is also a matter which depends very much on Government and the relevant ministry, the Ministry of Merchant Marine. What needs to be done in Greece will be covered in Section 3.2 of this paper.

This will do little to enable the possible level of preparedness to be forecast. One can state the obvious now: the better prepared Greece, at all levels, is to meet the competition, the less likely are other shipowners to take the risk of a major invasion; the lower the standard of preparedness, the more it will be seen as providing easily grasped spoils.

The second factor is that before 2004 the Channel Tunnel will have opened and experienced ten years, more or less, of operations. Any present forecast of the number of ferries which will displaced and whether they will have found alternative employment before 2004 must be guesswork. The more ferries there are laid up looking for work in 2003, the greater the competition will be to Greek ferries in 2004. There is a small rider to this, which will be mentioned later in this part of the paper under the sub-heading "Influx of capital".

For various reasons, the experience of other European countries which opened their coastal shipping to foreign tonnage, in advance of the Regulation, does not provide much help in trying to make a quantitative analysis because the geographical circumstances of countries are so different. In Britain there are some comparable routes, but the routes do not make up a system and there is no overall regulatory authority as in Greece. There is also a dearth of data. Unfortunately, the main source upon which we relied for our non-quantitative tentative conclusions remains confidential (November 1993) and cannot be cited.

The tentative conclusions which have been drawn from such statistical data as could be found and the impressionistic evidence gathered from diverse sources are:
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* Inferiority of ships or the standard of service provided act as a direct incentive to the entry of competition;

* It is more likely to be the top end, rather than the bottom end, of the passenger market which will attract competition from the shipping of other Member States, although the trend in the Greek market towards dual purpose ships serving both public and service operations and island vacation services will blur the distinction; and

* Shipowners of other Member States are likely to be sensitive to what seem to be unexploited opportunities.

Concerning the first conclusion, the fate of the Swansea and Cork Lines and the replacement of their unsatisfactory ship by a Strintzis vessel is well documented. High speed, new technology ferries can increase traffic on a route, something which EU shipowners, contemplating entry to Greek trades, will not ignore. During its first seven months of operation, the catamaran SeaCat Scotland carried 330,000 passengers and 75,000 cars on the Stranraer/Belfast route, nearly double the predicted volumes.

Within the existing system there are at least two possible unexploited opportunities which are likely to be exploited in attempts to by-pass crowded Piraeus. One might be more inter-island services, with co-ordinated connections between new technology ships and feeder ships taking passengers and cars to other islands, receiving imports directly from abroad and serving near islands: Crete springs directly to mind in this connection. The second unexploited opportunity is very near to the alternative mentioned to the inter-island services. This would be the establishment of fast direct services between some of the larger island and the north of Greece, particularly Thessaloniki. A Greek line did pioneer this during the 1980’s.

In Greece, the industry is regulated in order to achieve the objective of ensuring year round services to all the inhabited island which are part of the nation. 3 A number of these islands generate enough year round trade that shipowners want to provide services to them; others generate so little trade that shipowners, if they were considering their own commercial interests, would not assume the obligation of providing a service. The Ministry, in order to avoid any charge to the national budget in subsidies to induce owners to provide the commercially unattractive services, has very neatly linked the right to serve the attractive trades with the obligation to serve the unattractive trades, this

3 On all matters related to the system of regulation practiced by the Ministry, the reader will find additional information in two other publications, namely, S.G. Sturme Ring in the changes, Naf- tiliaki, no. 1022, Summer 1993, pp 25-31 and Greek Sea Bridges by Katerina and Stanley Sturme, Athens, December 1993, pp 2-12.
coupled with exemption from income taxation on the profits earned. Thus, the industry has developed in a completely non-competitive structure. Both the Ministry and the industry face fundamental changes in their actions and thoughts. Some sections of the industry are struggling against the imposed strait-jacket; other sections have adapted themselves to it so fully that they cannot imagine any more comfortable dress.

When the sword falls, it will be the coastal passenger and vehicle carrying ferries on which it will fall. It is these which are most likely to attract the attention of shipowners from other Member States. Just like Greek shipowners, they will be unwilling operators in the unattractive trades, but for various reasons they may find themselves willing to accept the burden of these in return for a presence in the attractive trades. The Ministry will no longer be able to make the overt linkage, as at present. But it will be able to provide inducements to shipowners to undertake the unattractive services, although it will be unable to cast a non-competitive net over all, as at present.

It seems possible that some are thinking that other Europeans will be deterred from entering the existing cabotage services because of their over-regulated state. This is unlikely; the EU will understand that if the system of regulation is not changed, Greece will be in breach of the Regulation, even if it goes out of its way to invite competition. In practice, however, there are four reasons why shipowners in other member States, desirous of entering the cabotage services, may be interested in the public service routes, since the inducements offered to shipowners to serve these routes must be offered on a non-discriminatory basis. These reasons are:

* All year round employment of their ships;
* The operating economy of serving a poor island where it can be done without diversion from a route serving rich islands;
* To obtain operating slots in ports where the number of slots is limited; and
* The increasing emphasis on a dual role for ferries.

There are relevant comments to make on each of these points.

Year round employment

Year round employment will not necessarily be sought by other European operators. Some European owned catamarans go as far afield as Australia to find profitable employment in the northern winter. It is difficult to see how the Ministry could expect, or insist, that all ferries remain in Greek waters all the year. One possibility which has to be provided for is vacation season only operators, whether Greek or others.
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On the other hand, owners may not want to send their ferries abroad for the slack season, or the ferries may not be suitable for such a transfer. If such ferries are not participating in the public service activities, then the chance of making a profit over the year would be seriously restricted. It would seem reasonable that the Ministry should issue public service contracts to interested shipowners only for the number of ships required to meet public service needs. The contract would specify frequency of sailings, characteristics of ships and so on, according to year round need, but should not be for specified ships. An owner would then have the possibility of using a large ferry to meet public service and vacations needs in the summer, with a smaller ferry to meet public service needs only in the winter, so long as the contractual terms are met.

It is worth nothing here that the present system does not guarantee that public service needs are always adequately met. There were complaints from other islands during the 1993 summer. If the obligations to provide these services are in the form of clear contracts between shipowners and the Ministry, the owner would have the possibility of bringing in another ship, perhaps chartered from another owner when, for any reason he is short of tonnage to fulfill his contractual obligations. He would also have the incentive to do this since he could feel sure that, in the face of a failure, he could lose the contract and the port slots granted to him.

Operational economy

In the pursuit of operational economy, a great deal of initiative should be left to shipowners. In preparing the ground for this, the Ministry, in consultation with representatives of the ferry owners, would need to identify the islands coming into the public service category. These are the islands, the obligation to serve which no owner, if he were considering his own commercial interest, would assume on a year round basis. Having identified the islands concerned, the Ministry would need to define the extent of, and the conditions deemed necessary for, a service which would ensure the continued viability of those islands. The definition would include matters such as the maximum fares for standard class accommodation and the charges for carrying vehicles, which the inhabitants of each island could be expected to bear, the frequency of service needed and a reasonable duration of the voyage each way.

On the basis of this identification and definition, calls for offers to undertake these services would be made to ferry owners, both Greek and non-Greek. Shipowners interested would then make offers to serve some of these islands, which offers should specify the compensation demanded. This could be in the form of an annual fee paid by the Government for providing the service, which is what the Regulation has in mind. But the Government is unlikely to be ready for such a deal and would probably be thinking of compensation in the form of guaranteed traffic rights in terms of the award of suitable slots - see below - on attractive routes would be served in the course of serving unattractive islands.
The call for offers would be competitive, with both Greek and foreign lines having the right to tender. There would also be competition outside the range of the public service requirement.

One could well imagine an owner concluding a contract under which he might use several ships to maintain the conditions of the contract. Each contract would impose an obligation and grant rights. The competition would be in the rights. There would be no obligation on an owner to take up his rights, and no guarantee that if he failed to attract an economic volume of traffic he would be protected. He would have a slot, which no other owner could use, except by delegation from the owner with the right. The rights would cover the use of a slot on the attractive island, but no guaranteed volume of traffic; the obligation at the public service island would also cover the use of a slot, with the obligation to use it and a guaranteed minimum of traffic.

The current system of licensing of routes militates against the use of new technology ships. For economic operation, these ships need high load factors and minimum time in port. Such ships are unlikely to have any place in winter operations. In the summer, however, an owner with a public service contract and obligations, with slots at attractive islands on the route, might use high technology ships to fulfil his obligations. In the summer, both ships may call at the attractive ports, but in the winter only conventional ships would be used.

The present system, despite its theoretical neatness, in fact gets the worst of two worlds in the sense that owners are subject to all the restrictions of a regulated system and a good deal of the lack of certainty of an unregulated system. Under the Regulation, only the fulfilling of the public service obligations can be regulated by contract; a contract can oblige a shipowner to make a certain number of calls each week throughout the year at Folegandros (a low traffic island) and the right to make additional calls if he finds it profitable. It can, as an induce, grant him rights to make calls at Santorini (a high traffic island) and grant him slots there at times arranged in relation to his calls at Folegandros, but it cannot oblige him to make use of all his rights at Santorini. In the summer it might even be that he would choose to use a new technology ship to call at both islands on some days of the week, but in the winter he would lay-up or send the new technology ship elsewhere.

Operating slots

An analogy with aviation is inescapable. Even in a fully derestricted airline system, the capacity of airports, flight control systems, noise and pollution considerations control the number of flights, the type of aircraft, the hours of operations and even the conditions of take-off and landing at most airports in the world. A number of slots are available each day and each airline wishing to make calls at airport X has to co-ordinate its services with the availability of slots throughout its route.
Within the Greek ferry system, there are severe capacity and environmental problems at a number of mainland and island ports. It is essential that a detailed survey of each port be made. It is not enough that the berthing capacity is sufficient to handle all the ships which may wish to make calls. The survey has to look at the urban factors on the landward side of each port and the quality of life for the residents as well as the physical capacity of roads to handle extra traffic.

In 2004, an increase in the number of ships wanting to use the ports must be expected and arrangements must be made to determine the number of slots which can be made available during each 24 hour period, taking into account all factors. Certain ports are clearly at saturation point in one or other aspect of their physical or environmental conditions. The three major mainland ports in the ferry system, Igoumenitsa, Patra and Piraeus have clearly reached capacity in one or more of their aspects; indeed all three are operating beyond capacity in important aspects. In two cases, further expansion of the ports is not to be contemplated and alternatives are needed; both Lavrio and Rafina are underutilised. Flisvos may be able to handle ferries carrying only passengers and cars, for example high technology ships. The building of the Rio/Antirio bridge should permit the spreading of a lot of the Patra load to Rio.

Strictness in the use of slots would be needed and permits to use particular slots should be based on a realistic assessment of the sea speed, the loading and unloading times and the time needed to manoeuvre ferries to ensure that they can be punctual in berthing and departing and so do not block the next time slot. Some of the problems in this connection arise because ferries are licensed to carry too many vehicles, so that time is wasted trying to coax the last few vehicles into the available space. Watching loading and unloading operations, it is clear that some ships, even some lines, handle passengers and vehicles much more slowly than others. Many of the ships are unable to maintain their accredited speeds which are still listed as they were on their maiden voyages thirty years ago. It seems also, that schedules are based on a quay to quay distance divided by the accredited service speed, without count of the time taken to clear and enter port and the time to work up to service speed once outside the port.

Another striking point in watching ferry operations in ports, is the skill with which captains can put their ships into small spaces, quickly and without scratching any paintwork. But no matter how skilful they are, the smaller the space in relation to the size of the ship, the slower the operation; in saying this, however, it needs to be recognized that the newer, or recently refitted, ships have more gadgets which increase their handiness compared with smaller and older ships. Despite all this, the new style ferries, that is, those which are conventional in general shape, hull form and propulsion, but more built up than the traditional ferries to provide better facilities for vacation travellers, because of their greater area of superstructure are very much more affected by wind.
than are the lower built ships. Many islands in Greece are very windy many
days of the year. Maneuvering times are, therefore, often much greater for
these ferries than for the older ones. This needs to be taken into account in
fixing the slots.

Dual role

Originally, ferries entered the island trades to meet the needs of islanders. This
is still their basic function and it is essential that the entry into force of the
cabotage regulation does nothing to impede the continued fulfillment of this
function. As the vacation demand for travel increased, additional passengers
were shoe-horned into the available space of existing ferries. Vacation travel
was seen as the Cinderella. If people really insisted on travelling, despite the
conditions, the ferries would carry them, but specific provisions were rarely
made. This situation has persisted to this day in Ministry policies and in the
attitude of many ferry owners; a good example of this is that something so
basic as being able to make a return reservation at the time of commencing a
journey is still impossible. On the side of the ferry owners, change arrived in
1987 by the entry into service of a ship which had been reconstructed in accor­
dance with a philosophy that the Procrustean system of fitting people to the
size of the available beds was out-moded and that travel within Greek system
could be an enjoyable experience, not a part of a preparation for eventual mar­
tyrdom.

In the years of 1987 through 1993, 30 regular passenger and vehicle ferries of
1.500 GRT and over joined the ferry fleet. Of these, 23 were new style ships
catering for both the public service routes and the vacation needs of Greek and
foreign vacationers. These ships are bigger, more luxurious and, in general,
faster than the conventional ferries. It is essential that their characteristics be
recognized and they be given the freedom to exploit the facilities they provide,
so long as public service needs are not ignored. It may be expected that ships
owned in other Member States of the Union which do try to compete in Greek
waters will be akin to these 23 ships and any attempt to deny them the
freedom to compete, even if Greek owned ships are being treated in a parallel
fashion, will evoke charges of discrimination which would prove very difficult to
disprove.

At this point it is useful to summarize what is the job of the MMM in relation to
the cabotage services. There are three aspects of it. First, it must ensure that
the inhabited islands are properly served and that the ship owner is able to
make a reasonable profit in doing so, unless it can be shown that his failure is
due to faults on his side. Second, it must ensure that through the allocation of
operating slots the number of ships permitted to use each port does not exceed
either the physical or environmental capacity of the port. Third, it is not the job
of MMM to ensure that all shipowners make a profit, nor to interfere in any way
in their operations outside the public service sector, although they must retain
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the right to expel sub-standard ships from the service, to penalize owners the ships of which are unpunctual in entering or leaving their slots and to prosecute ships which cause pollution.

Influx of capital

The arguments developed above are based on the assumption that the liberalization of Greek cabotage trades will lead to shipowners in other Member States of the Union putting some of their ships to compete in the opened trades. They might, however, react in another way by seeking to establish an ownership basis in Greece by purchasing all or part of some Greek coastal shipping companies. If a Greek company owns a ship, the ship is Greek. But how much of the capital of the company must be held by Greek nationals?

At the present time, with a fleet the average age of which is over 25 years, the ferry industry does not appear immediately as being in a healthy state. Many of the companies, unless they are sitting on large cash reserves, must have a relatively low capital value. With uncertainty regarding the future, the value of the goodwill must also be low. Such companies could present attractive targets for take over by other shipowners who could use the base thus acquired to launch a large scale entry into the de-restricted industry. When 2004 arrives it could then be found that the Greekness of shipping companies operating in the public service sector is illusory, that they are Greek shells, filled with non-Greek management and money.

The sort of trans-national companies which would be created by these purchases were once highly regarded as being a means by which management skills and technology would be transferred from richer to poor countries, while broadening the employment base in the latter. Later, however, when it was found that all important decisions were taken by the richer partner and exclusively in relation to his interests, the enthusiasm for such operations cooled considerably. It would be an unhappy day for Greece, if an activity as vital to the nation as the maintenance of the sea bridges should become a secondary consideration of non-Greek interests controlling an important Greek ship operating company who might decide that to invest in a Ruritanian-flagged gambling ship offered a better corporate return than the replacement of an over-aged ferry. They might even decide to transfer the ship to the open Ruritanian flag and have her convert into a gambling ship, without her being over-age.

The message is that it would be easier to deal substantively with a real Greek shipping company, or a real foreign shipping company, than with a half-and-half. The fact that the trans-national shell might have a prestigious panel of Greek directors, does not alter the fact that in business power resides in the money bags.
3.2 HOW GREEK SHIPPING SHOULD REACT

There is a basic difference between Greek ferry operations and those in other Member States of the EU. This is reflected in the contents of two of the sections of this paper. Section 3.1, dealing with the reactions of shipping in Member States, is about shipping as an economic activity. Shipping is also an economic activity in Greece, but in talking about reactions in Greece, one has to talk about bureaucrats and politicians. Shipping in Section 3.1 works within an overall framework of rules, but within those rules it has freedom of action. Shipping in Section 3.2 also works within a framework of rules but, in addition, there are sets of regulations which leave the shipowner with little economic freedom.

How the parties should react to be well placed in 2004, depends on their starting point, that is, the 1993 status. Two points are to be noted in this regard.

The first point is the anxiety of the drafters of the Regulation that the process of liberalization should be orderly. This is perhaps less apparent in the final text of the Regulation than in the preparatory and explanatory notes which were made, and in the Resolution of the European Parliament on the matter. They were very conscious that, both legislatively and operationally, because of the difference in the level of development, securing the necessary harmonization would be more difficult for Greece than for other countries, with a greater risk of creating serious disturbances in the internal transport market. Harmonization was the key word: liberalization and harmonization are two processes that have to go hand in hand. The deferral accorded to Greece was specifically to enable Greece to achieve the needed harmonization.

The second point is that, within the unwavering belief in the need to establish a competitive system with full and non-discriminatory access to the shipping of other Member States, the public service need was recognized as well as the institution of compensation to shipowners for undertaking commitments which, if they were considering their own commercial interests, they would not assume.

The system of regulation practiced by the Ministry has already been described. Here, it is only necessary to look briefly at certain effects of the system and to its overall consistency with the principles of the Regulation.

The first effect to note is the age structure of the ferry fleet. This is shown in Table I covering the 71 mainline ferries of 1,500 GRT and over in mid-1993. New technology ships are not included.

Unless a special waiver is granted, a vessel cannot remain in the fleet beyond the age of 35 years. Within the next ten years 27 ships, 38% of the fleet will become due for replacement, including two which reached 35 years in 1993.
Table I

<table>
<thead>
<tr>
<th>Type of ferry</th>
<th>No.</th>
<th>0-14yrs No.</th>
<th>0-14yrs %</th>
<th>15-19yrs No.</th>
<th>15-19yrs %</th>
<th>20-24 yrs No.</th>
<th>20-24 yrs %</th>
<th>25-29 yrs No.</th>
<th>25-29 yrs %</th>
<th>30-35 yrs No.</th>
<th>30-35 yrs %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional</td>
<td>48</td>
<td>2</td>
<td>4</td>
<td>5</td>
<td>10</td>
<td>14</td>
<td>29</td>
<td>18</td>
<td>37</td>
<td>9</td>
<td>19</td>
</tr>
<tr>
<td>New style</td>
<td>23</td>
<td>2</td>
<td>9</td>
<td>7</td>
<td>30</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>71</td>
<td>4</td>
<td>6</td>
<td>12</td>
<td>17</td>
<td>28</td>
<td>39</td>
<td>18</td>
<td>25</td>
<td>9</td>
<td>13</td>
</tr>
</tbody>
</table>

Obviously, shipowners are going to look to the Ministry, for indications of its future policy, before they commit themselves to the investment needed.

Between 1981 and 1990, the average age of vessels in the coastal fleet increased from 14.5 years to 21 years; a recent study gives the average age at the end of 1992 as 25 years. These figures apparently relate to the total coastal fleet of over 400 vessels. For the mainline ferries the situation is less unfavorable than for the total fleet; at mid 1993 the average age was 23 years. The adverse age structure strongly suggest that the policy pursued by the Ministry has placed due burdens on ship operators in serving public interest routes.

In this respect, the present situation is precarious. That the industry has survived at all is largely due to the lack of attractive investment opportunities. It is evident that the fleet is in desperate need of new investment. The task of the Ministry is to design a policy which protects the interests of island populations, is compatible with the Regulation, and permits to shipowners serving those public interests to make profits at an adequate level.

One other aspect of the overall policy which needs to be examined is the compulsory retirement age of 35 years. Obviously, all ships in the cabotage trades, whether Greek of foreign, must be safe and must be capable of maintaining the sea speeds and cargo and passenger handling rates needed to enable them to respect the time slots allocated to them. Given the conditions on all routes, a well constructed and properly maintained ship should have a safe, and economically viable life, of more than 35 years. Provided the inspection services are efficient and honest, and so can be relied upon to weed out ships which, whatever their age, are not up to a standard, there seems no reason to impose an arbitrary limit. Shipowners, themselves, will quickly dispose of a ship which is not economically viable because the costs of maintaining it to standard are too high.
Section V - Policy Making

In view of the number of ships due to be replaced before 2004, and bearing in mind that some of those which will not then have arrived at the age limit will need replacing because they can no longer maintain their classification, it is urgent that the Ministry determine the lines of its new policy so that owners can make rational decisions on fleet replacement and not be tempted to sell out, if they receive what appears to be a suitable offer. Until the Ministry clarifies future policy, it is not possible for owners to make a fair assessment of the present long term value of their enterprises.

Another cause for concern is that the device used to harness the profit motive to provision of a public service is contrary to the principles of the new Regulation. The device consists of limiting the competition on popular routes, by the creation of a quasi-monopolistic situation on each, in order to ensure their profitability, which provides the essential carrots for shipowners to accept the public service obligations. The system has proved incapable of handling new technology ferries and is in trouble dealing with the new type of generally larger ships built with the vacation market in view. As long as there were few of these ships, the problem could be handled. But now that one third of the main line ferries of over 1,500 GRT are in this category, the problem cannot be ignored.

The situation in the services to Ancona from Patra and Igoumenitsa is striking. During the period June through August 1993, 36 ships were operating on the route, of which 34 are Greek owned, but only 14 were Greek flagged; the other two are Italian vessels. The 20 Greek owned ships which are not Greek flagged consist of the majority of the vessels specially equipped for the sea bridge service, transporting lorries which formerly use land transport through Albania and Yugoslavia.

The concept of public service in the industry, as it is at present apparently defined by the Ministry, will need to be modified to bring it into accord with the provisions of the Regulation. It is clearly envisaged in the Regulation that shipowners who accept the obligations of providing such services may be compensated. The character of the present system has been sufficiently touched upon in Section 3.1, that there is no need to repeat it. The real questions to be faced: Since the shipowner is only permitted to serve the islands he would like to serve, under conditions he does not choose, does this bring all the cabotage ferry services under the umbrella of public service obligations as set out in the Regulation? Is it, therefore, compatible with the Regulation that competition occurs only at the point when licenses are awarded and that thereafter market shares will continue to be determined by the Ministry? It is obvious that the answer to both questions must be "No".

The present licensing system needs to be fundamentally changed, even scrapped, if the industry is to be able to meet the challenge of 2004 and it need to be changed soon. It must allow shipowners the time to make decisions about their future planning and to find and put into service any new ships which they
Institutional and Socioeconomic Issues in Greek Ferry Services

might decide are necessary to ensure their competitiveness. It must, also, allow experience to be gained in the operation of the new system so that any glitches in it can be ironed out before everyone is actively engaged in meeting the challenges which 2004 is likely to present. Before 2004, both legislatively and operationally, the Greek system has to be harmonized so effectively that it will be other shipowners, not the Greek, who will find it difficult to compete.

There are other activities which it is essential to carry out within the next few years. One of these, the survey of ports, both mainland and island, to determine the number of operational slots available, has already been covered.

Another activity which is important for the Ministry to make a clear survey of the vessel capacity needed to handle the true public service trades as defined by the Regulation; the definition is "obligations which the ... shipowners in question, if he were considering his own commercial interest, would not assume or would not assume to the same extent or under the same conditions". Once the dimensions of the need are known, a policy for meeting it can be developed. This survey should cover:

* Acceptable frequency of service for each island;
* Acceptable capacity, speed and voyage duration of the service; and
* The existence of viable alternatives which could be used in emergence situations.

The real function of these public service operations must always be kept in the center of the picture, namely, the maintenance of the economic, political and social cohesion of the nation.

The essential task of the shipowners is to ensure that the quality of service offered is as high as is possible. This does not mean luxury, but attention to the complaints which are voiced by ferry users regarding unpunctuality, the poor quality of most ferry food, the lack of attention to the maintenance of facilities used by passengers, the impossibly long itineraries of the "milk run" ships with calls as eight or even ten ports, so that relatively short journeys take hour upon hour to complete, and the impossibility of booking return passages. It seems unbelievable that at a small airline ticket agency one can book a round the world service, whereas on the ferries one cannot book a return passage, or a passage with more than one stage.

The industry as a whole seems unresponsive to the needs of passengers and of the lorries carrying freight, and to their complaints. If this "take-it-or-leave-it" attitude does not change, the perception of European ship owners will be that they can come in and quickly establish their supremacy. The regulatory system is rightly criticized by most shipowners. But they must come to terms with the
fact that the system is overprotective of them all, and while choking them with skimmed milk, ensures that none of their colleagues get any cream. Once the cabotage restrictions are lifted, the cream will be available to be fought for. To be able to succeed in even joining in the great cream scramble, the shipowners must, to revert to our original analogy, have provided themselves with protective headgear against the sword which will fall on 1 January, 2004. There will be no hand-outs of cream.

4 SUMMARY

This summary will set out what the Ministry has to do, and when, in the preparations for the entry into force of the EU Regulation. It must always be borne in mind that the survival of the Greek ferry fleet is neither the first, nor even the second concern in Brussels. Eleven years were given for the preparations and it must be expected that, if all is not ready, the attitude of the EU will be unsympathetic. What is needed form the Ministry is:

* A clearly defined and thought out policy, announced before the end of 1996, setting out the parameters proposed for a competitive system for the post 2003 period;

* A clear definition, before the end of 1998, of the fleet needed to maintain the public service operations and the arrangements proposed to secure the continued undertaking and profitability of these operations;

* Agreed and clear figures, announced before the end of 2000, of the intended capacity of each port and its facilities and equipment in, say, the year 2003; capacity to be expressed in terms of the number and duration of the time slots which will be available during the operational hours of each day; and

* The definition and announcement before the end of 2001 of the procedure which will be adopted in calling for bids from European and Greek operators for providing public interest and free market services, taking into account the announced competition policy.

Given that these matters, although essentially political in nature, concern the whole national economy of the future and that there will be two, or possibly more, general elections before the Regulation enters into force, it is essential that these policy decisions be taken in a national context and that the policies presented are based on a consensus between the main political parties, the coastal shipowners associations and the trade unions and other organizations concerned.
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UK ROADS TO WATER INITIATIVE: A FOCUSING STUDY

By J.L. Packer

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ABSTRACT ................................................. 467
UK Road to Water Initiative: A Focusing Study

UK ROADS TO WATER INITIATIVE:  
A FOCUSING STUDY

This paper draws upon a study undertaken on behalf of and paid for by the Department of Transport. The results of that work are the property of the Department of Transport which has granted permission for publication of this paper.

The views expressed in this paper are the author's and may not necessarily reflect those of the Department of Transport.

1 INTRODUCTION

The UK Department of Transport, in July 1991, held an industry seminar on the subject of encouraging the use of water transport, where feasible, for moving freight in preference to road. This initiative was part of Ministers' overall commitment to support the use of more environmentally-friendly modes of transport.

The seminar recommended that the Department investigate the scope for further research designed to assess the feasibility or otherwise of encouraging more use of the water mode. This focusing study was commissioned as the first research project and the practical way of moving forward from the seminar.

The objective for this outline study was "to target productive areas for initiatives and for further research into the potential for short sea, coastal and inland shipping, for both the Government and commercial interests". The study was to identify where water could be competitive for internal UK movements and where there could be scope for reducing or eliminating the road transport element of external movements by encouragement of greater use of regional port facilities.

The study is a basis for focusing the discussion on the next steps, on the policy options and on the actions to be taken by the various parties including research in depth into the target productive areas.

2 THE STUDY METHODOLOGY

The work was carried out using a wide range of published and unpublished sources and in consultation with a range of interests in the shipping, freight and
port industries. The study was in three parts, the statistical analysis, cost modelling and the opinion survey.

2.1 THE STATISTICAL ANALYSIS

**Internal UK traffic flows:** the prime source was the Department's Transport of Goods by Road, the annual report of the Continuing Survey of Road Goods Transport; the small statistical sample limited the analysis that could be undertaken but more detailed probing of the survey data ascertained the broad flows between the eleven economic regions by commodity groups. More comprehensive unpublished statistics for rail traffic flows were available from the Department. Coastal shipping flows, true coastal movements between ports on the GB mainland, were determined using UK Port Statistics and other information. The results of the statistical analysis were checked during the interview survey and by specific commodity and industry studies. A detailed study was undertaken of UK petroleum product distribution by pipeline, road, rail and coastal shipping.

**External UK traffic flows:** the prime sources were UK Port Statistics and the Department's 1991 Survey of Origins, Destinations and Transport of UK International Trade. This latter survey enabled analysis to be undertaken of traffic routeings by shipment mode for unit load traffic between the UK and Europe. Careful interpretation was required because of the limited 2% sample. The survey proved to be less useful for distributed semi-bulk traffic but a good picture was obtained by augmenting the data with some specific commodity studies for steels, wood products, animal feeds, grains, etc.

2.2 COST MODELLING

Cost models were developed to test the competitiveness of the water option and the alternative traffic routeings within the target areas identified by the statistical analysis. The cost comparisons were made under current cost relativities and external environmental conditions. Analysis was subsequently undertaken at the margin to examine the relativity between the different cost elements in the transport chain and the factors which might change the relationships. Cost structures were developed for:

* Road haulage: articulated bulk tip trucks and unit load articulated trailers;
* Port and terminal costs;
* Short sea unit load container and RoRo, and short sea bulk ships: by type, size, speed, distance, market or built up capital costs splitting into the at sea cost and the port interface cost (including ship time in port).
UK Road to Water Initiative: A Focusing Study

The cost models studied included:

* Coastal bulk versus road haulage direct, with/without a local road delivery;

* Bulk and semi-bulk traffic to/from Western Britain versus shipping through an East Coast port and trucking across;

* Unit load "coastal highways", particularly Scotland-South East England with various levels of cargo imbalance, frequency, volume etc.

* Continent-UK by alternative routeings for container and trailer traffic for various origins and destinations, but concentrating on northern UK traffic.

2.3 OPINION SURVEY

Interviews were conducted with senior management in companies representing shipowners and unit load operators, port operators, inland haulage companies and shippers and importers. The interviews provided a survey of opinions as to the potential for water, many of which are incorporated in the conclusions (see 5.0). They also provided a practical check on the figures in the traffic flow analysis, the cost models and the specific commodity studies.

3 GENERAL OVERVIEW OF THE FREIGHT MARKET IN THE UK AND ROADS TO WATER POTENTIAL - see Table I

3.1 INTERNAL FREIGHT

The growth of road freight has been particularly marked in Great Britain increasing from about 100 billion tonne kilometres in 1979 to just over 130 bt/km and 1505m tonnes in 1991. Improved road freight efficiency has brought about changes to distribution systems and heightened expectations about cost competitiveness and service quality (flexibility, speed and reliability). Moreover, a high proportion of total inland freight movements are concentrated within a central triangle of London-Teeside-Liverpool - distances of no greater than 400 km (250 miles). Relatively few road journeys are over 4 hours. Even Scotland to London can be achieved in 8 hours giving overnight delivery. These are distances (and times) at which shipping cannot normally compete other than for non-time sensitive freight such as warehouse movements (where still in existence) and low value bulk cargoes. The only significant true coastal movements remaining are of petroleum products, stone and coal where large movements are matched with coastal sources and coastal delivery.
3.2 EXTERNAL FREIGHT TRAFFIC

Unit load and dry bulk traffic through UK ports totalled 166m tonnes in 1991. Unit load was 58mt of which 45mt was short sea with Europe. Dry bulk was 108mt of which some 50% was distributed and collected bulks, moving internally throughout the UK and thus major road users. Routeing is determined as much by considerations of relative service quality and transit time as by relative transport costs. As a result, much unit load and higher value semi-bulk traffic is carried over longer land routes rather than taking a sea route to a port closer to the point of origin or destination.

3.3 POTENTIAL ROADS TO WATER TARGET AREAS

The study's analysis shows that potentially the most productive areas for roads to water targeting would be:

* The protection of existing coastal distribution traffic (31 million tonnes a year, 75% oil product) from the threat of further conversion to road;

* The identification of long haul internal traffic which can be converted to water under marginally changed conditions;

* The re-routeing of external traffic with the Continent, Eire and Northern Ireland, through ports closer to the points of origin and destination of the traffic. This requires that the shipping connections to these ports are competitive in cost and quality of service terms;

* The identification and implementation of measures to reduce the effect of high costs at the port interface.

An order of magnitude assessment of the possible roads to water conversion potential to target is shown in Table I. These are theoretical figures to show the maximum potential and some conversions are more feasible at today's costs than others. A conversion target of up to 3.5% of existing internal road traffic tonne-kilometres might be possible, and this will be mainly long haul road traffic. The percentage may appear to be small but this is a considerable volume of traffic and well worth targeting.

4 SOME PARTICULAR RESULTS OF THE STUDY

The study contained much detailed analysis. It is only possible to cover some of the broad results in this paper:

European Shortsea Shipping
UK Road to Water Initiative: A Focusing Study

<table>
<thead>
<tr>
<th>INTERNAL 1991</th>
<th>MTonnes</th>
<th>300km</th>
<th>450km</th>
<th>%Tonne-kms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road</td>
<td>1505</td>
<td>83</td>
<td>20</td>
<td>78.4%</td>
</tr>
<tr>
<td>Rail</td>
<td>136</td>
<td>14</td>
<td>4</td>
<td>9.6%</td>
</tr>
<tr>
<td>True Coastal Shipping</td>
<td>31</td>
<td>20</td>
<td>14</td>
<td>9.4%</td>
</tr>
<tr>
<td>Pipeline + Waterway</td>
<td>31</td>
<td>-</td>
<td>-</td>
<td>2.6%</td>
</tr>
</tbody>
</table>

EXTERNAL (Imports + Exports = 75% with Europe)

<table>
<thead>
<tr>
<th>Units</th>
<th>MTonnes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit Load</td>
<td>58</td>
</tr>
<tr>
<td>Distributed Dry Bulk</td>
<td>52 (50% of total dry bulk)</td>
</tr>
</tbody>
</table>

ORDER OF MAGNITUDE SAVINGS TO TARGET

<table>
<thead>
<tr>
<th>Traffic</th>
<th>MTonnes</th>
<th>% of road traffic Tonne-kms</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;Coastal Highway&quot;</td>
<td>2</td>
<td>1.0%</td>
</tr>
<tr>
<td>Coastal Bulk</td>
<td>3</td>
<td>0.8%</td>
</tr>
<tr>
<td>Re-Routeing External Traffic:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Continent</td>
<td>6</td>
<td>1.2%</td>
</tr>
<tr>
<td>- Ireland</td>
<td>3</td>
<td>0.5%</td>
</tr>
</tbody>
</table>

Table I: Great Britain freight market overview

* It is evident from Table I that coastal shipping will have to penetrate much further into longer haul road movements to have a significant effect on levels of internal road traffic. However only 14m tonnes (1%) moves by road over 450km and virtually no bulk commodities move by road over 300km. In contrast, coastal shipping movements are dominated by petroleum products (75%) and by stone aggregates and coal whilst other coastal traffic is now insignificant.

* Much external traffic, both unit load and medium/high valued semi-bulk, is not transiting through ports nearest their points of origin and destination indicating significant scope for roads to water initiatives. In particular northern unit load traffic with Europe routed through southern ports in 1991 amounted to 5mt and through Haven ports (Felixstowe, etc) to 3mt; much of this traffic was with France and Belgium but for Germany, the Netherlands and Denmark the volume totalled 2.5mt. Similarly the routeing for higher valued bulks, steels, wood products, grains, animal feeds, etc, depends on a number of factors besides cost alone.
Section V - Policy Making

- The at sea cost per kilometre is a small fraction of that for road haulage. The problem is the high "port interface" cost which, including all port charges, cargo terminal handling costs and ship time in port costs, is some 40% of the through cost for unit load and 60-80% of the through cost for bulk cargo. On current cost structures coastal unit load shipping is not generally competitive with road haulage direct over comparable distances below 800km and coastal bulk is not generally competitive below 400km where the consignee's depot is at the discharge port and 600km where delivery is inland.

- The port interface is the major cost and critical element in the transport chain with a sea routing. The conundrum is that high port costs are often largely due to low and irregular throughput; the ports are not going to make the investment necessary to reduce costs and ship time unless volumes are high and certain whilst coastal/short sea shipping systems competitive with road cannot be based on irregular and uncommitted traffic flows. Regional ports need services competitive on cost and quality which is difficult to secure when traffic flows are small. Putting the efficient handling systems on the ships might be the answer but this generally requires high cost dedicated ships and less flexible shipping systems.

- For external unit load traffic, small price and service quality relationships can change the routings and make considerable differences to inland road miles. The short Channel crossings, with their higher frequency of sailings and shorter overall transit times, generally provide a more attractive service package. This accounts for the considerable volume of northern UK traffic routing through southern ports (similarly for the volume of Ireland traffic transiting via Scotland and the shortest sea crossing). Routing German-Yorkshire traffic via the Humber ports is shown to give a through cost of some 20% lower than via the Channel and a reduction in the UK road distance of nearly 300km. Larger savings can be achieved for traffic shipped through inland ports on the Rhine and for French and Iberian traffic shipped by container direct to northern UK ports, but service quality is poorer and only non-time sensitive traffic is currently attracted to such services.

5 THE CONCLUSIONS

The conclusions of this initial focusing study were presented as key issues or results with a listing of options to be considered for further action within a number of areas.
5.1 TRAFFIC FLOW DATA AND STUDIES

There is a need for more data on the nature and volume of internal Great Britain long haul traffic, and more analysis of external flows and the available detailed origin/destination data. The following should be considered:

* A supplementary, detailed survey to the Department’s Continuing Survey of Road Transport;

* A corridor study of road haulage traffic along the main arteries - eg Scotland-South East - to assess road to rail/water potential;

* A study of traffic flows/routeings between GB and Northern Ireland and GB and Eire;

* Additional analysis of the Department’s 1991 "Origin, Destinations and Transport of UK International Trade" and a follow up survey in 5 years to assess the impact of the Channel Tunnel;

* Participation in various EC and European studies.

5.2 PETROLEUM PRODUCT DISTRIBUTION

The scope for halting and reversing the decline in petroleum distribution by sea, with its consequential increase in road mileage, should be considered by Government and industry.

5.3 DRY BULK SHIPPING

In the dry bulk sector, encouragement should be given to potential roads to water conversion to offset negative trends. For external traffic this means encouraging routeings via the nearest port and broader port coverage thus avoiding concentration on single port entry with nationwide delivery. The short sea industry needs to be responsive to opportunities and incentives in terms of roads to water conversion. The following should be considered.

* Establishment of a "sea freight promotional desk" [within Government] to act as a clearing house for all roads to water issues and future policies; to encourage communication within the short sea sector; to encourage importers/exports to minimise road haulage; and possibly to provide funding of feasibility studies for potential roads to water alternatives.
Section V - Policy Making

* A technical and economic feasibility study into low cost coastal bulk barge feeder systems for grains, animal feeds etc and coastal/river barging systems for re-distribution of stone and coal to riverside wharves.

* Special measures for domestic short sea shipping so that it is strong and responsive.

5.4 UNIT LOAD SHIPPING

Unless there is a significant change in cost structures coastal highway services may be feasible only if linked to international traffic. For external accompanied freight, there is potential for re-routeing through Northern ports (without changing current cost structures) by conversion to unaccompanied trailers and containers. It would be further enhanced by increasing competitiveness of the northern ports and through greater shipping service frequency. The target is 3.5 mtpa.

In support of such switching it may be worth considering:

* In relation to port developments, adjusting planning procedures to take account of need to reduce road haulage mileage;

* Based upon rigorous cost/benefit analysis adopting discriminatory measures such as road weight regulation, port taxes and motorway tolls;

* Use of co-ordinating agents - such as the proposed "sea freight promotional desk" and regional port federations - to develop and promote new markets, improve port productivity and competitiveness;

* Identify opportunities through further studies.

5.5 PORTS

This is a critical area. Ports need to reduce handling costs and improve turnaround times since this is the major element in the sea transport chain. Competitive, well-served regional ports are also crucial to reduce road mileage.

Options to consider include:

* A study of UK port charges and terminal charges to assess whether these distort modal choice;

* Promotion of northern ports to reduce road mileage;
* Possible funding of ports infrastructure as an influencing rather than as a reactive mechanism;

* Extend inland waterway grants to coastal shipping with an emphasis on reducing the cost of handling systems and dust suppression and greater flexibility on the 5 year throughput guarantee criteria.

5.6 SHIP TECHNOLOGY AND SHIP-TO-SHORE HANDLING SYSTEMS

The scope for improving roads to water potential through ship design appears to be limited. High port costs may often be the result of low or irregular throughput and this is difficult to correct through technology. Instead research into low cost, rapid, automated ship-to-shore transfer systems should be considered.

5.7 EQUALITY WITH RAIL

There must not be (or seen to be) inequality between rail and water if these modes are to be encouraged at the expense of road. In this respect, the 44 tonne lorry concession for combined transport movements to rail heads should be extended to shipping where traffic is being taken off the roads. Infrastructure equality between rail and sea ports might also be studied.

5.8 PLANNING

Location of industry has a key part to play in reducing road mileage. Industry should be encouraged to utilise ports as suitable locations for assembly, warehousing and distribution centres. Measures should be considered to ensure effective utilisation of waterside land in the roads to water context. An option is to extend Enterprise Zone status to ports areas where relocation of industry could also reduce road mileage.

5.9 THE IMPACT OF POLICY MEASURES AND ENVIRONMENT ASSESSMENT

Large shifts from roads to water will not occur under prevailing cost and service quality comparabilities. However, if "external costs" were fully reflected this could alter modal shares. To establish whether incentives might tip the balance in favour of a switch to water an assessment needs to be made of the full external cost savings.

A range of discriminatory measures should be examined - including road tolls, speed restrictions, driver hour restrictions, port taxes/rebates, "carbon tax", lorry weight incentives - to assess their impact on creating modal shift.
review should include comparison with measures applied in Europe. This study produced a number of models which could be used in the assessments.

ABSTRACT

UK ROADS TO WATER INITIATIVE

A FOCUSING STUDY FOR THE UK DEPARTMENT OF TRANSPORT

The objective of this outline study was "to target productive areas for initiatives and for further research into the potential for short sea, coastal and inland shipping, for both the Government and commercial interests". The study was to identify where water could be competitive for internal UK movements and where there could be scope for reducing or eliminating the road transport element of external movements by encouragement of greater use of regional port facilities. As a clear brief to policy makers the study should lead to research into the targeted productive areas.

The study is firstly a detailed overview of internal and external UK traffic flows. Cost models then test the competitiveness of the water option and the alternative routeings in the target areas identified. Secondly it provides a focus on the roads to water issues together with a number of key options for Government and industry to consider. The study provided much detailed commodity and traffic flow targeting.

Broadly the most productive areas for roads to water are:

* The protection of existing domestic coastal distribution (32 mtpa, 75% oil product) from the threat of further conversion to roads.

* The identification of longhaul internal traffic which can be converted to water under marginally changed conditions, including the feasibility of a coastal highway service.

* The encouragement of the re-routeing of external traffic, with the Continent, Eire and Northern Ireland, through ports closer to the points of origin and destination of the traffic. This requires that the shipping connections to these ports are competitive in cost and quality terms.

* The identification of, and implementation of, measures designed to reduce the effect of high overall costs at the port interface.
MARITIME RESEARCH PRIORITIES FOR EUROPE

By Th. H. de Meester

Paper will be added later
A STATISTICAL ANALYSIS THAT EXAMINES
FACTORS AFFECTING MARINE TRAFFIC
ACCIDENTS IN EUROPEAN WATERS FOR
EVALUATION OF TRAFFIC SYSTEMS
IN SHORTSEA SHIPPING

By K. Giziakis and E. Giziaki

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European Shortsea Shipping 469
ABSTRACT

In the operations of shortsea shipping in European Waters accidents to ships have occurred. In this paper, a selection of totally lost ships has been done for years 1984 to 1992. A descriptive statistical analysis outlines the today's situation for accidents and identifies causes of accidents. A loglinear analysis of the number of accidents quantifies the relative importance of single and interaction effects. Recommendations for reducing the number of accidents are made.

1 INTRODUCTION

Much that goes on in the world today may be described in terms of systems. There seems to be an increasing recognition of the fact that very little of the more important kind of human activity takes place in isolation. We think that these activities have become so interconnected and interdependent that it is standard practice today to look beyond their immediate inputs and outputs and to ask about their consequences for the rest of the system.

A "system" is defined by the machinery, the people and the procedures assembled and organized for the accomplishment of a specific task within a specified environment. The "safety" of the system is measured by the ability of the system to perform the tasks for which it was intended without experiencing losses due to accidents.

Accidents are failures of the system, failures which may have their origin in the physical apparatus of the system, in the people involved in the system's operations, in the procedures for operating the system, or in the environment where the system operates. An accident occurs when the system fails due to a stress that exceeds the system's ability to withstand it. Safety, in short, is concerned with "pathology" of systems.
A Statistical Analysis that Examines Factors Affecting Marine Traffic Accidents

The particular pathology that leads to marine accidents has recently begun to attract considerable public attention. There is a growing recognition of the complexity of the sea traffic safety problem and its many-sided nature. It has become widely appreciated in recent years that ship accidents are basically failures of a system and that it is meaningless to speak of simple causes of ship accidents. There are system failures that can be broadly grouped and identified with either the ship, the environment, or the seamen. These failures contribute to the creation of the accident event, the damage and injury due to the accident and the degree of loss after the accident. Every one of these failures, and many combinations thereof, can be viewed as contributory to the accident loss. Thus, if a particular feature of the system appears to be affecting the accident rate, changes can be made in that feature or in another element of this system that compensates for it.

The ability to find an effective programme aiming at the reduction of accident losses is severely limited by the lack of understanding of the many factors affecting the safety of ship operations.

In this paper an effort has been made:

First to present data for accidents in European Waters in such a way as to describe the today's situation;

Second to carry out a statistical analysis which examines factors affecting the safety of ship operations. The statistical significance of these factors and the effect of their interaction on the total number of marine traffic accidents have been presented;

Third certain models have been developed and used for understanding the relationship among factors and their effect on the total number of marine traffic accidents occurred in European Waters.

The statistical package for social sciences (SPSS - PC) software programme has been used for data analysis [1].

Section 2 of this paper is referred to the sources of data and the information collected. In Section 3, a brief description of the statistical methodology applied to the data has been included. In Sections 4 and 5 a descriptive statistical analysis of the total number of ships lost and of each particular type of ship lost in the European Waters is presented. Section 6 is concerned with the results of the statistical modeling. In the last part conclusions and policy recommendations have been made.
2 CASUALTY DATA

The casualty data used were collected from Lloyd’s Casualty Returns [2, 3] and include totally lost ships having size of 100 gross tonnage and over. The data file, for this paper, has been retrieved from a larger data base created at the University of Piraeus by a research group under the supervision of Associate Professor Dr. A. Goulielmos.

The period under investigation was from January ’84 to December ’92. It is important, the period of observation to be long, when trends are required. However, in the present paper, our interest was focused on the most recent casualty data in order to have a good representation of the present situation and to achieve homogeneity from the technological progress point of view.

The geographical area covered in the present paper extended to all seas around Europe, including coastal regions and port approaches. In particular the area covered was Baltic Sea, North Sea up to N60° 00’ W20° 00’ and Mediterranean Sea (Appendix A).

For each ship involved in a casualty the following information has been collected:

1. Flag;
2. Gross registered tonnage (GRT);
3. Age;
4. Type: tanker, bulk carriers, general cargo, ferry (ro/ro), passengers, fishing, container, barges, other;
5. Weather: rough seas, typhoon, fog and poor visibility;
6. Casualty categories: foundered, grounded, collisions, fire and explosions, missing etc.

3 THE METHODOLOGY.

In this paper two kinds of statistical analyses have been applied:

a) A descriptive analysis of the data that outlines the today’s situation;

b) A more advanced statistical technique, that is called loglinear analysis. This technique describes association patterns among categorical variables or interval variables for which the values are grouped into ordered categories [6, 7, 8, 9].
A Statistical Analysis that Examines Factors Affecting Marine Traffic Accidents

The variables used for classification, called factors, are the independent variables, while the dependent, response variable, is the number of cases in a cell of a crosstabulation.

The purpose of the analysis is to explore the interdependence among the factor variables and their dependence on the response variable.

Using a loglinear model the number of cases in each cell can be expressed as a function of the single factors (main effects) and the interaction among these factors.

Representing a contingency table with a loglinear model that contains as many parameters as there are cells (a saturated model) does not result in a simple, parsimonious, description of the relationship among the variables, but the saturated model is useful for exploring other models, that could be used to represent the data.

Many different models are possible for a set of variables. If models with and without higher order interaction terms fit the data, the simpler models are preferable, since the higher order interaction terms are difficult to interpret.

The hypothesis that a certain model fits the observed data is tested using the likelihood ratio chi-square. The likelihood ratio chi-square statistic is subdivided into interpretable parts that sum up to the total and signal their contribution to the model. Consequently, the partitioning property of chi-squared is used to extract components of test statistics, that describe certain aspects of the overall association in a table.

The goodness of fit of a particular model can also be assessed by examining the residuals. If the model is adequate the standardized residuals are approximately normally distributed with mean 0 and variance 1.

4 DESCRIPTIVE ANALYSIS OF TOTALLY LOST SHIPS IN EUROPEAN WATERS FROM 1984 TO 1992

The accidents occurred in European Waters in the specified time period contributed an average of 24% to the world losses.

The main types of accident were: "foundered", "fires and explosions" and "grounded". Their relative importance did not change over the years under consideration. Figure 1 shows the fluctuation over the years along with the total number of accidents. There is no obvious trend.
The aggregate data by type of accident for the years considered are shown in Table I. Almost 67% of the accidents in European Waters have resulted from the above mentioned categories. In particular, "foundered" was responsible for 28.9%, "fires and explosions" for 19.6% and "grounded" for 19.1%.

<table>
<thead>
<tr>
<th>Category</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
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<tbody>
<tr>
<td>Foundered</td>
<td>184</td>
<td>28.9</td>
</tr>
<tr>
<td>Fire &amp; Explosions</td>
<td>125</td>
<td>19.6</td>
</tr>
<tr>
<td>Collision</td>
<td>64</td>
<td>10.0</td>
</tr>
<tr>
<td>Grounded</td>
<td>122</td>
<td>19.1</td>
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<tr>
<td>Damaged</td>
<td>97</td>
<td>15.2</td>
</tr>
<tr>
<td>Contact</td>
<td>20</td>
<td>3.1</td>
</tr>
<tr>
<td>War Losses</td>
<td>12</td>
<td>1.9</td>
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<tr>
<td>Missing</td>
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<td>0.9</td>
</tr>
<tr>
<td>Other</td>
<td>8</td>
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</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>638</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

Table I: Distribution of total losses by type of accident
Attention must be paid to categories "fire and explosions", "collisions" and "grounded", because of the high risk of accidental pollution from these types of accident, which accounted for 48.7% of the totally lost ships.

General cargo and fishing types of ship were the main contributors to the number of accidents. Their relative importance did not change over the years. Figure 2 shows their contribution over the years as well as the total number of accidents. There is no obvious trend.

The aggregate data by type of ship are presented in Table II. General cargo and fishing types amount to 72.9%. A consideration should be given to ferry/passengers category, amounting to 8.1%, because it might have a larger contribution to human losses as compared to other categories.

Figure 3 describes the percentage distributions of grt and of the number of ships for several size groups. Ships of less than 1000 grt size were accounted for 55% of the number of accidents and 6% of total grt lost. At the other extreme, size group having ships over 10000 grt, the number of ships lost was 8% while grt lost was 59%. If we think of GRT contribution as a measure of economic value, then the larger ships have more economic importance than the smaller ships, although the number of lost ships were quite small. Another point worth mentioning is that the analysis of the number of ships ignores the economic aspect which may alter the results and it may be of interest to the decision makers [4].
Section VI - Papers Not Discussed at the Conference

<table>
<thead>
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<th>Category</th>
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</tr>
</thead>
<tbody>
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<td>General Cargo</td>
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<tr>
<td>Bulk carriers</td>
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<tr>
<td>Tanker</td>
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<td>5.3</td>
</tr>
<tr>
<td>Ferry</td>
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<td>8.1</td>
</tr>
<tr>
<td>Fishing</td>
<td>104</td>
<td>16.3</td>
</tr>
<tr>
<td>Container</td>
<td>8</td>
<td>1.3</td>
</tr>
<tr>
<td>Other</td>
<td>48</td>
<td>7.5</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>640</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

Table II: Distribution of total losses by type of ship

![Figure 3: Comparison of % GRT - % number of accidents by size groups](image)

Figure 3 pictures the relationship between the percentage of the number of accidents and the percentage of grt lost for certain age groups. In the age groups 10 - 15 and 15 - 20 years the percentage number of accidents was less than the percentage of grt lost. This indicated that larger ships, on average, were involved in total losses in the respective age groups. On the contrary, in the age group "over or equal to 25 years old" small ships, on average, were involved. Conclusions cannot be drawn simply from this presentation [5].

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Weather conditions were reported to have influenced the accident in 33% of the cases. In Table III the distribution of weather conditions is shown.

In Appendix A the number of totally lost ships and the geographical zones where these ships were lost, is shown.

<table>
<thead>
<tr>
<th>Category</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind</td>
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<td>0.5</td>
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<tr>
<td>Bad weather</td>
<td>184</td>
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</tr>
<tr>
<td>Typhoon</td>
<td>2</td>
<td>0.3</td>
</tr>
<tr>
<td>Fog</td>
<td>19</td>
<td>3.0</td>
</tr>
<tr>
<td>Not reported</td>
<td>431</td>
<td>67.4</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>639</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

Table III: Distribution of total losses by weather conditions
5 DESCRIPTIVE ANALYSIS BY TYPE OF SHIP

5.1 THE GENERAL CARGO

The general cargo ships had the biggest number, namely 362, of totally lost ships, as it is shown in Table II, having an average size of 1897 grt and mean age of 22.3 years.

Table IV A shows where the general cargo ships have been lost. 53.6% of the totally lost ships were occurred in Mediterranean Sea and 40.9% in N.W. European Waters.

Table IV B shows the type of accident that the general cargo ships had experienced. Foundering cause was responsible for 30.4% of the number of ships and grounding for 21.5%. These results were partly explained by the influence of weather, 37.6%.

5.2 BULK CARRIERS

This category of ships had a small number of accidents that involved ships having an average size of 21613 grt and mean age 19.8 years.

Table V A refers to geographical regions where accidents involving bulk carriers had occurred.

A striking result was that fires and explosions had the biggest contribution to the total number of accidents for this type of ship. The second contributory cause was groundings, 25%.

Although we were expecting the bulk carriers to be influenced by the weather less than general cargo ships, we found out that the contribution of the weather was 37.5%.

5.3 TANKERS

This category of lost ships had an average size of 17486 grt and a mean age of 18.3 years.

Table VI A refers to the geographical areas where the accidents occurred. 79% of tanker accidents have taken place in the Mediterranean sea.
A Statistical Analysis that Examines Factors Affecting Marine Traffic Accidents

<table>
<thead>
<tr>
<th>Category</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>N.W. Europe</td>
<td>148</td>
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<tr>
<td>Baltic Sea</td>
<td>20</td>
<td>5.5</td>
</tr>
<tr>
<td>E. Mediterr.</td>
<td>94</td>
<td>26.0</td>
</tr>
<tr>
<td>W. Mediterr.</td>
<td>100</td>
<td>27.6</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>362</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

Table A

<table>
<thead>
<tr>
<th>Category</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundered</td>
<td>110</td>
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</tr>
<tr>
<td>Fire &amp; Explosions</td>
<td>53</td>
<td>14.6</td>
</tr>
<tr>
<td>Collision</td>
<td>37</td>
<td>10.2</td>
</tr>
<tr>
<td>Grounded</td>
<td>78</td>
<td>21.5</td>
</tr>
<tr>
<td>Damaged</td>
<td>67</td>
<td>18.5</td>
</tr>
<tr>
<td>Contact</td>
<td>10</td>
<td>2.8</td>
</tr>
<tr>
<td>War Losses</td>
<td>3</td>
<td>0.8</td>
</tr>
<tr>
<td>Missing</td>
<td>2</td>
<td>0.6</td>
</tr>
<tr>
<td>Other</td>
<td>2</td>
<td>0.6</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>362</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

Table B

Table IV: Distribution of general cargo totally lost ships by geographical area (A) and by type of accident (B)

Fires and explosions were the most important cause amounting to 45.5% of the total number of accidents (Table VI B). This percentage added to the groundings, 15.1% and collisions, 9.1% amounts to a total of 69.7% and creates a very serious situation because of the high risk of pollution.

5.4 FERRY AND PASSENGER SHIPS

This category had an average size of lost ships of 4687 grt and a mean age of 22.9 years.

Table VII A refers to geographical areas within which the accidents had occurred. 75% of the ferry/passenger accidents had occurred in the Mediterranean region.

Fire and explosions were the most important cause of accidents for this type of ships totalling to 42.3%. Foundered and collision category had a share in the
Table A

<table>
<thead>
<tr>
<th>Category</th>
<th>Frequency</th>
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<tbody>
<tr>
<td>N.W. Europe</td>
<td>15</td>
<td>46.9</td>
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<td>3.1</td>
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<tr>
<td>E. Mediterran.</td>
<td>8</td>
<td>25.0</td>
</tr>
<tr>
<td>W. Mediterran.</td>
<td>8</td>
<td>25.0</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>32</strong></td>
<td><strong>100.0</strong></td>
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Table B

<table>
<thead>
<tr>
<th>Category</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundered</td>
<td>2</td>
<td>6.3</td>
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<tr>
<td>Fire &amp; Explosions</td>
<td>11</td>
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<tr>
<td>Grounded</td>
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<td>Damaged</td>
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</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>32</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

Table V: Distribution of bulk carriers total losses by geographical area (A) and by type of accident (B)

Accidents of 19.2% and 11.6% respectively. All three causes amounting to 73.1%, have a great risk of human casualties (Table VII B).

5.5 FISHING VESSELS

The average size of fishing lost ships was 334 grt and the mean age 19.1 years.

Table VIII A shows the geographical regions within which these accidents had occurred. 73.1% of the accidents have taken place in N.W. European Waters, where mainly the fishing grounds are located.

In Table VIII B the categories of accidents for fishing vessels have been presented. The biggest contribution was that of foundered category (39.4%), followed by grounded category contributing 16.3% to the total number of accidents. The weather had influenced 26% of the total number of accidents.
A Statistical Analysis that Examines Factors Affecting Marine Traffic Accidents

<table>
<thead>
<tr>
<th>Category</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
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<tr>
<td>N.W. Europe</td>
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<td>E. Mediterr.</td>
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<tr>
<td>W. Mediterr.</td>
<td>18</td>
<td>52.9</td>
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<tr>
<td>TOTAL</td>
<td>34</td>
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Table A

<table>
<thead>
<tr>
<th>Category</th>
<th>Frequency</th>
<th>Percent</th>
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</thead>
<tbody>
<tr>
<td>Foundered</td>
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<tr>
<td>Fires &amp; Explosions</td>
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<td>Collision</td>
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<td>Grounded</td>
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<tr>
<td>Contact</td>
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<td>3.0</td>
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<td>Damaged</td>
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<td>6.1</td>
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<tr>
<td>War Losses</td>
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<td>9.1</td>
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<td>3.0</td>
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<td>TOTAL</td>
<td>33</td>
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</table>

Table B

Table VI: Distribution of tanker total losses by geographical location (A) and by type of Accident (B)
Section VI - Papers Not Discussed at the Conference

<table>
<thead>
<tr>
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<th>Frequency</th>
<th>Percent</th>
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<tbody>
<tr>
<td>N.W. Europe</td>
<td>9</td>
<td>17.3</td>
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<td>Baltic Sea</td>
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<td>E. Mediterranean</td>
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<td>30.8</td>
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<tr>
<td>W. Mediterranean</td>
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<td>44.2</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td>100.0</td>
</tr>
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</table>

Table A

<table>
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<tr>
<th>Category</th>
<th>Frequency</th>
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</thead>
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<tr>
<td>Foundered</td>
<td>10</td>
<td>19.2</td>
</tr>
<tr>
<td>Fire &amp; Explosions</td>
<td>22</td>
<td>42.3</td>
</tr>
<tr>
<td>Collision</td>
<td>6</td>
<td>11.6</td>
</tr>
<tr>
<td>Grounded</td>
<td>5</td>
<td>9.6</td>
</tr>
<tr>
<td>Damaged</td>
<td>3</td>
<td>5.8</td>
</tr>
<tr>
<td>Contact</td>
<td>2</td>
<td>3.8</td>
</tr>
<tr>
<td>War Losses</td>
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</tr>
<tr>
<td>TOTAL</td>
<td>52</td>
<td>100.0</td>
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Table B

Table VII: Distribution of ferry - passenger total losses by geographical area (A) and by type of accident (B)
A Statistical Analysis that Examines Factors Affecting Marine Traffic Accidents

<table>
<thead>
<tr>
<th>Category</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
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<td>N.W. Europe</td>
<td>76</td>
<td>73.1</td>
</tr>
<tr>
<td>Baltic Sea</td>
<td>11</td>
<td>10.6</td>
</tr>
<tr>
<td>E. Mediterr.</td>
<td>3</td>
<td>2.9</td>
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<td>W. Mediterr.</td>
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</tr>
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Table A

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<tr>
<td>Other</td>
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<tr>
<td><strong>TOTAL</strong></td>
<td><strong>104</strong></td>
<td><strong>100.0</strong></td>
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</table>

Table B

Table VIII: Distribution of fishing totally lost ships by geographical area (A) and by type of accident (B)
6 LOGLINEAR ANALYSIS OF DATA

6.1 FACTOR CATEGORIES

The analysis considered uses the number of accidents, as a response variable and factors the type, flag, size and age of a ship.

The number of accidents includes all ships lost for the years 84 to 92 excluding those ships classified as war losses.

The categorization of factors have been done in such a way as to have meaningful results for shortsea shipping in European Waters.

The categorization of factors is the following:

1) TYPE (T) has six categories:
   T1 General cargo ships;
   T2 Bulk Carriers;
   T3 Tankers;
   T4 Ferry and passenger ships;
   T5 Fishing ships;
   T6 Other ships.

2) AGE (A) has three categories:
   A1 includes ships from 0 up to 10 years old;
   A2 includes ships from 10 up to 20 years old;
   A3 includes ships of over 20 years of age.

3) SIZE (G) in grt has three categories:
   G1 includes ships up to 500 grt;
   G2 includes ships from 500 up to 5000 grt;
   G3 includes ships of over 5000 grt.

4) FLAG (F) has three categories:
   F1 includes ships having an EEC country flag;
   F2 includes ships having flags of other European countries;
   F3 includes ships having other flags.

The categorization of factors can influence the percentage of explained variation of the number of accidents for the factor considered. Efforts are usually made for each individual factor to be categorized in such a way as to give first
A Statistical Analysis that Examines Factors Affecting Marine Traffic Accidents

meaningfull categories, second non-empty cells and third the best explanatory results.

6.2 AN ANALYSIS OF A THREE FACTOR MODEL

A loglinear model that uses all the above factors and the significant interactions does not fit to the data very well. There alternative models were tried.

A more appropriate model to the number of ships lost was proved the one that excludes size. The main effects, that is the total effect from the factors type (T), age (A) and flag (F) account for 88% of the total variation. Their contribution was statistically significant (p 0.0001).

The effect of each individual factor has been presented in Table IX

<table>
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<tr>
<th>Factor</th>
<th>Type (T)</th>
<th>Age (A)</th>
<th>Flag (F)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Explained Variation</td>
<td>54</td>
<td>24</td>
<td>10</td>
<td>88%</td>
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</table>

Table IX: Single factor effect

This approach shows not only the importance of a factor to the number of accidents, but it provides also the order of importance. The most important factor is the type of the ship lost followed by the agegroup.

A test for the significance of interactions has shown that the 2-way interactions had an influence on the number of accidents. The interaction effect accounts for 9.5% of the explained variation. The Type-Flag effect contributed 7% and it was statistically significant. All the other effects were not significant. An examination of the residuals of the fitted model Type (T), Age (A), Flag (F), Type-Flag (TF) suggested that there were no cells with bad fits (Appendix C).

A. Single Factor effects

1. Type of ship

The effect of factor type as it is displayed in Table IX is almost 54%. That is, this factor can explain 54% of the total explained variation. The estimated parameters give us an indication of the direction of the effect. The parameters and their standard errors are pictured in Appendix B. The general cargo (T1) and fishing vessels (T5) have shown a significant positive association with the number of totally lost ships. Positive T1 means that category general cargo is more likely than the average type
2. Age
This factor explains 24% of the variation. The estimates for the age factor had indicated a negative association for the age group 0-10 years and an increasing positive association for the other two groups. It is difficult from this result only to conclude about the influence of age in the number of accidents since the effect of the economic value of a ship, that influences the total number of accidents has not been removed [5].

3. Flag
This factor accounts for 10% of the variation. The estimated parameters had shown that EEC countries, category F1, and other non European countries had a positive association with the number of accidents.

B. Interaction effect

The type-flag interaction effect was statistically significant. The interaction effect of type and flag indicates their combined effect and their dependence. In Appendix B the estimated parameters and standard errors of the interactions are shown.

General cargo ships having EEC flags had a negative effect on the number of ships lost, while vessels having other non european flags had a large positive association. This means that general cargo ships registered with non european flags had a bad performance.

Bulk carriers having EEC flags had a negative effect to the number of accidents, while ships with other European and non european flags had a positive association. This is an indication that bulk carriers registered with non EEC flags, had bad performance in the area under study.

Tankers registered with an EEC flag had a positive association to the number of accidents, while the other European flags had a slight negative association and the non- European flags had a negative effect. That is, the tankers registered with an EEC flag had bad performance in the regions under study.

Ferry and passenger ships registered with EEC flags had negative association, while the other flags, i.e. other European and non-European flag categories had positive association.

The fishing type ships registered with an EEC flag had a positive association, while the other two categories of flag had a negative association.
7 CONCLUSIONS AND POLICY RECOMMENDATIONS

7.1 CONCLUSIONS

The types of accident that occurred very frequently in the area under study, were "foundered", "fires and explosions" and "grounded". They are accounted for almost 67% of the number of accidents. Their relative importance did not change over the years considered.

"Fire and explosions" was the main cause for bulk carriers, tankers and ferry ships, amounting to 34.3%, 45.5% and 42.3% respectively.

General cargo and fishing vessels have as a main cause of accident the "foundered" one, accounting for 30.4% and 39.4% respectively. The weather had contributed to this type of accident, since these types of ship were of relatively small sizes.

The "foundered" cause had a contribution by 19.2% to the ferry/passenger lost ships, which are engaged in shortsea shipping.

The "grounded" cause was of importance in general cargo and bulk carriers vessels contributing 21.5% and 25% respectively.

The "collision" cause had contributed to all types of ship excluding bulk carriers by a percentage ranging from 9 to 12.5.

On average, one third of the total number of accidents was influenced by the weather conditions. One can expect small ships to be affected more than larger ships. A striking result was that of the bulk carrier ships being affected by the weather - 37% of losses - although they had the larger average size of lost ships.

The loglinear analysis of the number of accidents, as a response variable, has shown that, from the factors chosen, type is the most important one explaining 54% of the total variation, age is the second in order of importance with 24% and flag is the third one with 10%.

The estimated parameters of the model have shown that general cargo and fishing vessels had bad performance to the number of accidents.

The general cargo ships registered with non European flags had a major contribution to the number of accidents for this type of ship. The bulk carrier type
of ship registered with a European, non EEC, flag had the most positive contribution to the number of accidents as compared to the other flag categories.

On the contrary, tanker ships registered with EEC flag had the most positive effect to the number of accidents.

Ferry/passenger ships engaged in shortsea shipping in European Waters and registered with EEC flags had negative association with total losses as compared to the other flags.

The analysis presented did not include economic effects such as the cost of accidents to ships, the cost to environment from an accident. There are indications [5] that including such factors the order of factors' importance might change. The statistical analysis applied in this paper, can give more comprehensive results if cost data are included in the analysis.

7.2 POLICY RECOMMENDATIONS

Measures should be taken to reduce "fire and explosions" to tankers, bulk carriers and passenger ships.

The risk of pollution from tankers engaged in shortsea shipping could be reduced, if efforts are made to control "fire and explosions", "groundings" and "collisions".

The risk of human losses can be reduced if measures can be taken to reduce "fire and explosions", "founderings" and "collisions" in passenger ships.

There is an indication from this study that a better information on weather and a serious consideration of its influence may reduce the number of accidents, mainly in general cargo ships.

Attention should be paid to the reduction of "foundered" cause in fishing vessels.

ACKNOWLEDGEMENT

The authors would like to thank Ass. Prof. A. Goulielmos for offering his invaluable comments in the writing of this paper.
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APPENDIX A: GEOGRAPHICAL LOCATIONS

No. of ships lost:
location 1: 286 ships
location 2: 31 ships
location 3: 9 ships
location 4: 139 ships
location 5: 175 ships
APPENDIX B: ESTIMATED PARAMETERS OF A 3-FACTOR MODEL

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<thead>
<tr>
<th>FACTOR</th>
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<th>ESTIMATE</th>
<th>STANDARD ERROR (S.E.)</th>
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</thead>
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<td></td>
<td>T2</td>
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<td></td>
<td>T3F1</td>
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### APPENDIX C: FITTED VALUES AND RESIDUALS FOR THE NUMBER OF ACCIDENT

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### A Statistical Analysis that Examines Factors Affecting Marine Traffic Accidents

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European Shortsea Shipping
PORT FACILITIES FOR FAST FERRIES

By K.C. Fear

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INTRODUCTION

Posford Duvivier is a firm of Consulting Engineers which has an internationally renowned expertise in the design of port facilities, with particular expertise in the design of facilities for roll-on/roll-off (ro-ro) ferries. Posford Duvivier have designed over forty installations for ro-ro ferries over the last thirty years.

During the past few years the UK ferry industry has seen dramatic developments in the field of fast ferries. Combined passenger and vehicle carrying vessels have been introduced on scheduled services around our coasts, often operating in waters which many would have predicted as being too rough for a reliable service to be maintained.

Following the introduction of vehicle carrying fast ferries, a number of port owners and operators have, during the last two years, approached Posford Duvivier for advice on providing suitable facilities for these vessels. The start of the design process for a ro-ro facility is to obtain information on the vessels that are to use the facility. Without this information the design decisions that follow can only be based on our experience of previous installations and from published information and in these circumstances Posford Duvivier would advise that the design could not proceed. Our experience of trying to obtain the most basic data about fast ferries from the primary source, ie. fast ferry designers, is not encouraging. We understand that, with vessel designs breaking new ground, builders and designers of fast ferries may fear a breach of confidentiality. However, without the information being quickly available, port operators or their consulting engineers will not be able to guarantee that a proposed fast ferry will fit the proposed facility or that the vessel will not be damaged due to the mooring or berthing facilities provided.

It needs to be borne in mind that, once a new service is announced, there is often only a few months (or even weeks) to design and construct the required port facilities.

The objective of this paper is to highlight to naval architects, designers and builders of fast ferries why detailed information on vessels is required by port engineers and to identify areas within the current codes of practice where further investigation or research may be required.
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PORT APPROACH

It may be an obvious statement to make, but most existing ro-ro ports are designed to cater for conventional ro-ro ferries. The approaches to the ports may have been dredged to deepen and widen them to suit the development of these vessels over the years.

Most of the proposed multi hulled fast ro-ro ferries are shorter and beamier than conventional ro-ro vessels. With the possible exception of SWATH type fast ferries, the draft required for fast ferries is considerably less than for conventional ferries.

The beam of a fast ferry is often the significant factor when considering the approach to the port. Existing dredged channels may require widening. However, some berths are approached through a harbour entrance or breakwater. Additional dredging would be costly, but this could be small compared to the cost of altering a harbour entrance or breakwater, should this be viable. Such proposed expenditure could possibly make a berth uneconomic for the operation of a fast ferry service.

The plan size and shape of a fast ferry combined with the maximum draft would be required from the ferry designers to determine whether a particular port is capable of receiving the vessel. An indication of the vessel’s manoeuvrability would also be required and whether tug assistance is necessary at high wind speeds or low operating speeds.

FENDER DESIGN AND BERTHING MANOEUVRES

The code of practice used for the design of port facilities in the United Kingdom is the British Standard Code of Practice for Maritime Structures BS 6349: 1984 (Reference No. 1).

The effective berthing energy equation is:

$$E (kN.m) = 0.5 M_D (tonnes) V^2 (m/s) \cdot C_M \cdot C_D \cdot C_S \cdot C_C$$

Where:  
E = Berthing kinetic energy  
$M_D$ = Displacement tonnage of vessel  
V = Berthing velocity of vessel  

(Total mass of vessel and contents divided by the acceleration due to gravity)
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Note: The total mass of the vessel is equal to the volume of water displaced by the vessel multiplied by the density of the water

\[ C_M = \text{Hydrodynamic mass coefficient} \]
\[ C_E = \text{Eccentricity coefficient} \]
\[ C_s = \text{Softness coefficient} \]
\[ C_c = \text{Berth configuration coefficient} \]

It can readily be seen that a doubling of the vessel's berthing velocity would quadruple the energy to be absorbed by the fendering system and the vessel's hull.

HYDRODYNAMIC MASS COEFFICIENT \( C_M \)

At present there is insufficient research into this complex entity for it to be evaluated satisfactorily. Hydrodynamic mass is influenced by the form and condition of the ship's hull, under keel clearance, type of quay or jetty and the velocity of the vessel. However, according to Vasco Costa (reference No. 2) the following equation is sufficiently accurate for mono hull vessels and this formula is given in BS 6349:

\[
C_M = 1 + \frac{2D}{B}
\]

Where: 
\( D \) = the draught of the vessel (m)
\( B \) = the beam of the ship (m)

The above expression was determined following experiments using models described by Grim (1955) (reference No. 4) and experiments using real ships referred to by Saunin (1963) (reference No. 5). To quote Vasco Costa, "Until now experiments are undertaken in order to permit greater insight into the problem of the evaluation of hydrodynamic mass. There seems to be no reason to use more elaborate expressions in cases where the ship is moving laterally."

Research has shown that the hydrodynamic mass coefficient can have values from 1.3 to 3.6 and BS 6349 suggests using values of 1.3 to 1.8 for \( C_m \) in the expression for the effective berthing energy. However, the research was carried out on conventional monohull vessels. When considering multi-hulled vessels there is, in addition to the mass of water around the hulls, there is a mass of water between the hulls which would have an influence on \( C_m \) although this volume of water may not act in total. With some twin hull designs the volume of water to be moved between the hulls represents up to 4 times the displacement tonnage of the vessel.
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It would appear that the current British Standard suggests the use of an expression for the hydrodynamic mass coefficient which is at best an estimation of the added mass and is probably applicable to large mono hulled vessels only. The calculation of the hydrodynamic mass of a multi hulled vessel moving laterally is an area where further investigation and academic research may be required.

**ECCENTRICITY COEFFICIENT \( C_E \)**

When the first point of contact with the fendering system occurs opposite the centre of mass of the vessel the eccentricity factor is unity assuming the velocity vector acts through the point of contact. As the point of contact moves away from the centre of mass and the velocity vector no longer passes through the point of contact, the energy imparted by the impact reduces. The energy transferred into the fendering structure by a berthing vessel will be imparted by the first and second contact. Depending on the positioning of the fendering system, the second impact may experience as much as twice the energy as the first. To estimate the eccentricity coefficient the position of the centre of mass of the vessel is required. BS 6349 gives the equation for \( C_E \) as:

\[
C_E = \frac{K^2 + R^2 \cos^2(\gamma)}{K^2 + R^2}
\]

Where:  
- \( K \) = the radius of gyration of the ship (in m). This is generally between 0.2L and 0.25L where L is the length of the ship (in m)  
- \( R \) = the distance of the point of contact from the centre of mass (in m)  
- \( \gamma \) = the angle between the line joining the point of contact with the centre of mass and the velocity vector

The above is simplified assuming \( \gamma = 90^\circ \) to:

\[
C_E = \frac{K^2}{K^2 + R^2}
\]

**SOFTNESS COEFFICIENT \( C_S \)**

This allows for the proportion of the energy that is absorbed by the ship’s hull during the berthing manoeuvre. This is another area into which little research has taken place and advice is given within BS 6349 to use values of \( C_S \) between 0.9 and 1.0. The final choice of the value of \( C_S \) is determined by whether a "soft" or "hard" fendering system is to be used. The definition of these terms is
that a "hard" fendering system is that the fenders deflect by 150mm or less under the impact of vessels for which the system is designed. A "soft" fendering system deflects more than 150mm under the same conditions. A value of 1.0 is recommended for \( C_s \) for a soft system and between 0.9 and 1.0 for a hard system.

Information from vessel designers on the rigidity of their vessel's hull at the point of contact with the fendering system may influence the decision on the softness coefficient.

**BERTH CONFIGURATION COEFFICIENT \( C_c \)**

This takes into account the effect of the volume of water being displaced between the vessel and the quay when berthing. A proportion of the ship's energy is absorbed by this action. However, the effect is negligible if the vessel is berthing against an open piled structure. A value of 1.0 for \( C_c \) would be used for an open piled structure and values of between 0.8 and 1.0 would be used for a solid quay.

**MODE OF BERTHING**

In addition to the aspects considered above, the energy to be absorbed by the fendering system is also affected by the mode of berthing. This is the manner in which the vessel approaches and comes into contact with the fendering system. The modes of berthing are defined in three ways within SS 6349.

Mode (a) (see Figure 1). This is where the vessel approaches the berth parallel to the berthing line. Contact is made with a number of fenders at the same time. No contact, other than the vehicle ramp, is made with any end fendering on the shore ramp.

When considering mode (a) berthing, BS 6349 gives the equation for calculating the radius of gyration (K) as:

\[
K = (0.19C_b + 0.11)L
\]

Where:  
- \( L \) = the length of the ship's hull between perpendiculars (in m)  
- \( C_b \) = the block coefficient of the hull

The block coefficient \( C_b \) represents the proportion of the volume occupied by the vessel's hull to the volume of the water within the "block" of water in which the vessel is floating. The block coefficient suggested in BS 6349 for ro-ro vessels and ferries is 0.54 to 0.63 (bulk carriers and other larger vessels can
have block coefficients of 0.85 - 0.9). Designers of fast ferries should be able to provide the block coefficient for their vessels. Alternatively, the actual figure for the radius of gyration of this vessel should be made known.

Mode (b) (see Figure 2) assumes a similar approach to the berthing mode (a) except once in contact with the breasting fenders the vessel moves parallel with and along the berthing line until contact is made with the end fender in front of the shore ramp.

The effective kinetic energy to be absorbed by the breasting fenders is calculated as for mode (a) berthing. The energy to be absorbed by the end fenders is calculated using the basic energy equation, \( E = 0.5 M_0 V^2 \) ie, with all coefficients being taken as unity. Estimating the velocity of approach along the berth is crucial due to the effect on the energy calculation.

Mode (c) (see Figure 3) assumes that the vessel makes an approach to the berth at an angle (\( \alpha \)) measured from the berthing line. BS 6349 recommends that \( \alpha \) should be a minimum of 15° and that approach velocities of 2.0 m/s to 3.0 m/s are assumed to calculate the effective energy to be absorbed by the breasting
dolphins. The effective energy equation for mode (c) is stated as:

\[ E = 0.5M_D C_0 C_2 C_3 C_E (V \sin(\phi))^2 \]

When considering the end fenders the approach velocity suggested is 0.5 m/s to 1.0 m/s and the energy equation is stated as:

\[ E = 0.5M_D (V \cos(\phi))^2 \]

It is assumed that mode (c) berthing would be used for short regular river crossings and not for ro-ro vessels. However, as fast ferries require a fast turn around this mode of berthing may be considered appropriate by vessel designers and operators.

It can be seen from the above that the designer of fendering systems may have to make a number of assumptions about the design vessel’s characteristics. The number of assumptions could be dramatically reduced if the designers of fast ferries would provide information about a particular vessel’s berthing.
characteristics and appropriate methods of berth approach. The method in which a vessel is to be operated should also be considered. The loaded displacement tonnage is required in addition to an accurate plan of the vessel at the plane of contact with the fenders.

**ADDITIONAL INFORMATION REQUIRED ON HULL PROFILES**

The above fender design process assumes that vessels will approach the berth in a consistent controlled manoeuvre which is described above as berthing mode a, b or c. As part of the design process the risk of a vessel approaching in a manner different from that assumed during the design is considered. If, for reasons of mechanical failure, or due to extreme weather conditions, the vessel which would usually approach parallel to the berth approached at an angle, the possibility of the vessel striking the quay between the fenders is considered. For this "accidental" condition a maximum approach angle of 15° is commonly used (see Figure 4). Should the vessel approach the berth at, say, 15° - 90° (see Figure 5) it is inevitable that the bow or stern of the vessel would come into contact with the structure between the fenders. This could be a solid quay or a walkway suspended between dolphins. However, as the estimated risk of this accident occurring is low, the cost to the port operator of designing a fendering system to cater for this cannot be justified and the vessel and quay would be repaired as necessary in this eventuality.

Scale plans of the vessel at the water line are required for the above design process in addition to sections showing an elevation through the hull. These are
then used to determine under what conditions the vessel could come into contact with the quay structure between the fenders.

Ports which have a large tidal range require fender facing panels to be very long, often in excess of 10m. The condition of a vessel berthing at extreme high and
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Low water is considered. Depending on the positioning of any elastomeric fender units, it is possible for the fender panel to move inwards more at one end than the other. Sections through the vessel showing the hull profile above and below any belting are used to determine whether it is possible for a vessel hull to be struck by a fender panel when one end is being compressed more than the other (Figure 6).

![Figure 6: Vessel berthing at LAT](image)

Suitable cross sections of the design vessel are required and information should be provided on acceptable hull pressures for the belting and for areas above and below the water line that could be hit by a fender panel at high or low water.

It should be noted that the use of tethered floating fenders is not considered suitable for berthing fast ferries. It is possible with typically fast ferry hull profiles for floating fenders to be pushed over or under the vessel’s belting which could allow the vessel to come into contact with the quay structure.
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MOORING

Once berthed, most vessels require to be moored with the use of ropes attached to bollards placed on the quay or on remote dolphins. Mooring fast ferries does present a problem due to the height of the mooring bits above the water. The preferred mooring layout must be agreed with the vessel’s designer and the operator. With fast ferries being light, but with a relatively large windage area, they are more lively at low operating speed than conventional ro-ro ferries. The preferred mooring layout should be made known to the port engineer. This will be checked against the layout and relative height of the existing bollards to ensure that the preferred mooring layout can be achieved without the ropes being set at steep angles. Additional bollards may have to be provided.

With an acceptable mooring arrangement planned, the forces exerted on the bollards, quay foundations and dolphin piles have to be assessed. The principal horizontal forces which act on a moored vessel are caused by wind and current. However, the mooring system has to withstand a combination of forces caused by the following:

* Wind;
* Current;
* Off quay hydrodynamic force and hydrodynamic interference from passing ships;
* Long swell waves;
* Waves caused by passing ships in narrow channels;
* Tidal rise and fall;
* Changes in vessel draught and/or trim due to operations;
* Ice.

The mooring system is usually designed to accommodate wind and current forces that have a return period of 1 in 50 years. The factors used in the design process allow sufficient residual strength to resist the smaller effect of the other forces. However, should conditions exist on a particular location to suggest that the other forces may have a significant influence on the design these will be considered in combination with the wind and current forces. In order to assess the effect of long swell waves or passing ships, complex mathematical models have to be set up and run. These models require input data from wave modelling, elasticity of mooring ropes and fenders and the friction coefficients between ships’ hulls and the fender faces.

When evaluating mooring loads, BS 6349 provides a table of nominal bollard and fairlead loadings for vessels up to 20,000 tonnes displacement and calculations are not necessarily required. It is assumed that all designs of fast ferries for the foreseeable future will be less than 20,000 tonnes displacement.

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However, the use of this table may not be applicable for fast ferries due to the low displacement tonnage relative to the windage area. It is envisaged that under certain conditions with a particular catamaran hull profile the effect of wind and current tunnelling between the hulls could exert a considerable force in the mooring lines. This is another area where academic research may be required. The resulting forces envisaged above may prove to be relatively small compared to other forces acting on the vessel. However, the combined effect may prove significant and there should be methods by which engineers can calculate these forces.

The longitudinal profile of design vessels is required, irrespective of the displacement tonnage, to determine the windage area when the vessel is being blown by onshore and offshore winds. This is used to determine the force being resisted by the fendering or mooring system, although this force is usually less significant than the berthing forces. However, the forces are used to size fenders, dolphins and jetties.

SHORE RAMP

When designing the layout and details of a shore ramp or pontoon, many factors which influence the final design have to be taken into consideration and these are outlined below:

LENGTH OF SHORE RAMP OR LINK BRIDGE FOR PONTOON

This is determined by the maximum and minimum ship ramp level, the level of the shore and the maximum acceptable gradient of the shore ramp. The maximum vessel ramp level is determined by the design ship with the highest ramp hinge height above water level (unladen) and the level of the highest recorded tide or mean high water springs and the need to design clearances for the shore ramp or restraints to suit extreme tide levels. The choice of the highest water level is determined by the importance placed by the vessel's operator on access to the shore ramp at all states of the tide. The degree by which the ship's ramp can be lowered below the hinge height is also taken into account. The minimum shore ramp level is determined by the design ship with the lowest hinge height (fully laden) with the ship ramp lifted as much as possible, and the level of the lowest recorded tide or mean low water springs.

Having established the maximum and minimum levels to be accessed ideally the shore ramp hinge should be set at the mid point between these two levels. Following the recommendations of BS MA 97: 1984 (Reference No. 3) the maximum gradient on a shore ramp is set at 1:10. This is considered to be the steepest incline that a fully laden heavy goods vehicle could climb from a stand-
ing start. If the shore ramp is for cars or light vans only, it may be possible to steepen the gradient to 1:8. It is usually not possible to fix the hinge of the shore ramp mid point between the highest and lowest level. Shore levels can be reduced by a short fixed ramp provided that the high tide level is below the roadway and durability of the bridge section and hinges is taken into account. Wave impact on the underside of the shore ramp may tend to increase the level of the hinge. Therefore the length of the bridge is determined from the existing shore level and the maximum level difference with the ship’s ramp level at its highest or lowest point to be accessed. The maximum level difference combined with a maximum gradient of 1:10 determines the length of the shore ramp (see Figure 7). However, it should be noted that the gradients may be related to "normal" tide ranges. These could be taken as Mean Spring Tides. The steeper gradients experienced at extreme tides should be acceptable to the port operator and shipping line.

**VEHICLE TRANSITIONS**

Having established the hinge level of the vessel, the length of ship’s ramp, the level at the connection point with the shore ramp, the length of the shore ramp and the shore level, the points where there are rapid changes of gradient need to be checked against the types of vehicles to use the ramp to ensure that there are acceptable vehicle clearances (Figure 8).

Vehicles with long wheel bases or long overhangs give most problems. Sports cars with limited ground clearance and goods vehicles or passenger service vehicles with bodies which overhang the front and back axles are usually the most difficult to accommodate. Where applicable, roll trailers should also be checked.

To achieve acceptable vehicle transitions the shore ramp may require shaping at the ends or the length may have to be increased. Vessels with very short ramps can be difficult to accommodate and although not popular with operators, blocks or separate removable wedges may be necessary to prevent grounding of vehicles in certain circumstances. Guideline on rates of change of gradient and the shaping at the ends of shore ramps are given in BS MA 97. Although these should be examined carefully for each design under consideration.

The changes in the vessel’s freeboard and the pitch and heeling experienced as vehicles enter and leave the vessel have to be taken into account when considering vehicle transition. Again, a vessel with a very short ramp can pose difficult problems to overcome at extremes of tide. Both these problems are prevalent for fast ferries which tend to be lively and have short ship ramps.
SHORE RAMP LENGTH = 10 x H

MAXIMUM LEVEL TO BE ACCESSED BY SLOPE RAMP

MINIMUM LEVEL TO BE ACCESSED BY SLOPE RAMP

SHIPS RAMP AT MAXIMUM ASCENDING GRADIENT

SHIPS RAMP AT MAXIMUM DESCENDING GRADIENT

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Figure 7: Shore ramp gradients
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VEHICLE CHECKED FOR GROUND CLEARANCE AT THESE POINTS. HEAVY GOODS VEHICLES, ROLL-TRAILERS AND PASSENGER SERVICE VEHICLES ALSO CONSIDERED IF APPLICABLE TO VESSEL.

SECTION THROUGH END OF SHORE RAMP AND SHIPS RAMP SHOWING VEHICLE TRANSITIONS.

Figure 8: Design check on vehicle transitions
When considering the fit of the shore ramp to the ship’s ramp it is vital to have as many details of the ship’s ramp as possible. The hinge heights above water level for unladen and fully laden vessels and the range of movement of the ramp are required for reasons given above. Details of the end of the ramp and finger flaps, if fitted, are also required so that recesses (well decks) or shaping at the end of the shore ramp can be designed or checked accordingly.

CHOICE OF ADJUSTABLE SHORE RAMP OR PONTOON

The decision whether to construct an adjustable shore ramp pontoon or hybrid structure which consists of a shore ramp with integral float tanks is dependent upon a number of factors. In ports subjected to severe weather conditions and swell, adjustable shore ramps which lift clear of the water are often the only satisfactory solution. They can also cater easily for a number of vessels with different hinge heights. The hydraulic or winch lifting systems are relative expensive, however, and the shore ramp needs to be equipped with cross levelling and tide and vessel following devices. Alternatively it could be manually adjusted, which adds to the operating costs.

Pontoons and hybrid structures have the advantage of following the tide with the vessel without the need for mechanical devices. Provided the ship’s ramp has been designed to be sufficiently long to cater for the changes in freeboard when vehicles are loading and unloading an acceptable transition can be maintained between the pontoon and the ship. However, pontoons cannot cater for a range of vessels with differing ramp hinge heights without the assistance of a small hydraulic ramp on top of the pontoon or internal ballast tanks so that the trim of the pontoon can be adjusted although additional dredging may be required. Pontoons are more easily moved from berth to berth than adjustable shore ramps should the need arise although they do require a lot of space.

MOORING FORCES TO BE ACCOMMODATED BY SPECIALIST SHORE RAMP

The information published on the Sealink Stena’s HSS vessel indicates that all the mooring forces, except in extreme weather conditions, are to be accommodated by the shore ramp via mooring devices at the end of the shore ramp. The specialist ramp is being designed and developed in tandem with the vessel. Port engineers will need to design abutments to resist the forces at the hinge of the shore ramp. It is expected that these forces will be large in comparison when considering the moment at the hinge which would be caused by winds blowing the vessel sideways. The lever arm over which this force will be exerted is likely to be in excess of 150m.
USE OF EXISTING SHORE RAMP

When it is proposed to serve a fast ferry from an existing shore ramp, the distance from the berthing line to the centre line of the proposed vessel's vehicle ramp needs to be checked. Some shore ramps constructed in the 1970s will be too narrow to accommodate the beam of many multi hull fast ferry designs. International Catamarans of Tasmania foresaw this problem with their 74m wave piercing catamaran. The stern vehicle ramp can be moved to a number of locations across the vessel, thus putting the ramp closer to the berthing line. However, once the door position has been chosen, panels are used to close the remainder of the stern entrance to the vehicle deck. Moving the door position while the vessel is being operated is not possible and the position chosen has to be compatible with the shore facilities at each port of call. Alternatively, two stern doors can be fitted to a 74m wave piercing catamaran.

PASSENGER ACCESS FACILITIES

The details that are required from naval architects are the size of the access, the coaming level above the water line and passenger door threshold details. Combined with the tidal levels and the vessel freeboard, the maximum and minimum level to be accessed is determined. The level of the passenger facilities onshore combined with a maximum acceptable gradient of 1:6 will determine the required length of the approach ramp. Passenger door details which determine that a dedicated facility needs to be provided should be avoided if possible.

SERVICES

The position of services required for a moored vessel should be provided by the vessel designers, together with the capacities of tanks etc. When a vessel takes on fresh water, for example, an existing water main may exist at a convenient position but it may not provide sufficient quantity in the time required to fill the storage tanks. When vessels are expected to turn round in less than 30 minutes, this may become a significant problem.

STABILITY OF QUAY WALL AND BERTHS

The trend in conventional ro-ro ferries has been to make them larger with an increased draught requirement. Older ports have been deepening their existing berths to cater for the larger vessels. Powerful bow thrusters fitted to ro-ro ferries have at some locations undermined the foundations of quay walls and
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jetties. The propulsion water jets fitted to many fast ferries are equally capable of scouring existing berths and undermining quay structures. Designers of fast ferries should make known the potential scour problem that their propulsion system may present. This would enable suitable scour protection to be designed for existing berths being converted to serve fast ferries.

CONCLUSIONS

The number of vehicle carrying fast ferries operating in UK waters will inevitably increase. The appeal of these vessels is the speed of operation and they are attracting new business and not merely taking trade from existing ferry operations. In order to take advantage of the speed of the new fast ferries, port facilities must be tailored to allow a fast turn round. The fendering provided must be designed to prevent damage to either the vessel or the berth structures. In order to tailor new or existing port facilities for this new class of vessel, information should be provided by the naval architects and operators of fast ferries. Without information from ferry operators, the designers of port facilities can only use their own experience and the statements given in design codes.

With some notable examples of long slender mono hulled fast ferries the trend would appear to be towards the use of multi hulled vessels for a vehicle carrying fast ferry operation. Many details of proposed vessels are required from naval architects for port engineers to satisfactorily consider and design port facilities. However, there would appear to be room for further academic research in the areas of berthing and mooring of multi hulled vessels. As with conventional ro-ro ferries, plans for larger and heavier multi hulled fast ferries are being considered. If the trend towards bigger and heavier vessels is established, the need to accurately determine berthing and mooring forces to ensure the safe operation of these vessels will become more critical.
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THE PORT OF PIRAEUS AND ITS SHORTSEA SHIPPING POTENTIAL FOR THE PROMOTION OF EUROPEAN COHESION

By A. Pardali-Lainou and E. Tzannatos

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THE PORT OF PIRAEUS AND ITS SHORTSEA SHIPPING POTENTIAL FOR THE PROMOTION OF EUROPEAN COHESION

ABSTRACT

In this paper the authors investigate the overall potential of Greece and Piraeus in the development of shortsea shipping operations for the promotion of European Cohesion. In this respect, the significance of shortsea operation is of paramount importance, since the legislative and physical barriers in the south-east Mediterranean region as well as techno-economic and environmental criteria do not allow the expression of optimism for the development of the other modes of transport.

According to this investigation it was revealed that the contribution of Greece in promoting European cohesion may be generally realised with the establishment of a network of international shortsea operations based on the containerised cargo shipments between Greece and Europe (EU, Black Sea and other Balkan countries). In these operations, the port of Piraeus will operate as a national port, as well as a "pendulum" port and will provide relief from truck borne goods to the western Greek ports, thus enabling them to develop passenger specialisation. The latter will inevitably lead to optimisation of the passenger movement between Europe and Greece via the Adriatic Sea and therefore it will enhance the passenger facet of shortsea-based European cohesion. Additionally, the establishment of the above mentioned shortsea operations will provide the prospect of promoting the European export and import trade with countries accessible via the Suez canal. In this case, the port of Piraeus will become the "southeasten gate" of Europe for the transhipment of containerised cargoes in and out of Europe through feederding operations.

In this network of international shortsea operations, the optimisation of intra-European passenger and cargo movement through the Adriatic Sea was considered a priority, because it was found to produce the most tangible and immediate benefits with minimum employment of resources and risk. In this respect, the Piraeus - Ravenna sea-route was found to be most suitable for the containerised transport of goods between Italy and Greece. Finally, an assessment of this shortsea operation enabled the authors to make suggestions for improving its efficiency and hence improving its effectiveness in the promotion of European cohesion.
1 INTRODUCTION

Cohesion: "It ain't what you do, but the way that you do it"

European cohesion is all about removing the legislative and physical barriers which hinder the international movement of passengers and goods within the continent. To this extent, it is primarily necessary to ensure that the application of the cohesion is carried out in a strategic manner which is capable of promoting a homogeneous cohesion throughout Europe, i.e. a strategy which does not produce geographical polarizations and preferential levels of social and economic development in some areas of Europe. This strategy should also be in line with other European policies, such as those provided by the Cohesion Fund, etc., which generally aim to smoothen these divisions in Europe and especially that of the north-south economic divide.

Following this argument, the next step is to accept that in the framework of the existing legislative and physical barriers, as well as that of other transport mode selection criteria such as techno-economic, environmental, etc., the critical issue is to identify the most appropriate means of achieving this transport related cohesion within Europe. In this respect, the general experience gained so far may be summed up as follows:

a. There is a need for further promotion of the flexible, speedy and generally cost-effective transport of passengers and goods;

b. There is a limited potential for further expansion of road, rail and air networks due to the small surface area of the continent;

c. There is a need for the application of ecological practices aiming to reduce the transport related environmental pollution.

In many cases, this status has established a new trend that presents waterborne transportation and especially shortsea shipping as a better alternative to pure inland transport, [1]. This trend is also verified by the tonnage analysis shown in Figure 1, where the most commonly employed small-sized ships occupy a significant portion of the total number of ships worldwide. At the same time, the unitization of cargoes has made cargo handling and transport methods very efficient. This is reflected in the 90% growth of the worldwide container fleet (in TEU), between the end-1982 and mid-1992 [2], whereas the regional container traffic around the world is predicted to increase significantly, as shown in Figure 2. The unitized form of cargo is today compatible with the most modern transport operations and therefore its application to shortsea is no exception. Small (<500 TEU) container ships cover 22.6% of the world capacity and represent 60.4% of the total container fleet, as shown in Figure 3.
Figure 1: Size distribution of the World Merchant Fleet (1970-1989), *(Source: [10])*
The Port of Piraeus and its Shortsea Shipping Potential

Figure 2: The regional growth of container traffic, 1980-1997 (million TEU Handled), (Source: [8])

Figure 3: World containership fleet distribution (by TEU capacity and number of ships), (Source: [8])
On the basis of these general comments, it is important to primarily investigate the probable involvement of Greece in the promotion of European cohesion through the utilisation of shortsea operations and the role the port of Piraeus will have to play in the achievement of this cohesion, (Section 2.1). The selection of the most cohesion-effective shortsea operation is then made, as this is specified by minimum demand of resources, as far as port and fleet infrastructure requirements are concerned for a given demand (Section 2.2). Suggestions were made for the improvement of the proposed shortsea operation, (Section 2.3). Finally, Section 3 presents the conclusions drawn on this work.

2 SHORTSEA SYSTEM

2.1 THE ROLE OF GREECE AND PIRAEUS

Greece is in the crossroad of the transport routes between Europe and the countries of Africa and Asia. In this context, Europe is taken to extend beyond the boundaries of the European Union and it includes the non-union countries of the Balkan and Central European region as well as those of the Black Sea. It is well known that the East-West cargo flow and vice-versa which pass through the Mediterranean Sea has an increasing trend and is the most dynamic expression of international trade, as shown in Table I.

<table>
<thead>
<tr>
<th>Year</th>
<th>MEDITERRANEAN</th>
<th>WORLD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TEU (x103)</td>
<td>compari-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>son index</td>
</tr>
<tr>
<td>1970</td>
<td>212.8</td>
<td>100</td>
</tr>
<tr>
<td>1975</td>
<td>862.8</td>
<td>405</td>
</tr>
<tr>
<td>1980</td>
<td>2,879.3</td>
<td>1,353</td>
</tr>
<tr>
<td>1985</td>
<td>4,377.4</td>
<td>2,057</td>
</tr>
<tr>
<td>1986</td>
<td>4,457.7</td>
<td>2,095</td>
</tr>
<tr>
<td>1987</td>
<td>4,627.2</td>
<td>2,174</td>
</tr>
<tr>
<td>1988</td>
<td>4,801.7</td>
<td>2,256</td>
</tr>
<tr>
<td>1990</td>
<td>5,447.0</td>
<td>2,560</td>
</tr>
<tr>
<td>2000</td>
<td>9,748.0</td>
<td>4,581</td>
</tr>
</tbody>
</table>

Table I: Current and projected container traffic in Mediterranean and the World 1970-2000, (Source: [9])

For Greece, the legislative barriers to European cohesion are mainly associated with the absence of European Union borders. The existing background of
The Port of Piraeus and its Shortsea Shipping Potential

general political unrest and dispute in the Balkan region is very likely to maintain this condition for sometime and Greece will remain at least for the foreseeable future the south "island-state" of the European Union. Although the legislative barriers appear to be time-dependent due to the dynamics of the political developments in the region, this "island-state" identity if Greece is furtherly strengthened by the more inherent physical barriers. The poor condition and limited potential for improvement of the existing inland transport infrastructure within this south-eastern region of Europe is widely acknowledged and is mainly due to the difficulties associated with the mountainous geomorphology of the region. Road and rail networks compare poorly with the equivalent inland transport networks in the rest of Europe, as shown in Figure 4 and 5.

Figure 4: Road traffic in main international transport networks, (Source: [12])
In this region of Europe, the cost of extended landscape alterations in order to make inland transport competitive to other forms such as sea and air is often prohibitive. Additionally, it is important to consider the social cost of inland transport development associated with the exhaust and noise pollution, as well as with the inland transport related accidents, parameters for which Greece has a very bad record compared with the rest of Europe.

A reflection of the above described picture is presented in the recent significant changes incurred in the transport of passengers, cars and truck freight between Italy and Greece via the Adriatic sea-route, as shown in Table II. This operation represents a typical example of shortsea-based international movement of passengers and goods within Europe and it would appear to be a good example of European cohesion practice, if not introduced mainly due to the deterioration of transport through Yugoslavia. Therefore, closer investigations [3] suggest
The Port of Piraeus and its Shortsea Shipping Potential

<table>
<thead>
<tr>
<th>Year</th>
<th>Passengers</th>
<th>Private cars</th>
<th>Trucks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1987</td>
<td>1,304,826</td>
<td>239,501</td>
<td>55,692</td>
</tr>
<tr>
<td>1988</td>
<td>1,461,369</td>
<td>264,908</td>
<td>68,975</td>
</tr>
<tr>
<td>1989</td>
<td>1,501,594</td>
<td>289,134</td>
<td>76,338</td>
</tr>
<tr>
<td>1990</td>
<td>1,643,850</td>
<td>313,417</td>
<td>90,573</td>
</tr>
<tr>
<td>1991</td>
<td>1,734,799</td>
<td>366,857</td>
<td>108,286</td>
</tr>
<tr>
<td>1992</td>
<td>2,017,510</td>
<td>422,089</td>
<td>139,848</td>
</tr>
</tbody>
</table>

Table II: Sea-borne traffic Greece, (Source: Sea-borne traffic Greece - Italy 1989-1992)

that this shortsea system is experiencing mainly on the Greek side some integration problems which are counter-productive to this much desired cohesion, they are very difficult to tackle and therefore they may soon lead to more basic transport complications for Greece. The port of Patra, despite having an adequate national road and rail connection with Athens, is overcapacitated especially during the summer season when passenger and car movement is at peak. On the other hand, the port of Igoumenitsa, despite undergoing further development, it suffers from the absence of rail connection and the inadequacy of the road system, i.e. no national road links with other main centres in Greece and no favourable (due to climate or geomorphology) road conditions.

Therefore, the contribution of Greece in promoting European cohesion may be realised with the establishment of a network of international shortsea operations based on the containerised cargo shipments between Greece and Europe (EU, Black Sea and other Balkan countries). In these operations, the port of Piraeus will operate as a national port, as well as a "pendulum" port and will provide relief from truck borne goods to the western Greek ports, thus enabling them to develop passenger specialisation. The latter will inevitably lead to optimisation of the passenger movement between Europe and Greece via the Adriatic Sea and therefore it will enhance the passenger facet of shortsea-based European cohesion.

Additionally, the establishment of the above mentioned shortsea operations will provide the prospect of promoting the European export and import trade with countries accessible via the Suez canal. In this case, the port of Piraeus will become the "southeastern gate" of Europe for the transhipment of containerised cargoes in and out of Europe through feeder operations.

The presentation so far shows the potential of Greece in promoting European cohesion through shortsea operations. It is however necessary to determine the possible sea-routes for effecting the proposed operations, carry their assessment on the basis of relevant requirements and identify the shortsea operations which have the higher potential of success.
2.2 SELECTION OF SHORTSEA SYSTEM

The shortsea operations serving the international movement of containerised cargo within Europe and involving the port of Piraeus may be arranged to operate on the following sea-routes:

- Between the port of Piraeus and northern Italian ports of the Adriatic Sea;
- Between the ports of north Mediterranean countries (Portugal to Italy) and those of European Black Sea countries, using Piraeus as a "pendulum" port.

These operations relate to direct cohesion, since they solely involve European cross-trading of containerised cargoes in the form of Greek import-export trade with Europe and intra-EuroMediterranean trade. Additionally, the already mentioned transhipment of containerised cargoes which serves the European trade with countries of Africa and Asia is proposed to be effected through feeder operations employed on the same sea-routes and employing the port of Piraeus as a hub port. With the inclusion of the passenger shortsea movement between Italy and Greece through the Adriatic Sea, Figure 6 presents the overall layout of possible sea-routes for the proposed shortsea operations.

For any given transport demand, the success of a proposed shortsea operation depends on the infrastructure of:

- The shortsea system ports;
- The shortsea system fleet.

The combination of these elements must provide an overall system infrastructure with the economic, technical and operational characteristics necessary for achieving a sustainable and satisfactory shortsea operation. Therefore, although the previously specified operations describe the full potential of Greece and the port of Piraeus towards the promotion of shortsea-based European cohesion, it is appropriate to acknowledge that the development of these shortsea operations as a whole is a very complex and cumbersome task. There are significant requirements of resources due to the difficult specification of the factors involved, such as different trade demands as well as port and fleet infrastructure variations and all these in the framework of varying legislative and physical barriers.

More specifically, apart from the legislative and physical problems associated with the European trading to and from the Black Sea, the ports of the latter have very poor infrastructure, especially as far as container terminal facilities are concerned. There is a number of shortsea shipping operators which cover directly this trade demand between north Mediterranean countries (Portugal to Italy) and European Black Sea countries mainly with Ro-Ro and Lo-Lo, as well as geared container vessels compatible with the low level of port facilities offered by the Black Sea ports. As far as Greek involvement in this European
Figure 6: Greek potential for shortsea-based European cohesion

- Piraeus <-> Ravenna
- Piraeus <-> West Med
- Piraeus <-> Black Sea
- Piraeus <-> Suez

EUROPEAN COHESION
EUROPEAN IMPORT-EXPORT
cross-trading is concerned, the container terminal of Piraeus is faced on one hand with the problem of infrastructural incompatibility with the Black Sea ports (Constanza in Romania, Varna in Bulgaria and Instabul in Turkey) and on the other hand with the poor level of cross-border inland transport services offered in the region. Therefore, the eastern side of its "pendulum" role in this intra-Euro Mediterranean trade is limited and it may be worth to note that the new container terminal at Thessaloniki is experiencing a similar situation for almost the same reasons. In general, despite a trade demand which follows the trend of ex-Comecon countries to move away from internal cross-trading, plans for the development of shortsea operations in this region have to be dealt with special caution due to the uncertainties involved, [4].

Therefore, a more pragmatic approach will be to turn our attention to the shortsea operations which will produce the most tangible and immediate benefits with minimum employment of resources and risk. The optimisation of passenger and cargo movement through the Adriatic Sea is very relevant to the promotion of European cohesion and the existing port and fleet infrastructure provides a good foundation for developing a satisfactory operation of such a system.

The shortsea operations involving the intra-European trade of containerised cargo between ports of Portugal, Spain, France, west Italy and Piraeus are competing very successfully with the inland transport alternatives along the south Mediterranean coast. To this extent, they cover shortsea-based cohesion, as this is developed between the regional areas of south east and south west Europe. On the other hand, the proposed optimisation of the Adriatic shortsea operations is aiming to improve the cohesion between Greece and central, north/north west Europe.

Finally, it is important to note that the optimisation of the Adriatic short-sea operations improves the shortsea role of Piraeus as a European hub port through feeder operations. After all, improvement of European export trade through the optimisation of shortsea containerised cargo movement between norther Italian ports of the Adriatic Sea and the port of Piraeus is again relevant to European trade competitiveness and hence to European economic growth, convergence and cohesion.

Turning our attention now to the requirements these operations involve it is necessary to present the port and fleet infrastructure available for the optimisation of the proposed shortsea operations, identify infrastructural and other areas of weakness and suggest solutions for further improvement.

2.2.1 Port infrastructure

In this context, it is appropriate to examine parameters relating to level of container traffic, terminal facilities, productivity and cost, which will provide a picture of the position offered by the port of Piraeus in relation to other ports in
The Port of Piraeus and its Shortsea Shipping Potential

the Mediterranean and the eastern region in particular, as well as in relation to the ports involved in the specifically considered shortsea operations in the Adriatic.

Traffic

The container terminals of Piraeus are currently handling around half a million TEU’s and this is the result of a steady traffic increase beyond expectations during the last thirteen years, as shown in Figure 7. The transhipment of containerised cargo occupies 20% of total traffic, whereas the remainder is associated with import and export trade of Greece. The overall traffic includes 59% imports from EU and 36.5% export of Greece to EU. In a container traffic comparison with other Mediterranean ports, Piraeus maintains during the last five years its position in the top five Mediterranean ports and it is the first port within the east-Mediterranean basin, as shown in Table III. For the significance of the investigated shortsea operations in the Adriatic it is important to note that the Italian ports of Ravenna, Trieste and Venice are the busiest ports in this particular sea.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
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<th></th>
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</tr>
</thead>
<tbody>
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<td>1</td>
<td>412,078</td>
<td>397,163</td>
<td>550,000</td>
<td>761,795</td>
<td>780,336</td>
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<td>282,157</td>
<td>413,317</td>
<td>450,146</td>
<td>464,470</td>
<td>610,275</td>
</tr>
<tr>
<td>3</td>
<td>409,542</td>
<td>439,696</td>
<td>447,920</td>
<td>488,917</td>
<td>552,309</td>
</tr>
<tr>
<td>4</td>
<td>332,860</td>
<td>375,000</td>
<td>426,045</td>
<td>463,000</td>
<td>511,465</td>
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<tr>
<td>5</td>
<td>342,736</td>
<td>390,308</td>
<td>387,162</td>
<td>364,445</td>
<td>370,546</td>
</tr>
<tr>
<td>6</td>
<td>320,683</td>
<td>371,521</td>
<td>481,710</td>
<td>446,470</td>
<td>350,331</td>
</tr>
<tr>
<td>7</td>
<td>479,034</td>
<td>416,173</td>
<td>416,371</td>
<td>411,182</td>
<td>333,756</td>
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<td>8</td>
<td>325,119</td>
<td>238,205</td>
<td>310,217</td>
<td>344,353</td>
<td>329,490</td>
</tr>
<tr>
<td>9</td>
<td>94,500</td>
<td>157,636</td>
<td>259,232</td>
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<td>-</td>
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<tr>
<td>10</td>
<td>154,495</td>
<td>156,148</td>
<td>197,732</td>
<td>253,349</td>
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</tr>
<tr>
<td>11</td>
<td>78,060</td>
<td>194,670</td>
<td>251,708</td>
<td>-</td>
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</tr>
<tr>
<td>12</td>
<td>273,096</td>
<td>273,805</td>
<td>228,567</td>
<td>218,296</td>
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</tr>
<tr>
<td>13</td>
<td>91,838</td>
<td>32,633</td>
<td>154,191</td>
<td>163,985</td>
<td>-</td>
</tr>
<tr>
<td>14</td>
<td>148,875</td>
<td>144,682</td>
<td>157,075</td>
<td>-</td>
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</tr>
<tr>
<td>15</td>
<td>131,602</td>
<td>142,380</td>
<td>136,121</td>
<td>139,018</td>
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<tr>
<td>16</td>
<td>67,000</td>
<td>106,842</td>
<td>122,503</td>
<td>143,109</td>
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<td>111,508</td>
<td>145,000</td>
<td>134,278</td>
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<tr>
<td>18</td>
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<td>80,616</td>
<td>77,586</td>
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</tr>
</tbody>
</table>

Table III: 20 top Mediterranean ports (TEU), (Source: Containerisation International Yearbook 1993)
Figure 7: Overall and transhipment container traffic at the port of Piraeus 1980-1989 (x103 TEU), (Source: Port of Piraeus statistics)
The Port of Piraeus and its Shortsea Shipping Potential

Terminal facilities

The development of Piraeus in terms of container terminal facilities has been quite significant during the last five years or so and the facilities offered by the three terminals provide today a very promising picture of the port in comparison with other major ports in the Mediterranean region, as shown in Table IV. For the significance of the investigated shortsea operations in the Adriatic it is important to show a more detailed picture of the terminal facilities of Piraeus and the best equipped Italian ports of the Adriatic, i.e. Ravenna, Trieste and Venice, as in Table V, VI and VII, respectively.

<table>
<thead>
<tr>
<th>Berths depth (m)</th>
<th>Max Area (ha)</th>
<th>Total Porters (no)</th>
<th>Port/ers of Trans-panam (no)</th>
<th>St. car (no)</th>
<th>Other (no)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Genova (3 term)</td>
<td>3170</td>
<td>15.0</td>
<td>129</td>
<td>14</td>
<td>4</td>
</tr>
<tr>
<td>Livorno</td>
<td>3062</td>
<td>12.5</td>
<td>39</td>
<td>3</td>
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</tr>
<tr>
<td>Triest</td>
<td>2100</td>
<td>18.0</td>
<td>40</td>
<td>4</td>
<td>-</td>
</tr>
<tr>
<td>Piraeus</td>
<td>1500</td>
<td>16.0</td>
<td>50</td>
<td>6</td>
<td>-</td>
</tr>
<tr>
<td>Barcelona</td>
<td>1426</td>
<td>14.0</td>
<td>36</td>
<td>6</td>
<td>-</td>
</tr>
<tr>
<td>Algeciras (3 term)</td>
<td>1240</td>
<td>14.0</td>
<td>45</td>
<td>9</td>
<td>-</td>
</tr>
<tr>
<td>La Spezia</td>
<td>1138</td>
<td>14.5</td>
<td>16</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Marscill (2 term)</td>
<td>1100</td>
<td>14.5</td>
<td>65</td>
<td>9</td>
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<tr>
<td>Malta</td>
<td>1036</td>
<td>14.5</td>
<td>22</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>Valencia</td>
<td>1030</td>
<td>14.0</td>
<td>35</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Ravenna</td>
<td>840</td>
<td>8.5</td>
<td>30</td>
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<tr>
<td>Napoli</td>
<td>684</td>
<td>12.0</td>
<td>14</td>
<td>4</td>
<td>-</td>
</tr>
<tr>
<td>Venice</td>
<td>550</td>
<td>11.6</td>
<td>18</td>
<td>4</td>
<td>-</td>
</tr>
<tr>
<td>Alexandria</td>
<td>531</td>
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<td>16.3</td>
<td>2</td>
<td>-</td>
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<tr>
<td>Damietta</td>
<td>1050</td>
<td>14.5</td>
<td>50</td>
<td>4</td>
<td>-</td>
</tr>
</tbody>
</table>

(Source: Containerisation International Yearbook 1993)

Table IV: Mediterranean container terminal facilities 1993

Handling Productivity and Cost

As far as productivity of handling is concerned, the port of Piraeus maintains a high position among the top Mediterranean ports, as shown in Table VIII. In terms of moves per shift and crane is second to Fos together with other ports including Venice. Ravenna is the middle of the scale and Trieste is very low. In terms of container handling costs, the port of Piraeus is producing at very low cost and Ravenna is the cheaper port in the Mediterranean, as shown in Table IX. Venice and Trieste terminals are producing at medium levels of cost. It is
Section VI - Papers Not Discussed at the Conference

1. Main port

* Berths and cranage:
  One container berth, length 400, with two 40t container gantry cranes. Two Lo-Lo berths available.
* Terminal facilities:
  Total area 12ha; reefer points 216 electric; straddle carriers 10 Peiner (30t); yard tractors 14 Sisu.
* Consolidation:
  CFS on terminal - Covered area 3.000m2.
* Computer systems:
  In operation.

2. St George Container Terminal

* Berths and cranage:
  Total quay length 300m, depth 12,5m, providing one container berth, with one 40t Metka container gantry crane, six ro-ro berths and three Lo-Lo berths.

3. Venize:los Container Terminal:

Berths and cranage:
* Total quay length 800m, minimum depth 12m, equipped with three 46t Rokas container gantry cranes.
* Terminal facilities:
  Reefer points 190 electric; straddle carriers 10 Mitsubishi, 10 TCM; fronthandlers 15 various (8t-35t); yard tractors 18 Sisu.
* Consolidation:
  Cover area 1000m2.
* Computer systems:
  Development out to tender.
* Future plans:
  Completion of the terminal will provide one ro-ro, two container and seven Lo-Lo berths on a total quay length of 2,200m, depths ranging from 12m to 16,5m. Equipment will include 20 straddle carriers (12 Valmet and 8 Peiner) and 7 Sisu yard tractors. The covered area will extend over 2 ha.

Table V: Container terminal facilities at Piraeus

important to note that, the transhipment costs of Piraeus are the lowest in the Mediterranean which is a very significant comparative advantage to any other port, as shown in Table X. Therefore, together with its location in the Mediterranean region, it has the capability to develop its "hub" services.
### The Port of Piraeus and its Shortsea Shipping Potential

<table>
<thead>
<tr>
<th>RAFFENA</th>
<th>VENICE</th>
<th>TRIESTE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Berths and craneage:</strong></td>
<td><strong>Total quay length 55 m, depth 12m, with on Ro-Ro berth and equipped with one 35t Costamasnaga and three 42 Reggiane-Paceco container gantry cranes</strong></td>
<td><strong>Berth31: 1.160, d.12,2</strong>&lt;br&gt;<strong>Berth49: 1.188, d.12,3</strong>&lt;br&gt;<strong>Berth50: 1.222, d.15,8</strong>&lt;br&gt;<strong>Berth51: 1.230, d.16,8</strong>&lt;br&gt;<strong>Berth52: 1.250m, d.18m</strong>&lt;br&gt;<strong>Berth53: 1.240m, d.18m</strong>&lt;br&gt;<strong>Berth54: 1.200, d.16,8</strong>&lt;br&gt;<strong>Berth55: 1.202, d.16,5</strong>&lt;br&gt;<strong>Berth56: 1.168, d.14,3</strong>&lt;br&gt;<strong>Berth57: 1.354m, d.14m</strong>&lt;br&gt;<strong>Container handling by 42 Reggiane Paceco gantry cranes.</strong></td>
</tr>
<tr>
<td><strong>Terminal facilities:</strong></td>
<td><strong>Total area 18ha (container stacking 14.5ha); storage 11,000 TEU (three high reefer points 40 electric; yard gantries 3 rubber-tyred Reggiane-Paceco (35t), 3 rubber tyred MGN; front-handlers 1 Belotti B75(40T), 1 Belotti B81(6,5T) 5 Kalmar (12t, 28x2, 35x2); yard tractors 15 CVS; yard chassis 20 Nuova OMT (40ft flatbed)</strong></td>
<td><strong>Total area 40ha; storage 4000 TEU (grounded); reefer points 224 electric; yard gantries 2 rail-mounted Magirus Galileo IHI(35t); mobile cranes 3 Ormig 1750TG (150t), 3 Ormig 40TTV (40T), 1 Demag 2000 (72t), 1 Gotwald(52t) straddle carriers 23 Peiner TS(35T); front-handlers 3 Hyster 6t, 4 Kalmar 16t, 1 Kalmar 27t; yard tractors 9 Mafi NS8145/SR25-200,5 Daf TT13 Q2DF, 15 Magirus Deutz 232D6FS, 8 ATA 85 OOSH; yard chassis 20 Calabresse 19T-15/P 6 (20t flatbed), 15 Bertoja TC40 (40ft flatbed), 8 Mancini, 190 Mafi (20ft flatbed x 150, 40 ft flatbed x 40)</strong></td>
</tr>
<tr>
<td><strong>Consolidation:</strong></td>
<td><strong>CFS adjacent to terminal covered area 1,5ha; forklifts 5 Caterpillar V50C 2.5t 5 Fenwick ELV105X 1t</strong></td>
<td><strong>CFS on terminal. covered area 3.3ha; Storage 170 TEU</strong></td>
</tr>
</tbody>
</table>

*Table VI: Container terminal facilities (1)*
### Section VI - Papers Not Discussed at the Conference

<table>
<thead>
<tr>
<th>RAVENNA</th>
<th>VENICE</th>
<th>TRIESTE</th>
</tr>
</thead>
</table>
| **Computer systems:**  
Hardware Olivetti CPS32  
software Olivetti; functions full operative managment system | Hardware IBM syst.38/300  
IBM syst.36; software in house; functions terminal logistics, gate control, infor-mation exchange with port users | Hardware IBM 4381/KJ 2;  
software in-house container storage, operational sequences, administration, ship planning and com-munication system |
| **Rail facilities:**  
Five tracks serve dy rail mounted yard gantry | Direct access to national rail network. Terminal equipped with two 35 t Costamas-naga rail-mounted road/rail transfer gantries spanning four 400m tracks | 5 tracks totalling 5000m |
| **Hours of working:**  
Receiving/delivery  
063-1930; vessels 24 hours a day (in four shifts) | Mon to Fri 8-12, 13-17, 17-2330, 2330-0530; Sat. 8-1430,1430-2100; Son 800-1430, 1430-2100, by arrangement. | 700-1400, 1400-2100  
2100-0400. |
| **Future plans:**  
Completion of the terminal with the addition of one container gantry crane | | Two ro-ro berths are built at the new 6,5 ha Riva Traiana terminal, with depth 12m alongside. Additional container handling equip-ment to be purchased in-cludes three container gantry cranes and six tail mountain yard gantries |

(Source: Containerisation international year book 1993)

**Table VII:** Container terminal facilities (2)
### The Port of Piraeus and its Shortsea Shipping Potential

<table>
<thead>
<tr>
<th>Ports</th>
<th>Moves per hour and crane</th>
<th>Moves per shift and crane</th>
<th>Average shift time (hours)</th>
<th>Number of shifts per 24 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marseille Fos</td>
<td>25</td>
<td>150</td>
<td>7.0</td>
<td>3</td>
</tr>
<tr>
<td>Barcelona</td>
<td>24</td>
<td>140</td>
<td>6.0</td>
<td>4</td>
</tr>
<tr>
<td>Valencia</td>
<td>24</td>
<td>140</td>
<td>6.0</td>
<td>4</td>
</tr>
<tr>
<td>La Spezia</td>
<td>22</td>
<td>130</td>
<td>6.0</td>
<td>4</td>
</tr>
<tr>
<td>Palermo</td>
<td>20</td>
<td>140</td>
<td>7.0</td>
<td>2</td>
</tr>
<tr>
<td>Piraeus</td>
<td>20</td>
<td>140</td>
<td>7.2</td>
<td>3</td>
</tr>
<tr>
<td>Ravena</td>
<td>20</td>
<td>120</td>
<td>6.5</td>
<td>4</td>
</tr>
<tr>
<td>Venice</td>
<td>20</td>
<td>140</td>
<td>7.0</td>
<td>3</td>
</tr>
<tr>
<td>Algeciras</td>
<td>18</td>
<td>140</td>
<td>8.0</td>
<td>3</td>
</tr>
<tr>
<td>Limassol</td>
<td>18</td>
<td>120</td>
<td>7.7</td>
<td>2</td>
</tr>
<tr>
<td>Livorno</td>
<td>16</td>
<td>90</td>
<td>6.0</td>
<td>4</td>
</tr>
<tr>
<td>Trieste</td>
<td>16</td>
<td>90</td>
<td>7.0</td>
<td>3</td>
</tr>
<tr>
<td>Genoa</td>
<td>15</td>
<td>100</td>
<td>6.0</td>
<td>4</td>
</tr>
<tr>
<td>Salerno</td>
<td>15</td>
<td>80</td>
<td>6.5</td>
<td>3</td>
</tr>
<tr>
<td>Napoli</td>
<td>14</td>
<td>90</td>
<td>6.5</td>
<td>4</td>
</tr>
<tr>
<td>Malta</td>
<td>14</td>
<td>110</td>
<td>8.0</td>
<td>3</td>
</tr>
</tbody>
</table>

(Source: Port Development International, December 1991)

**Table VIII:** Mediterranean container handling productivity 1991 (average actual handling rates)

<table>
<thead>
<tr>
<th>Ports</th>
<th>Full</th>
<th>Empty</th>
<th>Mix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ravenna</td>
<td>159</td>
<td>119</td>
<td>151</td>
</tr>
<tr>
<td>Salerno</td>
<td>161</td>
<td>128</td>
<td>154</td>
</tr>
<tr>
<td>Naples</td>
<td>167</td>
<td>133</td>
<td>160</td>
</tr>
<tr>
<td>Piraeus</td>
<td>171</td>
<td>115</td>
<td>160</td>
</tr>
<tr>
<td>Valencia</td>
<td>167</td>
<td>143</td>
<td>162</td>
</tr>
<tr>
<td>Algeciras</td>
<td>178</td>
<td>139</td>
<td>170</td>
</tr>
<tr>
<td>Livorno</td>
<td>193</td>
<td>102</td>
<td>175</td>
</tr>
<tr>
<td>Venice</td>
<td>192</td>
<td>158</td>
<td>186</td>
</tr>
<tr>
<td>Trieste</td>
<td>203</td>
<td>156</td>
<td>193</td>
</tr>
<tr>
<td>Barcelona</td>
<td>188</td>
<td>158</td>
<td>182</td>
</tr>
<tr>
<td>marseille</td>
<td>199</td>
<td>193</td>
<td>198</td>
</tr>
<tr>
<td>La Spezia</td>
<td>205</td>
<td>175</td>
<td>199</td>
</tr>
<tr>
<td>Genova</td>
<td>217</td>
<td>135</td>
<td>200</td>
</tr>
</tbody>
</table>

(Source: Port Development International, December 1991)

**Table IX:** Mediterranean container handling costs comparison 1991 (in USD) import/export cargo

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Table X: Mediterranean container handling costs and productivity comparison (transhipment cargo)

<table>
<thead>
<tr>
<th>Ports</th>
<th>Handling cost (USD/box)</th>
<th>Output (boxes/shift)</th>
<th>Shifts/24 hours</th>
<th>Output (boxes/24 hours)</th>
<th>Ship’s cost (USD/box)</th>
<th>Total cost (USD/box)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antwerp</td>
<td>93</td>
<td>210</td>
<td>3</td>
<td>630</td>
<td>32</td>
<td>124</td>
</tr>
<tr>
<td>Piraeus</td>
<td>99</td>
<td>140</td>
<td>3</td>
<td>420</td>
<td>48</td>
<td>147</td>
</tr>
<tr>
<td>Rotterdam</td>
<td>145</td>
<td>190</td>
<td>3</td>
<td>570</td>
<td>35</td>
<td>180</td>
</tr>
<tr>
<td>Thamesport</td>
<td>154</td>
<td>165</td>
<td>3</td>
<td>495</td>
<td>40</td>
<td>194</td>
</tr>
<tr>
<td>Palermo</td>
<td>124</td>
<td>140</td>
<td>2</td>
<td>280</td>
<td>71</td>
<td>195</td>
</tr>
<tr>
<td>Malta</td>
<td>138</td>
<td>110</td>
<td>3</td>
<td>330</td>
<td>61</td>
<td>189</td>
</tr>
<tr>
<td>Felixtowe</td>
<td>168</td>
<td>140</td>
<td>3</td>
<td>420</td>
<td>48</td>
<td>216</td>
</tr>
<tr>
<td>Valencia</td>
<td>181</td>
<td>140</td>
<td>4</td>
<td>560</td>
<td>36</td>
<td>217</td>
</tr>
<tr>
<td>Le Havre</td>
<td>185</td>
<td>150</td>
<td>4</td>
<td>600</td>
<td>33</td>
<td>218</td>
</tr>
<tr>
<td>Barcelona</td>
<td>226</td>
<td>140</td>
<td>4</td>
<td>560</td>
<td>36</td>
<td>262</td>
</tr>
<tr>
<td>Algeciras</td>
<td>222</td>
<td>140</td>
<td>3</td>
<td>420</td>
<td>48</td>
<td>269</td>
</tr>
<tr>
<td>Cyprus</td>
<td>195</td>
<td>120</td>
<td>2</td>
<td>240</td>
<td>83</td>
<td>278</td>
</tr>
<tr>
<td>Marseille</td>
<td>261</td>
<td>150</td>
<td>3</td>
<td>450</td>
<td>44</td>
<td>3-5</td>
</tr>
</tbody>
</table>

(Source: Port Development International, December 1991)

2.2.2 Shortsea system fleet

The fleet must be operationally and technically compatible with the proposed system constraints, as these are expressed by the sea-routes, the existing port infrastructure and the techno-economic and other comparisons with alternative means of transport.

The proposed sea-route between the port of Piraeus and the north Italian ports of the Adriatic may be covered by container ships either via the Corinth Canal or around the Peloponese. In order to keep both options open for selection according to the combined influence of parameters such as type of cargo (dangerous or not), value of time, frequency and ship capacity as in any particular case, it appears appropriate to specify for these ships a "Corinthmax" specification of a moulded beam of 18.5m and a fully laden draught of 6.7m. [5]. This specification is consistent also with the berthing depth at the port of Piraeus and the Italian ports of the Adriatic. Although Ravenna appears to be the most restrictive to access, it has able depth allowance for the ships under consideration. Therefore, on average the container ships should be up to about 6000 dwt with an upper carrying capacity of 400 TEU. A ship suitable for this operation may be of pure or Lo-Lo container form and may have the following specification:

* Deadweight = 5463
* Beam = 16.79 m
The Port of Piraeus and its Shortsea Shipping Potential

* Service speed = 14.5 kn
* Net tonnage = 2029
* Draught = 5.48 m
* Horse power = 4800 bhp

This ship was selected among a dozen of similar ships owned by a local container operator who specialises in similar shortsea operations in the Mediterranean and is attracting a volume of around 50000 TEU per year.

In order to provide a cost comparison between the different modes of "door-to-door" cargo transport through the Adriatic, the following examples are presented:

* Truck freight: Milan to Athens via the ports of Ancona and Patra;
  Total cost = 2100 USD for 12.2m truck or 72 m³;
* Shortsea: Milan to Athens via the ports of Ravenna and Piraeus;
  Total cost = 1800 USD for 40 ft container or 66 m³.

In the above example if we take into account the maximum permissible weight in each operation, the "door-to-door" cost per tonne is lower in the case of shortsea containerisation, as it is shown below:

* Truck freight cost = 87 USD/ton (max. weight 24 tons);
* Shortsea container cost = 57 USD/ton (max. weight 32 tons).

New building demand for supporting this venture is low, since there is able fleet availability at Greek, other European and other international level to cover the expected containerised cargo traffic on this sea-route. In general however, even the big foreign carrier carriers operating in the eastern Mediterranean arena, such as Sea Land, Nedlloyd, P&O, Mertzario Maritima and Compagnie Maritime d’Affretement, understand that local container operators offer local commercial and operational expertise and therefore a better service, [6].

On the basis of the reference made to the port and fleet infrastructure, the Piraeus - Ravenna sea-route appears to be best suited to the requirements of the shortsea operation. In terms of container traffic the two ports of the shortsea system are the most compatible and the differences in terminal facilities are overrided by the very attractive cost of container handling in both cases. As a matter of fact, the depth restriction at Ravenna appears to enable the port to develop specialization of shortsea operations and this is reflected to a certain extent in the production of services at the lowest observed cost in the Mediterranean. Also, it is important to note that the port of Ravenna is adjacent to the road and rail links between south and central/north Europe.

The significance of this port will also be enhanced by the fast-speed rail and road intermodal networks planned adjacent to the port, as shown in Figure 5 and 6. These intermodal networks of:
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a. Bremen to North Italy via Austria;
b. United Kingdom to Italy via Benelux (have already been financed by the European Community and construction is under way).

Finally, in order to provide an overall picture of the shortsea operation, it may be appropriate to consider a rough comparison between expected traffic demand and port/fleet infrastructure. A very optimistic scenario for this shortsea operation will be the complete transfer of truck freight along the Italy - Patra and Igoumenitsa sea-routes to container freight along the Ravenna - Piraeus sea-route. With reference to the statistics of Table IV and assuming a freight volume of 72m³ per truck and 66m³ per 40ft container, the expected container traffic of the shortsea operation will be about 300000 TEU per year. Therefore, even on the basis of this extremity, the port infrastructure of Piraeus and Ravenna is capable of supporting this level of demand. On the other hand, this transport demand represents 750 shipments per year by full capacity ships of 400 TEU and provides an indication of the low demand upon fleet availability.

2.3 OVERALL ASSESSMENT AND SUGGESTIONS

Mediterranean port infrastructure as far as traffic figures are concerned may be looked at in different ways and when considered on their own they usually provide a very partial picture. The same is true for the terminal facilities. Mediterranean ports have been put generally in an unfavourable light in terms of costs and productivity levels, when compared with the ports of northern Europe. Although the port of Ravenna has a good record in this respect, the port of Piraeus is a typical example of such performance, since traffic and terminal facilities are out of balance with the cost and productivity levels of the port. However, even in this respect, it has a very good position among other EuroMediterranean ports and it is the best in the east Mediterranean region. In a port which combines different and distinct operations the basic problem is that of port organisation and management. For the port operations relevant to container, passenger and conventional cargo, it is necessary to develop areas of specialisation each with its own dedicated manpower and equipment. In this manner the port authority becomes efficient and effective. As far as the container cargo is concerned it is necessary to:

a. To concentrate the container operations into one area (by transfer of all operations to the Ikonio terminal) in order to enable the development of economies of scale;

b. To improve the existing berths and the installations taking into account:
   i. The international trend towards sea-borne cargo unitization in conjunction with larger ships and ports;
   ii. The necessary distinction between the requirements of deepsea and shortsea ships, mainly due to (i). This provides a better matching...
The Port of Piraeus and its Shortsea Shipping Potential

between the port infrastructure and shortsea requirements, thus reducing port costs for shortsea operations. The provision of mobile cranes which are better suited to shortsea operations, since they may be used in all quays and free the gantry cranes for the larger ships.

c. To examine the ability of double "box" lifting operation (2x20ft per platform), in order to reduce the time at port, the indirect port costs and increase crane productivity;

d. To organise the areas and installations, the operation of ship and quay, the filling and emptying of "boxes", the storage and distribution and the customs control, in order to reduce time and cost;

e. To reduce the time consuming procedures (bureaucracy) and with the application of new systems (EDI and EDP) to become more efficient and effective. Initially, through P.-MIS port system, it may be possible to achieve:

- Transfer of information at a reduced paperwork;
- Transfer of information in real time;
- Automatic error detection and correction;
- Cost effective management of "boxes" (reduced manpower and equipment demand for steady and increasing number of cargo units);
- Planning of ship’s arrival;
- Information regarding ships characteristics;
- Real time optical coverage of quay;
- Planning of preventive and corrective maintenance.

f. Introduction of VTS;

g. Provide manpower specialisation in the operation of new systems and container handling operators must be able to operate all relevant equipment in order to achieve manpower rotation in three shifts;

h. Establish around-the-clock working schedules.

The proposed optimisation of the Ravenna-Piraeus sea-route will be furtherly enhanced by overcoming the nautical-technical and economic implications provided by the presence of the Corinth Canal. Taking into account the current status and expected development in shipping technology, it is recommended that the Canal tariffs should be reviewed with the purpose of attracting more use of the Canal. For example, it is considered unacceptably high to place a 35% extra charge for the passage of ships which are currently consistent with the most efficient modes of maritime transport, such as Ro-Ro and container
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ships. Similarly, the extra charges of 25% for night and 30% for Sunday and Bank Holiday passage may be considered as being on the high side. In a world which rapidly recognizes the overall benefits of shortsea shipping operations, it is important to offer every encouragement in the direction of promoting the shipbuilding growth of small-sized ships consistent with this type of operation.

The suggestions for improving the port infrastructure at the container terminal of Piraeus are compatible with the conventional port and ship technology. It may be important to note that new trends in shortsea shipping technology call for a system where the principal transport work is done by the ship and involves the provision of a mechanized automatic handling system between the quay and ship. These innovative technologies are generally aiming towards the significant reduction or even elimination of the traditionally manpower consuming cargo handling operations. Some typical examples of such systems are currently investigated and proposed and among them the SEA LIFT project presents an interesting system for very efficient container coastal operations, [7].

3 CONCLUSIONS

On the basis of this analysis, a number of conclusions can be made as follows:

1. All of the proposed shortsea operations which describe the full potential of Greece in promoting European cohesion may be fully supported by the infrastructure offered of the port of Piraeus. This covers the direct cohesion attributed to intra-European trading. The shortsea operations linking Piraeus with the ports of south-west Europe are satisfactory and competition by other modes of transport is negligible. The short-sea operations involving the European Black Sea countries appears to be problematic mainly due to legislative barriers associated with their non-Union status, the undeveloped and unpredictable trade demands. The lack of terminal infrastructure, i.e. poor terminal facilities, low productivity and high costs cannot operate in the direction of promoting cohesion.

2. The only common borders of Greece with EU is the Adriatic Sea and it is reasonable to invest in the drafting of transport-lanes through the common borders, i.e. on the sea-routes. The currently offered combined transport of passengers and goods in the Adriatic, despite promoting European cohesion, has several techno-economic and environmental drawbacks. These are mostly associated with the intensification of cargo traffic especially after the crisis in the Balkans and these are also reflected in the operational difficulties of the ports of Patra and Igoumenitsa, as well as the problems of their connection with the hinterland. Therefore, in order to make these operations more efficient and cohesion-effective, a good proposal appears to be the distinction of the existing cargo and passenger operations.
3. The establishment of a shortsea operation involving the containerised cargo transport between Piraeus and Ravenna, promotes European cohesion effectively, efficiently and with significant alleviation of the negative side-effects. This is achieved by the specialisation of shortsea passenger operation in the ports Patra and Igoumenitsa and the corresponding ports in east coast Italy.

4. The port of Piraeus is capable of responding to this role because it has the ability to adequately cover this service because of the specialisation it has developed in this type of cargo.

5. The port of Ravenna is of an equivalent infrastructure to that of Piraeus and its location assists the speedy and flexible distribution of this type of cargo through the networks of fast-speed trains and roads.

6. Although this operation is functional with the existing infrastructure, it is possible to achieve significant improvements with the introduction of new methods, systems and practices.

7. Most improvements require the solution of organisational and management problems. Most the financial requirements for implementation of these and other solutions are covered by EU funds.

ACKNOWLEDGMENTS

The authors would like to thank Mr. M. Sarlis and Capt. D. Angelopulos, of Sarlis Container Services S.A. for offering valuable information to this work, from their commercial and operating experience in this field.
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TRENDS IN COASTAL SHIPPING IN GREECE AFFECTING THE SHIP-PORT INTERFACE AND THEIR INFLUENCE ON PORT DEVELOPMENT

By E. Basdanis, S. Papadimitriou, S. Theofanis

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1The opinions and findings expressed or implied in this article are those of the authors
TRENDS IN COASTAL SHIPPING IN GREECE AFFECTING THE SHIP-PORT INTERFACE AND THEIR INFLUENCE ON PORT DEVELOPMENT

1 INTRODUCTION

Coastal Shipping plays a vital role in the transport sector in Greece, since it provides the essential means of transport connecting mainland Greece with the extended island complex.

On the other hand, an important element of the Greek Coastal Shipping System is port infrastructure. It is widely recognised that encouragement of all forms of shortsea shipping cannot be only a matter of involvement in sea operating conditions [4]. Infrastructural aspects need further insight and in that context ports possess a prominent position as nodes in an integrated shortsea shipping chain [5].

Moreover, in the case of provision of ferry services, which is a predominant characteristic of the Greek Coastal Shipping System, the planning of the port facilities is essential to be integrated in the planning of the overall transport system [13,15].

In view of the facts mentioned above, effort is placed in this paper to examine the effect of the trends in Coastal Shipping in Greece on the ship-port interface and the resulting influence on port development.

Taking advantage of the data provided in two databases concerning coastal shipping fleet and port infrastructure in Greece [1,2], respectively, an assessment of the existing situation both for fleet and ports is performed. Trends in fleet technology development affecting port infrastructure are analysed and presented. Subsequently the effects of the current and anticipated advances on the port environment are determined and assessed.

Finally, conclusions are drawn and policy recommendations are presented regarding port development needs arising from the occurring and expected changes in the Greek Coastal Shipping System and particularly those concerning the coastal shipping fleet.

Since there is little information internationally available regarding the role and the function of ports in ferry services, the paper aims not only at giving specific
information about ports serving coastal shipping in Greece, but also at providing an approach in assessing the impact of ferry fleet development on associated ferry ports.

2 EXISTING SITUATION

2.1 GREEK COASTAL SHIPPING FLEET

Excluding traditional "feeder ships" (carrying bulk and general cargo) and "passenger - only ships" (whose presence is steadily declining and their number is insignificant), coastal shipping fleet in Greece is composed of: [7,9,12]

* Passenger/car ferries;
* Passenger/car ferries/open deck;
* High speed vessels (Hydrofoils, Catamaran, SES);
* Freight Ro-Ro vessels.

Data sets provided by the NIREUS database [1] were examined in order to assess the current state of the coastal shipping fleet.

Although this database is at the stage of development and therefore all information required for a thorough assessment of the fleet is not available, nevertheless it can provide valuable data.

For the purpose of the paper two sets of data were considered, i.e. those concerning the state of the fleet in 1988 and 1993 respectively. This choice can be attributed to two reasons, namely that according to professional practice five years represent a reasonable interval for basic reviews in ferry systems [13] and that, as stated elsewhere [9], the ferry mode of operation in Greece has ballooned to explosive proportions in the last five years.

Tables I A and I B and Figures 1 A, 1 B, 1 C present the fleet distribution, for the two sets of data, when considering the number of vessels, the GRT and the passenger carrying capacity. Feeder ships and pure passenger ships were excluded.

Since the adoption of new technology high speed vessels is limited and still evolving and the predominance of the passenger/car ferries unquestionable, selection of data for the later was subsequently decided. A lower tonnage limit of 700 GRT was also chosen. The two sets of data (Tables II-VII) were analysed in terms of GRT (Figure 2), length o.a. (Figure 3), draught (Figure 4), speed (Figure 5), passenger carrying capacity (Figure 6) and truck carrying capacity (Figure 7) distributions.
As far as tonnage is concerned an increase of 24.2% has occurred between 1988 and 1993, while the total GRT increase during the same time period was 55.2%. Additionally, while tonnage between 1,000 and 3,000 GRT continues to predominate, there is a tendency to shift towards tonnage between 5,000 and 9,000 GRT.

Average length o.a. and draught showed increases of 12.2% and 6.4% respectively, considerably lower than that of the average tonnage, since these dimensions do not increase proportionally to GRT.

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Figure 1 A

VESSEL FLEET DISTRIBUTION BY NO. OF VESSELS (1988)

VESSEL FLEET DISTRIBUTION BY NO. OF VESSELS (1993)

Figure 1 A

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VESSEL FLEET DISTRIBUTION BY GRT
(1988)

VESSEL FLEET DISTRIBUTION BY GRT
(1993)

Figure 1 B

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**Figure 1 C**

**VESSEL FLEET DISTRIBUTION BY PASSENGER CARRYING CAPACITY (1988)**

- Passenger Ferry Vessels: 49%
- Catamarans: 0.5%
- Hydrofoils: 2%
- Passenger Ferry Vessels/Open Deck: 48%

**VESSEL FLEET DISTRIBUTION BY PASSENGER CARRYING CAPACITY (1993)**

- Passenger Ferry Vessels: 52%
- Catamarans: 0.5%
- Hydrofoils: 3%
- Passenger Ferry Vessels/Open Deck: 48%
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<table>
<thead>
<tr>
<th>GRT</th>
<th>1988 No. of ships</th>
<th>1988 %</th>
<th>1903 No. of ships</th>
<th>1903 %</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1000</td>
<td>5</td>
<td>7.81</td>
<td>4</td>
<td>5.00</td>
</tr>
<tr>
<td>3000</td>
<td>27</td>
<td>42.19</td>
<td>26</td>
<td>32.50</td>
</tr>
<tr>
<td>5000</td>
<td>12</td>
<td>18.75</td>
<td>14</td>
<td>17.50</td>
</tr>
<tr>
<td>7000</td>
<td>6</td>
<td>9.38</td>
<td>11</td>
<td>13.75</td>
</tr>
<tr>
<td>9000</td>
<td>7</td>
<td>0.94</td>
<td>12</td>
<td>15.00</td>
</tr>
<tr>
<td>11000</td>
<td>2</td>
<td>3.13</td>
<td>4</td>
<td>5.00</td>
</tr>
<tr>
<td>13000</td>
<td>3</td>
<td>4.69</td>
<td>5</td>
<td>6.25</td>
</tr>
<tr>
<td>&gt;13000</td>
<td>2</td>
<td>3.13</td>
<td>4</td>
<td>5.00</td>
</tr>
</tbody>
</table>

Table II

<table>
<thead>
<tr>
<th>No. of ships in sample</th>
<th>1988</th>
<th>1993</th>
</tr>
</thead>
<tbody>
<tr>
<td>AVG. GRT</td>
<td>4445</td>
<td>5520</td>
</tr>
<tr>
<td>SUM GRT</td>
<td>284500</td>
<td>441600</td>
</tr>
</tbody>
</table>

Figure 2: Frequency distribution of GRT

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### Table III

<table>
<thead>
<tr>
<th>Length</th>
<th>1988</th>
<th>%</th>
<th>1903</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;70</td>
<td>7</td>
<td>10.94</td>
<td>6</td>
<td>7.79</td>
</tr>
<tr>
<td>90</td>
<td>14</td>
<td>21.88</td>
<td>12</td>
<td>15.58</td>
</tr>
<tr>
<td>110</td>
<td>14</td>
<td>21.88</td>
<td>15</td>
<td>19.48</td>
</tr>
<tr>
<td>130</td>
<td>13</td>
<td>20.31</td>
<td>19</td>
<td>24.68</td>
</tr>
<tr>
<td>150</td>
<td>11</td>
<td>17.19</td>
<td>17</td>
<td>22.08</td>
</tr>
<tr>
<td>170</td>
<td>5</td>
<td>7.81</td>
<td>6</td>
<td>7.79</td>
</tr>
<tr>
<td>&lt;170</td>
<td>0</td>
<td>0.00</td>
<td>2</td>
<td>2.60</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>No of ships in sample</th>
<th>1988</th>
<th>1903</th>
</tr>
</thead>
<tbody>
<tr>
<td>AVG. Length</td>
<td>64</td>
<td>77</td>
</tr>
</tbody>
</table>

**Figure 3:** Frequency distribution of length o.a.
Section VI - Papers Not Discussed at the Conference

<table>
<thead>
<tr>
<th>Draught</th>
<th>1988</th>
<th>1903</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;2.00</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>2.00-3.00</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>3.00-4.00</td>
<td>15</td>
<td>16</td>
</tr>
<tr>
<td>4.00-5.00</td>
<td>23</td>
<td>25</td>
</tr>
<tr>
<td>5.00-6.00</td>
<td>13</td>
<td>19</td>
</tr>
<tr>
<td>&lt;6.00</td>
<td>5</td>
<td>8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>No of ships in sample</th>
<th>1988</th>
<th>1903</th>
</tr>
</thead>
<tbody>
<tr>
<td>AVG. Draught</td>
<td>3.24</td>
<td>3.46</td>
</tr>
</tbody>
</table>

Table IV

Figure 4: Frequency distribution of draught
### Table V

<table>
<thead>
<tr>
<th>Speed</th>
<th>1988</th>
<th></th>
<th>1903</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. of ships</td>
<td>%</td>
<td>No. of ships</td>
<td>%</td>
</tr>
<tr>
<td>&lt;13.00</td>
<td>2</td>
<td>3.08</td>
<td>2</td>
<td>2.63</td>
</tr>
<tr>
<td>13.00-14.00</td>
<td>6</td>
<td>9.23</td>
<td>5</td>
<td>6.58</td>
</tr>
<tr>
<td>14.00-15.00</td>
<td>14</td>
<td>21.54</td>
<td>14</td>
<td>18.42</td>
</tr>
<tr>
<td>15.00-16.00</td>
<td>6</td>
<td>9.23</td>
<td>6</td>
<td>7.89</td>
</tr>
<tr>
<td>16.00-17.00</td>
<td>8</td>
<td>12.31</td>
<td>6</td>
<td>7.89</td>
</tr>
<tr>
<td>17.00-18.00</td>
<td>11</td>
<td>16.92</td>
<td>12</td>
<td>15.79</td>
</tr>
<tr>
<td>18.00-19.00</td>
<td>5</td>
<td>7.69</td>
<td>11</td>
<td>14.47</td>
</tr>
<tr>
<td>19.00-20.00</td>
<td>10</td>
<td>15.38</td>
<td>13</td>
<td>17.11</td>
</tr>
<tr>
<td>20.00-21.00</td>
<td>1</td>
<td>1.54</td>
<td>4</td>
<td>5.26</td>
</tr>
<tr>
<td>21.00-22.00</td>
<td>2</td>
<td>3.08</td>
<td>3</td>
<td>3.95</td>
</tr>
</tbody>
</table>

| No of ships in sample | 65 | 100.00 | 76 | 100.00 |
| AVG. Speed           | 16.58 |        | 17.12 |        |

Figure 5: Frequency distribution of speed
### Table VI

<table>
<thead>
<tr>
<th>Passenger Carrying cap.</th>
<th>1988</th>
<th>1903</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of ships</td>
<td>%</td>
<td>No. of ships</td>
</tr>
<tr>
<td>400-500</td>
<td>7</td>
<td>10.45</td>
</tr>
<tr>
<td>500-700</td>
<td>11</td>
<td>16.42</td>
</tr>
<tr>
<td>700-900</td>
<td>12</td>
<td>17.91</td>
</tr>
<tr>
<td>900-1100</td>
<td>11</td>
<td>16.44</td>
</tr>
<tr>
<td>1100-1300</td>
<td>8</td>
<td>11.94</td>
</tr>
<tr>
<td>1300-1500</td>
<td>6</td>
<td>8.96</td>
</tr>
<tr>
<td>1500-1700</td>
<td>6</td>
<td>8.96</td>
</tr>
<tr>
<td>1700-1900</td>
<td>4</td>
<td>5.97</td>
</tr>
<tr>
<td>1900-2100</td>
<td>1</td>
<td>1.49</td>
</tr>
<tr>
<td>&gt;2100</td>
<td>1</td>
<td>1.49</td>
</tr>
</tbody>
</table>

| No of ships in sample   | 67   | 100.00 | 80 | 100.00 |
| AVG. Pass.              | 1037 |       | 1201 |       |
| SUM. Pass.              | 69450 |       | 96050 |       |

**Figure 6:** Frequency distribution of passenger carrying capacity
Trends in Coastal Shipping in Greece

<table>
<thead>
<tr>
<th>Truck carrying cap.</th>
<th>1988</th>
<th>1903</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. of ships</td>
<td>%</td>
</tr>
<tr>
<td>&lt;10</td>
<td>4</td>
<td>8.51</td>
</tr>
<tr>
<td>10-30</td>
<td>16</td>
<td>34.04</td>
</tr>
<tr>
<td>30-50</td>
<td>15</td>
<td>31.91</td>
</tr>
<tr>
<td>50-70</td>
<td>9</td>
<td>19.15</td>
</tr>
<tr>
<td>70-90</td>
<td>1</td>
<td>2.13</td>
</tr>
<tr>
<td>90-110</td>
<td>2</td>
<td>4.26</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>No of ships in sample</th>
<th>1988</th>
<th>1903</th>
</tr>
</thead>
<tbody>
<tr>
<td>AVG. Trucks</td>
<td>38</td>
<td>44</td>
</tr>
<tr>
<td>SUM Trucks</td>
<td>1772</td>
<td>2540</td>
</tr>
</tbody>
</table>

Table VII

Figure 7: Frequency distribution of truck carrying capacity
Nevertheless there is a definite tendency towards lengths o.a. between 110 and 150 m and draughts over 5.00 m, while vessels with length greater than 170 m appeared for the first time during the last five years.

Average operating speed increased only by 3.2% during the period under consideration but a shift to values greater than 18 kn is evident.

As far as passenger carrying capacity (P.C.C.) and truck carrying capacity (T.C.C.) are concerned comparisons revealed an increase of average and total values of 15.8% and 27.7% for the P.C.C. and 15.8% and 43.3% for the T.C.C.

Apart from the distributions presented above, for the 1993 set of data graphs of GRT vs. draught, length o.a. and breadth respectively (Figure 8), length o.a. vs. draught (Figure 9) and GRT vs. passenger carrying capacity, passenger cars capacity and trucks capacity respectively (Figures 10) were plotted. These graphs are particularly helpful when determining the "standard vessel" for port planning purposes [13]. It should be stated that passenger car and truck carrying capacities are best expressed in lane meters [13], but this parameter is not available in NIREUS Database.

The graphs reveal a high correlation between the data sets examined, apart from those relating GRT to car and truck carrying capacity of vessels. The later can be attributed to wide differences in conventional positive displacement ferries design.

2.2 GREEK PORTS SERVING FERRY TRAFFIC

Greek ports serving ferry traffic exhibit a series of infrastructural, suprastructural, organisational and managerial deficiencies, the most important of them being [3,6]:

a. Development of quays, mainly, in parallel to the shoreline, with inadequate landside area;
b. Conversion of traditional general cargo piers to ferry berths, with insufficient rehabilitation for this type of traffic;
c. Poor level of wave protection in port basins;
d. Inefficient traffic management in the port area and poor land access to the port;
e. Lack of services for embarking or disembarking port users;
d. Inflexible "operating type" organisation of the port authorities, which responsible for the operation and management of the port.
Trends in Coastal Shipping in Greece

Figure A: GRT Vs. Draught

Figure B: GRT Vs. Length

Figure C: GRT Vs. Breadth

Figure 8
Land areas per berth are very low ranging between less than 0.05 ha to 1.0 ha. These figures, when compared with normal design figures of 4.5 ha up to 9.0 ha per berth, depending on their synergistic effect [13], give a clear indication of the land space inefficiencies in most Greek ferry ports.

Ship - land connection, in all cases, is performed through fixed ramps in the quay, since the low water level variations exercised do not necessitate the use of mechanically or hydraulically operated linkspans or floating ramps.

In order to evaluate the seaside conditions and berthing capacity, in a number of island ferry ports, particularly those with poor characteristics, a set of ports was chosen and up to date data from a relevant database were analysed [2]. The chosen set consists of ports in Cyclades, Dodecanese, Crete and East Aegean Sea.

Although the choice of universal parameters in order to evaluate berthing capacity and seaside conditions is not an easy task, three parameters were chosen for the purpose of the paper, namely maximum berth depth, turning cycle diameter and wave protection level. The first two parameters give a good indication of the maximum "standard vessel", when allowing properly, for the draught and length o.a. respectively. For comparison purposes a 10% increase of the draught for the berth depth and a 2.5 multiplication coefficient of the length o.a. for the turning cycle diameter were considered. These coefficients fall well within the range of values accepted in literature [13]) provided that ferries have lateral thrusters as far as the length o.a. is concerned.
Figure A: GRT Vs. Passenger carrying capacity

Figure B: GRT Vs. Trucks

Figure C: GRT Vs. passenger car units

Figure 10
Wave protection level was determined according to the maximum wave height occurring in the port basin. Based on maximum permissible values for heave and surge, when loading or unloading ferry vessels, three levels of protection were chosen (h = maximum wave height), namely:

* Good (when \( h \leq 0.5 \) m)
* Fair (when \( 0.5 < h \leq 1.0 \) m)
* Bad (when \( h > 1.0 \) m)

These levels may be locally worsened, in case a synergistic wind effect on vessel is occurring.

The maximum berth depth and the cumulative max berth depth distributions are presented in Table VIII and Figures 11, while the turning cycle diameter and the cumulative turning cycle diameter distributions are showed in Table IX and Figures 12 spectively. Protection level distribution is given in Figure 13.

<table>
<thead>
<tr>
<th>Ports max berth depth</th>
<th>No. of ports</th>
<th>%</th>
<th>Cumulative %</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;3.00</td>
<td>1</td>
<td>1.96</td>
<td>1.96</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>9.80</td>
<td>11.76</td>
</tr>
<tr>
<td>5</td>
<td>6</td>
<td>11.76</td>
<td>23.53</td>
</tr>
<tr>
<td>6</td>
<td>9</td>
<td>17.65</td>
<td>41.18</td>
</tr>
<tr>
<td>7</td>
<td>7</td>
<td>13.73</td>
<td>54.90</td>
</tr>
<tr>
<td>8</td>
<td>14</td>
<td>27.45</td>
<td>82.35</td>
</tr>
<tr>
<td>9</td>
<td>1</td>
<td>1.96</td>
<td>84.31</td>
</tr>
<tr>
<td>10</td>
<td>6</td>
<td>11.76</td>
<td>96.08</td>
</tr>
<tr>
<td>&gt;10</td>
<td>2</td>
<td>3.92</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Table VIII

Combining Figures 4 and 11 A it can be noted that approximately 90% of the ferry fleet currently in operation presents draughts lower or equal to 6.0 m, for which a berth depth of 6.6 m up to 7.0 m is required. Approximately 45% of the port sample satisfies this berth depth limitation.

Using the same methodology and relating Figures 3 and 12 B, it is deduced that again approximately 90% of the fleet has length o.a. lower or equal to 150 m,
**Trends in Coastal Shipping in Greece**

<table>
<thead>
<tr>
<th>Ports turning cycle</th>
<th>No. of ports</th>
<th>%</th>
<th>Cumulative %</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;150</td>
<td>4</td>
<td>9.76</td>
<td>9.76</td>
</tr>
<tr>
<td>200</td>
<td>9</td>
<td>21.95</td>
<td>31.71</td>
</tr>
<tr>
<td>250</td>
<td>4</td>
<td>9.76</td>
<td>41.46</td>
</tr>
<tr>
<td>300</td>
<td>5</td>
<td>12.20</td>
<td>53.66</td>
</tr>
<tr>
<td>350</td>
<td>3</td>
<td>7.32</td>
<td>60.98</td>
</tr>
<tr>
<td>400</td>
<td>6</td>
<td>14.63</td>
<td>75.61</td>
</tr>
<tr>
<td>&lt;400</td>
<td>10</td>
<td>24.39</td>
<td>100.00</td>
</tr>
<tr>
<td>No. of ports in sample</td>
<td>51</td>
<td>100.00</td>
<td></td>
</tr>
</tbody>
</table>

Table IX

for which a turning cycle diameter of 375 m is required. Only 30% approximately of the port sample attain this turning cycle diameter figure.

Additionally Table 10 and Figure 13 reveals that 79% of the port sample exhibits fair or bad wave protection level characteristics.

<table>
<thead>
<tr>
<th>Protection level</th>
<th>No. of ports</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bad (h&lt;1.0m)</td>
<td>20</td>
<td>42.55</td>
</tr>
<tr>
<td>Fair (0.5&lt;h&lt;1.0m)</td>
<td>17</td>
<td>36.17</td>
</tr>
<tr>
<td>Good (h&lt;0.5m)</td>
<td>10</td>
<td>21.28</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>47</strong></td>
<td><strong>100.00</strong></td>
</tr>
</tbody>
</table>

Table X: Wave protection level

Figures presented above support the statement that inefficiencies in Greek ferry ports do not concern, mainly, docks and piers [9], but other elements of port infrastructure, among them being external protection works (moles, breakwaters) and port basin areas.
Section VI - Papers Not Discussed at the Conference

Figure A: Frequency distribution of max. berth depth

Figure B: Cumulative distribution of ports max. berth depth

Figure 11
Figure A: Distribution of turning cycle diameter

Figure B: Cumulative distribution of ports turning cycle

Figure 12
Section VI - Papers Not Discussed at the Conference

Figure 13: Port basin wave protection level

In fact port development works undertaken in island or mainland ferry ports from the mid 1980's onwards, mainly through E.C. regional funding, have substantially ameliorated port infrastructure, particularly that associated with quay construction. Nevertheless the inherent inefficiencies of the limited landside spaces and the poor port basin protection were not confronted adequately.

A recent study dealing with the estimation of operational characteristics in Rafina [10], an important mainland hub ferry port, revealed interesting results regarding effective berth occupancy. Remarkably low values of effective berth occupancy ranging between 1% and 10%, even in the peak demand period of the year were measured. These values are by far lower than those accepted as lowest values in literature [13], ranging between 10% and 15%. At the same time excessive residence period for vessels were observed. Although berth occupancy in Greek ferry ports needs further study, this situation can be definitely attributed to the limited time zone in which vessel departures are scheduled and it is an indication of inefficient berthing capacity management. The relatively low operating speed of most vessels and the long distances covered at sea are nevertheless as explanation for that situation.
3 TRENDS IN GREEK COASTAL SHIPPING

3.1 TRENDS IN DEMAND

One of the key parameters in analyzing future developments in the Greek coastal shipping is the anticipated level of change in demand.

Although a detailed approach of trends in demand is beyond the scope of the paper and the subject is covered extensively elsewhere [7] some indicative figures regarding passenger traffic demand are given here in.

Published data of the Statistical Service (Table XI) show an increase of 289% in the number of passengers travelled between 1964 and 1991. This figure accounts for an annual increase of 5.4%, although a closer examination of the data reveals a decrease in the growth rate, as the annual growth rates between 1964 - 1970, 1970 - 1980 and 1980 - 1990 are 8.33%, 4.30% and 3.65% respectively. However demand has increased substantially during the latter part of the 1980’s as the annual increase between 1985 and 1990 is 5.66%.

3.2 TRENDS IN FLEET

Trends in fleet may be examined in terms of type of technology, size of vessels, speed, carrying capacity etc.

Regarding the type of technology it may be observed that, currently, the predominance of the conventional positive displacement passenger/car "combi" ferries is unquestionable. Speculative scenarios according to which specialization leading to adoption of freight Ro-Ro vessels for freight traffic and high speed vessels for passenger traffic are not, for the moment, substantiated.

On the contrary a tendency is reported in other areas e.g. Baltic Sea [13] towards inergration of the pure freight Ro-Ro traffic with ferry traffic.

Introduction of new technology high speed vessels is limited, mainly, to pure passenger carrying hydrofoils. Other types of high speed vessels have either limited presence (SES, Catamaran), or are at the stage of adoption (SWATH).

Notwithstanding this fact, high speed vessels may play an active role in future, provided that their economic viability and adequate seakeeping characteristics will be proved.

As far as size of vessels is concerned and with a view to positive displacement ferries, it is evident that we have entered the era of ferries with tonnage greater
Table XI: Trends in passenger demand

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than 13,000 GRT with length o.a. and draught at the magnitude of 180 m and 8.00 m respectively. Nevertheless the authors believe that the explosive increase in vessel size experienced during the last five years will not continue and sizes will be stabilized around the magnitude stated above. Three reasons, reported in literature [13], support this statement, namely:

a. Vessel capacity utilisation becomes more and more problematic with size increases, as a result of seasonal and daily fluctuations;
b. There are limits to the possibility of maintaining short loading and discharge time when vessel sizes increase, making the overall system inefficient;
c. Infrastructure costs increase disproportionally in relation to increasing vessel sizes.

Vessel operating speed is a decisive parameter for the operation of the ferry systems. Although the average operating speed of conventional ferries in Greece remains relatively low there is a definite tendency for attainment of operating speed in excess of 20 kn, while intention is reported to put in operation conventional ferries with operating speed greater than 25 kn. Increases in speed would inevitably lead to changes in the service scheduling pattern, with a view to attain better fleet exploitation. The latter statement applies also to the introduction of high speed vessels.

Although results regarding passenger and particularly vehicle carrying capacity are not so straightforward, due to the multitude of designs applied in conventional ferries, there is a general magnification tendency. Based on figures presented in literature [13], an equivalent carrying capacity of approximately 3,000 lane meters, equal to 600 passenger car units (P.C.U.) may be a rough average upper value.

4 EFFECTS ON PORTS

Trends in demand and mainly trends in fleet presented above will inevitably have effects in ferry ports, both in infrastructural as well as in organisational aspects.

For systematic approach reasons, effects in ports will be distinguished when dealing with conventional positive displacement ferries and high speed vessels.

Conventional ferries increase in size will obviously result in demand of greater basin turning areas and greater landside areas, particularly marshalling yards for embarking vehicles.
Further integration of pure freight Ro-Ro services with ferry services will complicate landside operations, particularly in relatively large hub ferry ports.

Introduction of informatics and telematics in the form of an integrated Management Information System (M.I.S.) may facilitate much better the management of landside operations.

Increases in operating speed and the resulting change of the service scheduling patterns will alter the current level of berth utilization, towards a rather more rationalized use of port infrastructure, thus alleviating, partially at least, present peak demand inefficiencies.

Increases in operating speed have a distinct effect in port turnaround times, since decreases in seagoing times will result in relative increases of the port lay periods, thus necessitating better port handling of passengers and vehicles.

Provision of better wave protection, taking into account limitations in port basin areas, is a prerequisite for most island ferry ports, in view of the increase in vessel size.

Provision of special port facilities at the land/sea interface, e.g. lateral upper deck passenger gangways, is a matter of integrated tailor made design of both the ferry vessel and the berth. Nevertheless, the need for such a facility has not yet arisen.

As far as the planning of port facilities for accommodating high speed vessels is concerned, the following should be mentioned:

a. Hydrofoils do not require any special berthing provisions, apart from an excellent wave protection of the port basin.

b. Other types of high speed vessels may require a special berthing arrangement, depending on their type and design. For example a vehicle carrying catamarans may require a tailor-made linkspan, in order to ensure prevention of any underside damage while the vehicles are loading or unloading [14]. Similarly a dry dock berthing ramp is required for Air Cushion Vehicles [15], while SWATHS require a special fendering arrangement to protect the pontoons.

So far, there is not any specialised terminal available, able to accommodate high speed vessels, since the associated demand is limited to hydrofoils.
5 CONCLUSIONS AND POLICY RECOMMENDATIONS

5.1 CONCLUSIONS

Based on the analysis presented above, the following conclusions are reached:

a. Greek coastal shipping fleet transformation during the last five years has inevitably influenced associated port facilities;

b. Despite port development works undertaken from the mid 1980's onwards, certain inefficiencies exist, particularly in island ports, associated mainly with port basin areas and lack of adequate external protection works;

c. Insufficient landside port areas and poor land access to them are common problems for all Greek ferry ports, irrelevant of their size;

d. Berthing capacity utilization is rather low, partially due to the existing service scheduling patterns;

e. Insufficient landside operation and traffic management augments landside area shortages;

f. Further integration of ferry services with freight Ro-Ro services, together with increased vessel sizes, will impose more complicated landside management problems;

g. Increases in vessel operating speeds will inevitably affect the existing service scheduling patterns and will contribute to demands in diminishing the port turnaround time;

h. Introduction of high speed vessels in Greek Coastal Shipping is currently rather limited and therefore prediction of needs for associated port facilities is difficult. In most cases port facilities accommodating high speed vessels are tailor-made and hence they have to be integrally planned with these vessels;

i. The existing "operating" type organisation pattern of the port authorities in Greece does not provide a flexible framework of operation and management of ferry ports or individual ferry terminals.

5.2 POLICY RECOMMENDATIONS

The following policy recommendations regarding development and operation of ports serving Greek Coastal Shipping are presented:

a. Port investment policy should be directed towards completion of infrastructure projects in selected ferry ports, rather than scattering economic resources among all ports, an action which results in incomplete port projects. In this context selection of solely one port for development in each island is recommended.
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b. Complete utilization of existing ferry port facilities should be ensured, before a decision for new port investment is taken, provided that service scheduling patterns can comply with a higher level of utilisation and an acceptable level of service is guaranteed.

c. New port investment should be generally directed towards the provision of adequate land access to port areas, sufficient landside areas, ample port basin areas and good external protection works, depending on local conditions.

d. Attention should be paid to operation and traffic management aspects of ferry ports. Relevant studies and development of Management Information System (M.I.S.) may decisively contribute to the overall quality of service in these ports. Development of Vessel Traffic Management Services (V.T.M.S.) may complement these measures in selected hub ferry ports.

e. Adoption of a more flexible "landlord type" organisation of the port authorities may provide the incentive to private operators to run individual ferry terminals in hub ferry ports, with a aim of providing cost-efficient operations at a higher level of service.
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AN ASSESSMENT OF FUTURE MARINE PROPULSION TECHNOLOGY FOR SHORTSEA SHIPPING

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AN ASSESSMENT OF FUTURE MARINE PROPULSION TECHNOLOGY FOR SHORTSEA SHIPPING

ABSTRACT

This paper investigates the future trends in the marine propulsion of shortsea ships intended for the promotion of European cohesion through the international movement of passengers and cargo within Europe. The success of this venture is based on the ability of the shortsea ship to compete successfully with the other intra-European transport modes. The aim is to provide efficient and environmentally friendly ships and in this respect the gas turbine engine appears to be the best available option. The high power/weight and power/size ratio of the gas turbine provides a potential for realizing a higher degree of payload or volume utilization with higher transport speeds and low power requirements. In order to generate equal cargo and/or passenger revenue, a diesel powered ship would need either a larger hull or higher sea speed with subsequent increase in initial and operating costs. The low initial and maintenance costs of the marine gas turbine offset the fuel cost advantage of an equivalent diesel engine. The inherent reliability of the gas turbine engine is enhanced by preventive and corrective maintenance schemes which provide the shortsea ship with maximum operational availability at minimum cost. The marine gas turbine offers a high degree of comfort to crew and/or passengers and its operational characteristics comply with the current and proposed legislation for the protection of the marine environment. Finally, the technologically young gas turbine presents the potential for further performance and efficiency improvements and hence wider acceptance, specially within the highly competitive and environmentally sensitive shortsea shipping sector.

1 INTRODUCTION

It is widely recognized that European cohesion is promoted by enhancing the international movement of passenger and goods within Europe. In a continent which is considered in many respects as the most developed in the world, land and air transport networks are becoming congested and shortsea shipping presents the potential of a transport efficient and cohesion effective mode of intra-European passenger and cargo movement. In the traditional assessment of transport modes, the criterion of energy consumption provides from a techno-economic point of view a first indication of transport efficiency. Therefore, in the movement of goods by sea the specific energy consumption in terms of
kWh/tonne-km is typically about one-fifth that of road transport and one-third of rail, [1]. This comparison also provides a first indication of the environmental significance of water transport, since generally lower energy consumption is consistent with energy preservation and reduced pollution.

As we turn our attention to the sea, it is important to recognise that the application of "wise" transport management on this less spoiled, so far, element of nature may be our last reserve. "Wise" transport management means the avoidance of all these practices which have often made land and air transport usually inefficient and socially expensive. Therefore, a better approach today is that of assessing efficiency of transport not only with the conventional criteria of narrow techno-economic importance but also with criteria which are relevant to the preservation of the environment. Generally ships have the highest payload/weight ratios in comparison to other means of transport, but the payload capacity decreases with increasing speed, as shown in Figure 1. In the management of shortsea shipping, the application of technology on the "wet side" of the operation must aim at the development of a competitively tuned ship, thus shifting the graph towards the high payload/weight-high speed region.

This ship must also be safe, reliable, flexible, comfortable/ergonomic and last but not least environmentally friendly, especially with respect to exhaust and oil pollution, [2, 3]. As far as intra-European cargo or passenger movement is concerned, the success of shortsea operations and shortsea-based cohesion is dependent upon the ability of the shortsea fleet to meet these ship performance requirements in the best possible manner and (unlike the deepsea) in direct competition with the other land-based transport options which are often readily available to the user almost throughout the continent.

The involvement of technology in ship performance is generally associated with the architectural and mechanical infrastructure of the ship. Although, the performance and efficiency of the shortsea ship in port is specially significant due to its frequent port calling pattern, it is also necessary to recognise the significance of the ship's performance and efficiency during the shorthaul part of the operation as this is reflected in its "payload/weight vs speed" characteristic. Therefore, for any particular type of ship (monohull, catamaran, SWATH, ACV, or other), the general trend in the shortsea ship design of up to 5000 dwt is that of low resistance and/or light weight hull construction coupled with high propulsion power for competitively fast operation at sea. The latter is very important since a faster ship, apart from the quick journey coverage, can achieve a more frequent port calling pattern, accommodate earlier arrivals and later departures and apply a more efficient and effective weather routing. However, detailed definition of the above mentioned trend can only be provided after thorough investigation of the economical and ecological environment of a particular shortsea operation. The propulsion system and more particularly the propulsion engine is at the core of the ship’s electro-mechanical infrastructure and it af-
fects decisively the performance of the ship. All types of propulsion engines do not affect ship's performance in the same way and the choice depends highly on the ship's mission. The shortsea ship which is intended for the intra-European transport of goods and passengers must be powered in a way that is consistent with performance requirements of the ship and to the extent and manner these requirements are dictated by the intra-European transport demands. Shortsea shipping represents a mode of transport which has to succeed and in order to do so, it is necessary to recognise that its propulsion system "cannot be judged by price alone".

Therefore, in order to present the future trends in the propulsion technology of shortsea ships, it is necessary to lay down the basic criteria of the marine propulsion system selection, to present the current status and trends and to provide an assessment of the available or expected options with particular reference to the current and future demands of shortsea shipping.
2 MARINE PROPULSION FOR SHORTSEA SHIPPING

2.1 PROPULSION REQUIREMENTS

In a trade-off study involving different main propulsion engines there are numerous factors to be considered, but the most important in mercantile shipping applications are:

1. Costs:
   - Initial: purchase and installation;
   - Operational: fuel, maintenance and manning;
2. Reliability;
3. Environmental adaptability:
   - Pollution: noise, exhaust, fuel and lub oil sludges, vibration;
4. Space and weight requirements;
5. Operational flexibility;
6. Auxiliary system adaptability;
7. Automation adaptability.

The propulsion engine must provide the shortsea ship with the ability to operate in the movement of passenger and/or cargo in the most techno-economically competitive manner to the other transport modes. This means the provision to the transport user of a low cost and high quality service, in which all the above mentioned engine criteria are involved and the order of their presentation reflects the priority of consideration for achieving this service from an propulsion engine selection point of view.

2.2 PROPULSION ENGINE STATUS AND TRENDS

In the field of marine propulsion, the diesel engine is the dominant prime mover and the motorship represents about 97.5% and 85% in terms of the total number and gross tonnage, respectively, of all the merchant fleet currently available, [4]. The remaining ships are mostly steam ships of old age and the difference between the percentages of motorship population and size indicates that most of the steamships are large-sized.

The dominance of the diesel engine in the field of marine propulsion has been so far mainly based on the fuel bill advantage of this engine. This may be easily proved since earlier attempts to review the issue of marine propulsion engines for commercial ships and the probable introduction of gas turbines into this fleet [5, 6, 7], came to a halt with the significant increase in fuel prices after the first Oil Crisis in 1973. Since then, the marine propulsion engine research has mostly been concentrated in the reduction of fuel and maintenance costs, consistent
with the development of a economical and trouble free marine diesel engines. For a certain part of this research which was directed towards the ability of the marine diesel engine to burn the cheaper heavy fuel oil, the compromise between fuel and maintenance cost reduction was not at all easy. Over the same period, other engine research projects were aiming at the improvement of the pure in-engine design and operational parameters in order to improve resistance to engine wear, reduce specific fuel consumption, increase thermal efficiency and specific power. Therefore, the marine diesel engine technology was in many respects renewed and the research efforts were fruitful in producing engines which today present an upper thermal efficiency of about 54%, specific fuel consumption as low as 114g/bhph and an upper power limit of about 67000bhp from a single engine, [8]. Although, these engine developments were significant for the entire motorship fleet, they were mostly beneficial to the large deepsea ships with which the high power and efficient marine crosshead diesel engines have been associated for sometime. The development of the marine diesel engine has been the product of engineering efforts to produce solutions to occurring problems and demands by introducing new technologies in the design and operation of this engine. However, since in many respects engineering is the "art of compromise" within an intra-technological, techno-economic and environmental framework of study, solutions to new demands upon the marine diesel engine are becoming limited, due to their counteractive nature and hence reduced margins of compromise.

At the same time, the introduction of other prime movers for marine vehicles is investigated. The use of wind, solar and wave energy for marine propulsion was mainly investigated in the '75 to '85 period, in an effort to reduce the bunkering costs of ships, [9, 10, 11]. Problems associated with the nature of these renewable resources limit their potential to the provision of an assistive role to the conventional "thermal" engines of ships and therefore after the relaxation of the oil market prices, the high initial investment of these systems halted their application into marine propulsion. On the other hand, other alternative systems for self supporting propulsion have significant commercial interest and the most recent research on fuel cells has produced encouraging results, [12]. The same is true for the less recent SEMP technology, [13]. However, both the electro-chemical and electro-magnetic use of energy for marine propulsion purposes requires high capital investment and commercial utilization (specially of the first) in marine propulsion units is not expected to occur in the foreseeable future.

In a more realistic approach, the technology of gas turbine propulsion appears to be closer in satisfying the propulsion requirements of future shortsea ships. In any system configuration such as:

* Gas turbine - reversing reduction gear - fpp;
* Gas turbine - reduction gear - cpp;
* Gas turbine - reduction gear - waterjet.
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The advantages currently offered by the marine gas turbine meet many of the operational demands upon these ships, whereas most of its disadvantages appear to have an inferior influence in this particular shipping operation. Away from its current status, it is also important to note that, the technologically young gas turbine presents the potential for sizeable improvements, which is characteristically reflected in its development trend. Typical example is the recent case of the ICR WR-21 (RB211 version) engine offering a flat efficiency profile yielding up to 30% fuel savings compared to present simple-cycle systems without significant compromise on its main advantages, [14]. The development of a new generation of lightweight high speed surface craft has continued to gather momentum and now covers catamarans, SWATH ships, surface effect ships (SES) and high speed monohulls with speeds up to 60 knots. Many of these designs are for passenger only or passenger/car/truck freight transport [15], but there is an increasing number of designs for up to 5000 dwt craft capable of carrying cargoes, such as the "Techno-superliner TSL-A" and the "SHI Ovoid" [16] projects for container transport (up to 200 TEU), and it is these designs which are of particular interest for gas turbine propulsion.

2.3 ASSESSMENT OF MARINE DIESEL AND GAS TURBINE PROPULSION

Costs

For the range of commercially available engine powers, the initial cost of the marine propulsion engine per unit horsepower is decreasing as the rated power of the engine increases. In absolute terms, the high power demand for competitive speed and Payload/Weight ratio ships is associated with high initial cost for propulsion, whether the gas turbine or the diesel engine alternative is concerned. However, with particular reference to the predicted hull forms for shortsea ships it is important to note that, the lower power to weight ratio of the gas turbine engine implies that for a given deadweight and speed a gas turbine ship can need less power than an equivalent diesel ship, thereby offsetting the probable initial cost and fuel consumption advantage of the diesel engine. As a comparison of initial cost trends between the two propulsion modes it may be mentioned that, for example, the Eurodyn gas turbine engine of 2.6 MW is soon becoming commercially available (in 1995), at a competitive price to equivalently powered and currently available high-speed diesel engines, while it will be similarly competitive to these engines in terms of fuel consumption. Alternatively, at the higher power range, the WR-21 ICR gas turbine engine system comes at a purchase cost comparable to the 240 USD/kW for an equivalently powered diesel engine of about 20 MW. On the other hand, gas turbine installation and testing costs are low, mainly because of its compactness and its structural and operational simplicity. Assuming that ship delivery schedule is controlled by the machinery installation and testing schedule, which is almost always the case, shipbuilding time of gas turbine powered ships is
reduced and ship availability is brought forward. In terms of fuel consumption, the WR-21 ICR system has a minimum specific distillate fuel consumption of 0.197 kg/kWh through the 100 to 75% power rating, in comparison to a minimum of about 0.170 kg/kWh for an equivalent diesel engine running on HFO.

Generally, in order to keep the bunkering costs of propulsion as low as possible, it is necessary to look for engines of high thermal efficiency (or low specific fuel consumption) and low cost fuel compatibility. As far as the latter is concerned, the gas turbine engine is disadvantaged since it requires running on distillate fuel (MDO, Gas oil). The spot market price differential between HFO 380 cSt and MDO is currently about 65 USD/ton. Therefore, in the previous example of 20 MW engines, this may represent an annual bunkering cost advantage for the diesel engine of up to 150000 USD, assuming an operating profile of 260 days/year at 75% MCR and minimum specific fuel consumptions for both engines.

However, fuels of low unit cost are usually associated with poor quality and hence higher engine wear and maintenance. In maintenance assessment of propulsion engines, it is necessary to distinguish between the qualitative and quantitative demands on manpower and material resources, as shown in Fig. 3. A "value for money" approach is here recommended, since the supply of either "too much" or "too good" crew and materials is expensive. It is however encouraging that, as far as the maintenance of the marine propulsion engine is concerned, these two extremities of maintenance practice rarely co-exist.

Further, these maintenance requirements are satisfied through the introduction of work practices which are discriminantly described as preventive and corrective maintenance. Different marine propulsion engines have different maintenance requirements and subsequently the implementation of their maintenance work differs too. Depending on the technology of the propulsion engine, the ability to apply effectively preventive maintenance schemes based on propulsion engine parameter monitoring and scheduled inspections for the prevention of engine failure is an asset for any commercial ship, since corrective maintenance is usually more expensive due to the associated lost earnings.

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during the engine downtime and also due to engine component replacement costs.

For the marine gas turbine, these preventive maintenance schemes are an inherent characteristic due to its derivation from the aero units, where downtime is of paramount importance. When corrective maintenance has to be applied the gas turbine engine is designed to permit rapid replacement of externally mounted controls and accessories and also the accomplishment of major internal tasks onboard ship by permitting easy separation of engine sections (usually with the aid of rail systems). This leads to the gas turbine maintenance philosophy based on modular replacement, by which upkeep is achieved by exchanging sections of the engine rather than by overhauling the complete engine. Full utilization of the modular structure of the engine may also be achieved through the onboard duplication of the sections. Modular replacement assists the engine's scheduled overhaul, since time between overhaul is actually determined by the life of one or two assemblies which are exchanged while the mechanically sound and fit assemblies continue to be in service for a much longer period. The operational and structural simplicity of the gas turbine, as this is reflected in the fewer moving parts, implies low logistics and manpower requirements and promotes maintenance standardization within a particular fleet of similarly powered ships. The comprehensive instructions covering the actual work to be done to support scheduled and corrective maintenance on marine gas turbines are contained in manuals based on manufacturer's recommendations and approved by the appropriate seaworthiness authority/classification society. In an "out of limit" condition, the marine gas turbine offers the ability to apply trouble shooting chart-based procedures which lead quickly and accurately to fault diagnosis with the minimum associated work and the prevention of unnecessary unit or engine removals. The maintenance work on a marine gas turbine does not allow deviations from a prescribed set of maintenance instructions and engine crew know-how demand is limited to the correct interpretation and implementation of these instructions, which also include information on tool handling.

Although there has been significant improvement in maximizing the "idiot-proof" quality of marine diesel engines with the introduction of computer-based plant monitoring and diagnostic systems, the gas turbine propulsion technology traditionally covers this aspect even better and extends its superiority into the area of corrective maintenance with greater emphasis.

Finally, in marine engine maintenance it is necessary to consider the lubrication of the engine. The marine gas turbine is associated with a lub oil consumption which may reach one per cent of that in an equivalent diesel engine and almost independent of engine rating. For example, a 15 MW marine gas turbine engine may have a lub oil consumption of 0.22 kg/hr and this compares with 15 kg/hr of an equivalently rated diesel engine. This difference represents currently a significant annual saving for the gas turbine engine which may be up to 100000
USD, assuming a lub oil price of 1 USD/kg and constant lub oil consumption rate for 260 days per year.

The operational demands of a shortsea ship favour the maintenance capability offered by the gas turbine propulsion technology, since engine repair delays can be kept to a minimum and often "squeezed" within the turnaround time at port. The ship is allowed to keep up with its tight journey schedules minimizing profit losses due to delayed, adjourned or cancelled operations and maximizing earnings due to an extended operating schedule which may reach up to 350 days in a year. More directly, low engine manning and lubrication costs in conjunction with lower engine initial costs essentially offset the higher bunkering costs and the operating cost differential between the diesel and gas turbine propulsion engine is eliminated.

Reliability

The prime objective of the shipowner is to achieve from the propulsion system maximum availability and minimum "out of service" time during the life of the ship. The reliability of marine gas turbine engines is well proven with more than 3.5 million hours of operation in naval applications and an even longer reliable operating history in the air. The maintenance schemes offered by the marine gas turbine ensure a high degree of reliability, specially through the highly sophisticated preventive maintenance methods which offer quick fault detection, diagnosis and often engine self-correction.

Environmental adaptability

The propulsion engine of a shortsea ship is a source of exhaust and fuel oil waste pollution and every effort should be made to minimise the impact of these pollutants on the environment, especially if one considers that shortsea ships are involved in "sensitive coastal" shipping operations.

Exhaust emissions: As far as diesel engine exhaust emissions are concerned, IMO has identified NOx and SOx as the major pollutants, and the pending legislation on exhaust emissions from shipping is targeted at reducing atmospheric pollution from these species by 30 and 50% from current levels, respectively. The SO2 emissions are related to the sulphur content of the fuel, whereas the NOx emissions are mostly related to the local combustion parameters of temperature and oxygen concentrations.

It is estimated that the 100-120 million tonnes of marine fuel used annually, produces a pollution of about 12 million tonnes from each gaseous component. Conventional slow speed marine diesel engines in steady state operation are now known to produce NOx at a rate of about 15 g/bph, whereas the medium speed engines discharged at a NOx rate of about 10 g/bph. In terms of weight of fuel used, the corresponding rates are about 85 and 60 kg/tonne fuel, respectively. Typical NOx emission rates from high powered marine gas turbines are
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about 5 g/bhph. Concerning SO2, the high speed diesel engine running on distillate fuel compares favourably to the gas turbine due to the low sulphur content (<1.5%) fuel used in both engines. On the other hand, a highly powered slow speed diesel engine running on HFO 380 cSt fuel with an average sulphur content of 4.5%, produces SO2 at about 100 kg per tonne of fuel used. It is of course technically possible for the diesel engine to achieve the targeted exhaust emission reductions, but it is very costly since it usually involves one or more of the following:

a. Modified fuels (sulphur content reduction from an average of 2.8 to 1.5%);
b. Exhaust gas treatment (catalysts, scrubbers, etc.);
c. Operationally modified engines.

Therefore, if for example, the marine diesel engine was forced to run on desulphurized fuel (with 1.5% S), its fuel cost advantage over the distillate running of the gas turbine will be eliminated. Similarly, exhaust gas treatment methods have significant initial and operating costs, and modification of combustion parameters apart from being usually expensive are also detrimental in other aspects, e.g. increase of fuel consumption or higher emission of other species. On the other hand, the failure to comply with these exhaust control measures (especially during coastal operations) may soon imply payment of environmental fees, as is already the case for other transport vehicles.

Fuel oil waste: With the term marine fuel oil waste reference is mainly made to the sludge formed during storage and/or during centrifuging aboard the ship. This sludging is often attributed to fuel oil instability or incompatibility and is known as "carbonaceous sludge". The carbonaceous sludge formation tendency is related to the deterioration of the residual oil which is the basic constituent of the marine blended fuel. Therefore, sludge formation is not relevant to distillate fuels and does not apply to distillate running gas turbines and high speed diesel engines. In the case of blended diesel oils the sludging is very limited and does not represent a significant pollutant. In order to provide an indication of the quantities of fuel waste produced, in the case of HFO 380 cSt fuel 1% waste is suggested not to be excessive. The quoted figure suggests that if for example, a 20 MW running on this fuel with a specific fuel consumption of 170 g/kWh it will produce about 5.5 tonnes of fuel waste weekly. The disposal of fuel waste at a reception facility, according to international conventions, implies extra storage demands thus reducing the payload capacity of the ship. The disposal of these wastes incurs costs to the shortsea ship operator, whether he hands the wastes over to a reception facility or he disposes the wastes at sea facing severe penalties. The environmental impact of the fuel oil waste problem is reflected in the estimated 1 million tonnes of waste produced annually from the 100 to 120 million tonnes of fuel used in shipping every year.
The marine gas turbine engine package includes heat and noise enclosures and together with the low vibration level of the engine offer improved habitability for crew and/or passengers. Finally, the environment of the gas turbine engine room is far cleaner than the spaces used to house diesel engines and therefore is a better place to work.

**Weight and space requirements**

The power to weight advantage of the marine gas turbine and its significance in promoting more passenger and/or cargo capability in modern fast ferries and fast cargo ships in shortsea operations has already been mentioned. For the same power output engines, the power to weight ratio of the marine gas turbine engine typically ranges between one-tenth to one-fifth of that of a diesel. For example, the 2.6 MW Eyrodyn system has an all-up weight (including gearbox), of about 2 tonnes in comparison to a weight of about 20 tonnes for an equivalently powered high speed diesel engine (excluding gearbox), whereas on the other end of the power range, the 50 tonnes weight of the 20 MW WR-21 ICR system (which has auxiliary extras at the expense of weight and size) still compares with the weight of about 250 tonnes for a 20 MW diesel. The power density of the marine gas turbine (horsepower per unit volume) is superior to any other prime mover and space savings may also be relinquished for improving crew/passenger habitability and/or for ergonomical design of machinery spaces. Typical space savings of about 60% are offered by gas turbine units in comparison to equivalent diesels. Recently, major improvements have been made in the direction of reducing the large size and weight of intake and exhaust ducting by optimizing the geometry of the ducting mainly with respect to the intake/exhaust flow requirements.

**Operational flexibility**

The marine gas turbine engine offers to the shortsea ship superior flexibility of operation reflected in a high state of readiness from almost any condition. The time to achieve any operating mode, such as maximum speed, full manoeuvrability or a low-speed mode. Rapid start and acceleration of propulsion system from cold depends on the main propulsion engine and is a specialist requirement for ferry services and other ships operating on tight shortsea schedules. Safe preparation of the propulsion system depends on uniform heating to the working temperature of engine components and achieving satisfactory clearances between relative moving parts. The larger the engine mass, the longer these processes take, hence slower response. The marine gas turbine propulsion system can be ready for service in less than a few minutes. Gas turbines are normally most efficient at rated power output, with efficiency falling of considerably at lower power. This condition is somehow relieved through the ability of the marine gas turbine to manoeuvre quickly and hence restrict the period of inefficient operation. However, in order to efficiently accommodate manoeuvring
Auxiliary system adaptability

The high propulsive power and service load demand imposed upon the ships today is aiming at higher speeds, more effective cargo storage and handling and better habitability for crews and/or passengers. The shortsea ships, in their close competition with the other modes of transport, experience this growth in energy requirements mostly through the need to provide fast and comfortable services. The energy level is such that diesel engine plants can only provide coverage through significant size expansion. The "power density" of the gas turbine engine offers the ability to efficiently (with minimum penalties) satisfy all hotel service demands by utilizing the exhaust energy of the turbine in order to generate electricity and heat, for air conditioning, ventilation, refrigeration, waste treatment, warm water supply, cooking, lighting and other services.

Automation adaptability

The marine gas turbine presents fully automated propulsion capability leading to minimal crew requirements, excellent reliability and efficient as well as flexible operation.

3 CONCLUSIONS

Intra-European shortsea operations should and are expected to play a major role in the promotion of European cohesion through the international movement of passengers and goods within Europe. This expectation will become a reality if the shortsea fleet is equipped with the propulsion system and engine which will make shortsea ships competitive to the other transport modes currently available in Europe. In these shortsea shipping operations the current and future needs for rapid port turnaround, high sea-speed and maximum passenger and/or cargo space to achieve a high transport rate per ship-year, coupled with the recently emerging legislation for the protection of the marine (and specially coastal) environment, all point to the gas turbine as a desirable prime mover for shortsea ships of today and of the foreseeable future. This conclusion has been drawn with reference to the following realizations:

* For a fast shortsea ship of high payload/weight ratio, reduction in weight is essential and by using gas turbines in preference to diesel engines an 80% reduction in machinery weight and 60% saving in engine room space is possible. This gives increased cargo space or deadweight, reduced ship size, in conjunction with higher ship speed without increase in power.
Engine purchase and installation costs for the gas turbine powered ships are lower than those of an equivalent diesel engine. The maintenance cost of the gas turbine engine is lower than that of an equivalent diesel, mainly due to the lower manning and material requirements provided by a structurally and operationally simple engine. The maintenance schemes applied to the gas turbine enhance the inherent reliability of the engine and ensure maximum propulsion availability thus increasing ship revenue. The operational flexibility of the gas turbine engine offers excellent manoeuvring capabilities for achieving less turnaround time at port and extending the revenue making operation at sea. These economic features easily offset the fuel cost advantage of the marine diesel engine, which is also recently threatened by the environmental protection legislation on the use of heavy fuel oil in shipping.

The gas turbine engine is environmentally friendlier than the diesel engine in terms of the production of exhaust emissions and oil pollutants. Its small size, cleanliness and vibration-free operation offer the comfort demanded by crew and/or passengers.
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<th>No.</th>
<th>Reference</th>
</tr>
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<tbody>
<tr>
<td>11</td>
<td>The Motorship</td>
</tr>
<tr>
<td></td>
<td><em>Wave Power for Ship Propulsion</em></td>
</tr>
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<td></td>
<td><em>Gas Turbines Recover Greater Efficiency</em></td>
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<td>MER, October 1993, pp 39-40</td>
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<td></td>
<td><em>Gas turbines were the only option for the Stena HSS vessels</em></td>
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<td></td>
<td>MER, February 1994, pp 27</td>
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<td>16</td>
<td>The Motorship</td>
</tr>
<tr>
<td></td>
<td><em>Future Ship Designs Approach Realization</em></td>
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<td></td>
<td>June 1992, pp 19-22</td>
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GREEK SHORT SEA SHIPPING: A TENTATIVE CONTRIBUTOR TO THE EUROPEAN COHESION

By A.M. Goulielmos

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GREEK SHORT SEA SHIPPING: A TENTATIVE CONTRIBUTOR TO THE EUROPEAN COHESION

1 INTRODUCTION

"Greek Short Sea Shipping" needs to be defined. For the purpose of this paper we feel obliged to define first the size of the Greek vessels that will fall under our examination. As far as the geographical coverage of the European Short Sea Shipping is concerned this according to one definition¹, extends to the area from White Sea (North), Black Sea, UK, Iceland, Mediterranean and Morocco (South).

This paper, however, will deal only with the Greek Mediterranean Cargo Vessels that belong to the following vessel types: tankers, chemical tankers, refrigerated ships, dry cargo ships, (twindeckers, single deckers), roro-lolo ships, cellular containerships, gas carriers, and miscellaneous ships.

As far as the vessel sizes are concerned, we will choose those falling between 500 GRT and 5999 GRT.

This paper will not deal with the so called Greek Cargo Coastal Trading Vessels, which are defined as the vessels trading exclusively between ports of one Mediterranean Country. Vessels of Greek flag appeared to trade exclusively between Greek ports in 1989 were of a total of GRT 85,306 ( roro 46%, dry cargoes 23% and tankers 31% of a total of 45 ships, in accordance with data from LMIS).

Also, this paper will not deal with Greek Passenger Coastal Shipping, subject which the author has dealt with at another similar occasion².

¹MERC & Dynamar SV, (1991), Shipping Market Analysis p.iii.


European Shortsea Shipping
2 THE PURPOSE OF THIS PAPER

European Union expects\(^3\) that between 1993 and 2000 freight and passenger traffic in EEC will be increased by between 25 and 30 percent. The Maastricht Treaty, too, is expected to give a great push forward to the European Union's transport policy. It is expected that the following targets will be at least achieved:

1. The development of the trans-European networks;
2. The achievement of the cohesion of the European Union;
3. The promotion of safety and competitiveness of European industries;
4. The increase & integration of the environmental protection;
5. The respect of the principles of subsidiarity and proportionality.

In accordance with the above, European Cohesion and industrial efficiency are two of the objectives of the Maastricht Treaty and these cannot be achieved if European Networks are not continuous over the sea. Greek Mediterranean Shipping (GMS) by interconnecting almost exclusively European ports (due to the sizes of its vessels), may work towards European cohesion and transport efficiency as far as the transport of goods is concerned. The success of European Union as a common market and as an export power to a certain degree is closely tied up with the efficiency of the EEC short sea shipping\(^4\), where GMS is a member. Similar with the above objectives, other objectives are contained in the White Book (approved in Dec. 1992 under the title of "Future development of a Common Transport Policy\(^5\)) of the EEC Commission and have made clear that transport (obviously land or sea) movement in EEC should be continuous. Also, transport imbalances due to geography or to procedures should be reduced; that the various modes of transport should be integrated; that support to Nations external to European Union (Central & East Europe) should be provided. It is also sad that although ports belong to the trans European Networks, maritime transport is not.

European Short Sea Shipping on the other hand has been considered\(^6\) vital in connection with the above strategy bearing in mind that it transports the one

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\(^4\)Ibid.

\(^5\)Com (92) 494 final 2/12/92.

\(^6\)Com (93/526 final 4/11/93 p.4-5 For the Cohesive Approach to Shipping Matters.
third of the cargoes moving in European Union\(^7\). This type of shipping can be exploited better if conditions of free and fair competition existed among various modes of transport\(^8\). Short sea shipping can especially help in the development of other regions of European Union encouraging the development of their ports and their hinterlands\(^9\).

This paper will examine whether:

(a) GMS faces a strong competition from vessels that are registered under European and also under non European Union flags\(^10\);
(b) GMS is able to help European Union’s cohesion if improves on fleet’s efficiency, vessel size and age;
(c) GMS has been successful in the past in serving Mediterranean trade.

Moreover the position of Greece Near East Europe and Black Sea does entitle its fleet (GMS) an important role on behalf of the Country and on behalf of the European Union?

In addition we will examine the policy measures that can be recommended to the Greek Government so that GMS to play the role it should play in Europe’s cohesion.

This paper will extend into following sections:

**Section 1.3** GMS: the fleet;
**Section 1.4** GMS: the market;
**Section 1.5** GMS: the competition;
**Section 1.6** GMS: the policy recommendations.

GMS is a rather neglected subject and as a result no international work has been ever appeared so far.

\(^7\)Com (93/526 final 4/11/93 p.4-5 *For the Cohesive Approach to Shipping Matters*.

\(^8\)Com (93/526 final 4/11/93 p.4-5 *For the Cohesive Approach to Shipping Matters*.

\(^9\)Com (93/526 final 4/11/93 p.4-5 *For the Cohesive Approach to Shipping Matters*.

\(^10\)Such flags are those of countries like Turkey, Egypt, Algeria, Morocco, Tunisia, Syria.
3 THE GREEK MEDITERRANEAN SHIPPING: THE FLEET

The composition of the Greek Short Sea\textsuperscript{11} shipping is given Table I (end of 1991). As Table I indicates the total Greek Short Sea Shipping amounted to 774,370 GRT at the end of 1991, where the same fleet was in 1981 four times larger (2,75 m GRT and 1,017 ships). Cargo ships have a dominant position with 57\%, where passenger ships cover a 38\%. Obviously, the shipping crisis that has taken place between 1981 and 1986 had its impact also on Greek Short Sea Shipping curtailing same to one third (flagging out being a situation that is noted in this paper\textsuperscript{12}).

\begin{table}[h]
\centering
\begin{tabular}{|l|c|c|c|}
\hline
 & No. of ships & GRT & \% \\
\hline
1. Tankers & 105 & 127,455 & 16 \\
2. Dry Cargo ships & 171 & 316,822 & 41 \\
3. Passenger Ships & 156 & 291,577 & 38 \\
4. Miscellaneous vessels & 43 & 38,516 & 5 \\
\hline
Total & 475 & 747,370 & 100 \\
\hline
\end{tabular}
\caption{Greek short sea shipping (sizes 500-5999 GRT), 1991, (Source: "Argo" Greek Shipping journal, year Editions 1982-1992)}
\end{table}

It must also be noted that Greek shipping world maintains a high esteem\textsuperscript{13} for GMS, because it is considered to:

1. Mainly transport the Export and Import cargoes of the Country, because its ships (their sizes) are suitable for this trade, helping thus the development of the important seaborne trade of the Country;
2. Be traditionally a pool from which ocean shipping shipowner come from (ocean going shipping unlike to Mediterranean Shipping maintains one of the top four positions in the World); this is so because the entry into GMS

\textsuperscript{11}This term includes GMS, Greek Passenger Shipping and Miscellaneous ships made up by vessels falling in size between 500 GRT & 5599 GRT.

\textsuperscript{12}Registrations (according to Naftika Chronica) during 1993 have shown that 175.795 GRT has been added to GMS of which 19\% only under Greek flag (Cyprus 21\%, Panama 25\%, Malta 30\%, total 76\%).

\textsuperscript{13}Institute of Economic & Industrial Research, (1988), Trends and Developments in Mediterranean Merchant Marine, p.7,9 (in Greek with English Supplement).
is easier due to lesser capital requirements (due to lower ship prices), and thus GMS is a sector where Shipowning and Shipmanagement know-how can be acquired (frequently and by former sea captains);

3. Help boost Country's employment of Greek Seamen and an inflow of shipping foreign exchange can also be remitted to Greece through this sector.

A quality feature of the fleet is certainly its age distribution. This is shown in Table II. As Table II shows only 32% of fleet’s GRT is under 19 years and this does not improve even if we exclude passenger ships. Exclusion of Passenger Ships improves marginally the picture as the percentage of ships under 19 years rises from 32% to 34%.

<table>
<thead>
<tr>
<th>Age</th>
<th>No of ships</th>
<th>GRT</th>
<th>% (GRT)</th>
<th>Passenger Ships</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>NO</td>
</tr>
<tr>
<td>0-4</td>
<td>32</td>
<td>59.233</td>
<td>8</td>
<td>11</td>
</tr>
<tr>
<td>5-9</td>
<td>9</td>
<td>15.732</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>10-14</td>
<td>39</td>
<td>79.125</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>15-19</td>
<td>64</td>
<td>96.212</td>
<td>12</td>
<td>31</td>
</tr>
<tr>
<td>20-24</td>
<td>121</td>
<td>214.105</td>
<td>28</td>
<td>38</td>
</tr>
<tr>
<td>25-29</td>
<td>106</td>
<td>161.438</td>
<td>21</td>
<td>32</td>
</tr>
<tr>
<td>30+</td>
<td>104</td>
<td>148.326</td>
<td>19</td>
<td>19</td>
</tr>
<tr>
<td>Total</td>
<td>475</td>
<td>774.170</td>
<td>100</td>
<td>156</td>
</tr>
</tbody>
</table>

Table II: Age distribution of Greek Short Sea Shipping (31/12/91), (Source: Argo Shipping Journal 1992)

As for vessels size distribution the situation is presented below in Table III.

As Table III indicates 59% of the GRT of ships is under the 2999 GRT size. Thus, GSSS has not exploited economies of scale. Also as we will see in a later section, we will specify the "successful size". This will be approached by estimating the degree of presence of certain flags in Mediterranean Ports.

As far as the types of vessels are concerned the RoRo type of ships which are considered of a newer technology are not seen as having a great frequency (6% only of the total fleet in GRT terms has appeared in Mediterranean Ports in
Table III: Size distribution of Greek Short Sea Shipping, (31/12/91), (Source: Argo)

1989 in the most regular basis). In refrigerated ships Greek flag had no appearance in Mediterranean ports during 1989. In Chemical tankers Greek flag appeared, only with 2,3% in GRT terms in Mediterranean ports in 1989.

Therefore, GMS has shown signs of inefficiency given, as shown, that sizes are low, ages are high and technologically advanced ships are absent. These accusations are not, however, adequate to dismiss GMS from its cohesive role in European Union if we do not examine its success -if any- in the market (see appropriate section below).

4 GMS: THE MARKET

4.1 THE PROTECTIONIST ENVIRONMENT

GMS has argued\(^{14}\) that the market environment within which it works is dominated by maritime policies pursued by various Countries that influence the competitive conditions of the market. GMS has also argued that it faces a wide spectrum of impediments for access to various trades due to protectionist and

\(^{14}\)Institute of Economic & Industrial Research op cit. p.181 and after.
Section VI - Papers Not Discussed at the Conference

discriminatory policies pursued by certain Countries\textsuperscript{15}. The European Countries that pursue certain protectionist measures for some time are France, Italy, Portugal and Spain. Countries like Algeria, Egypt, Israel, Libya & Morocco have for some time exercised protectionism measures in the form of cargo reservation. Other Countries like Lebanon and Syria have exercised governmental cargoes reservation. Also, cargo sharing as a protectionist measure has been pursued for some time by Malta, Tunisia, and some ex USSR democracies. Finally, Turkey has offered a strong financial support to its own fleet.

As for the European Countries, France, exercises for some time protectionist measures in the form of cargo reservation and cargo sharing. Italy, too, exercises cargo sharing and cargo reservation as well as provides financial support to its fleet. Portugal has adopted also reservation of governmental cargoes, cargo sharing, and gave a number of subsidies to shipping state owned companies. Spain exercises cargo reservation as well as cargo sharing and it supports its fleet financially (subsidies, loans and credit schemes).

4.2 THE MARKET SCENE

In this section we will look into the Market scene and identify the flags that appear in the Mediterranean cargo trades recently\textsuperscript{16}. Our data will also indicate the frequency of flag appearance in Med trades, which will be considered as a sign of the most competitive or successful flag in Mediterranean.

4.2.1 The dry cargo market

In the dry cargo market and for vessels in the small size 500 to 1599 the most successful\textsuperscript{17} flags were Italy (19%), Spain (18.4%), Turkey (8.5%), Cyprus (8%), Honduras (5.4%), Panama (5%), Greece (4.8%) and S.Vincent (3.8%). These eight flags accounted for almost 73% of GRT. In the medium sizes of dry cargo shipping i.e. between 1600 to 2999 GRT, Italy (12%) and Spain (12%) were again the top flags followed by Germany (7.7%), Greece (7%), Turkey (6%) and Panama (5%). These six flags accounted for almost 50%.

\textsuperscript{15}Non-European Countries Flags appearing in the Market are Algeria, Cyprus, Egypt, Israel, Lebanon, Liberia, Libya, Malta, Morocco, Panama, Syria, Tunisia, Turkey and certain ex USSR democracies.

\textsuperscript{16}LMIS op. cit.

\textsuperscript{17}In the sense of a frequent appearance in chartering business. These are defined as the flags flown by the ships which have appeared in 1989 for more than once a month (25 voyages and more) in any two Mediterranean ports during the year.
Greek Short Sea Shipping

In the larger sizes i.e. 3000 to 5999 the successful fleets were Spain (21%), Greece (11%), Germany (6.5%), Cyprus (5.7%) & Italy (5.6%). The five countries account almost for the 50%. If we pull together all vessel sizes then Spain will take the first position and Italy the second, as shown in Table IV.

<table>
<thead>
<tr>
<th></th>
<th>GRT</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Spain</td>
<td>204,534</td>
</tr>
<tr>
<td>2.</td>
<td>Italy</td>
<td>146,503</td>
</tr>
<tr>
<td>3.</td>
<td>Greece</td>
<td>85,966</td>
</tr>
<tr>
<td>4.</td>
<td>Cyprus</td>
<td>72,746</td>
</tr>
<tr>
<td>5.</td>
<td>Ex-Yugoslavia</td>
<td>72,700</td>
</tr>
<tr>
<td>6.</td>
<td>Germany</td>
<td>59,762</td>
</tr>
<tr>
<td>7.</td>
<td>Panama</td>
<td>58,948</td>
</tr>
<tr>
<td>8.</td>
<td>Turkey</td>
<td>58,294</td>
</tr>
<tr>
<td>9.</td>
<td>Honduras</td>
<td>38,294</td>
</tr>
<tr>
<td>10.</td>
<td>S.Vincent</td>
<td>27,087 (824,834)</td>
</tr>
<tr>
<td>11.</td>
<td>Rest</td>
<td>336,503</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1,161,337</td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

Table IV: Top ten fleets in Med Trades 1989 (500 - 5999 GRT), (Source: LMIS)

As shown from the table, the successful Countries in the dry cargo Short Sea Shipping in the Mediterranean Ports are mainly Spain & Italy by far, followed by Greece and Germany. Serious appearance have also certain flags of convenience like Cyprus, Panama, and ex Yugoslavia. It is known that Spain has followed the economics of scale trend and built larger sizes of ships as well Spain increased its fleet. Serious increases in the fleets were accomplished and by Turkey and Panama. Spain and Italy also have maintained their fleets despite the crisis that has taken place between 1980 and 1988, which meant to have secure penetration in certain trades. And this is well shown by the figures appeared in the table and we may accept that the protectionist measures mentioned above worked positively forwards maintaining and increasing the fleet of these two Countries. For the Greek fleet, one cannot be sure how much

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tonnage behind Cyprus, Panama and other registries can find that is owned by Greek shipowners. However, as indicated by the statistical evidence in the above footnote Greeks must have tonnage under Panama & Cyprus flags.

The above results are based on data which excludes vessels that have traded exclusively between ports of the one and same Mediterranean Country. If the case was not so, then certain countries like Italy, Spain etc would have boosted their tonnage presence due to their geographical shape.

4.2.2 The tanker market

In the Tanker Market and in the small sizes 500 to 1599 GRT the top flags were Italy (41%), Greece (36%) and Panama (7%). In the medium sizes (1600 to 2999) the top flags were again Italy (55%) & Greece (13%). In the larger tankers the top flags were Italy (53%), Spain (23%), Morocco (5%) with the last position need by Greece (2.1%). From the above data we may conclude that the well known flags dominate in the tanker market. Italy and Spain have moved into the larger sizes, so that they how enjoyed economics of scale as well as in the tanker short sea market.

Table V indicates the top six flags in the tanker business

<table>
<thead>
<tr>
<th></th>
<th>GRT</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Italy</td>
<td>177,351</td>
</tr>
<tr>
<td>2.</td>
<td>Greece</td>
<td>53,884</td>
</tr>
<tr>
<td>3.</td>
<td>Spain</td>
<td>40,713</td>
</tr>
<tr>
<td>4.</td>
<td>Panama</td>
<td>18,129</td>
</tr>
<tr>
<td>5.</td>
<td>Turkey</td>
<td>13,376</td>
</tr>
<tr>
<td>6.</td>
<td>Malta</td>
<td>10,885</td>
</tr>
<tr>
<td>7.</td>
<td>Rest</td>
<td>45,754</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>360,092</td>
</tr>
</tbody>
</table>

Table V: Top six flags in the tanker business, (Source: LMIS)
5 GMS: THE COMPETITION

As it is shown above, certain Countries compete Greek flag in the Mediterranean trades. In the dry cargo market and in the small ages (ships less than 9 years) serious appearance had Spain with 18.1%, Turkey with 15.2% and Germany 21.5% (total 54.8%). In the tanker business young tonnage (0 - 9 years) has Italy (60%), Spain (13%) and Panama (11%).

One may therefore conclude: (1) that fleets which have followed massive newbuilding schemes under state financing support like Spain and Turkey, (2) fleets that enjoy cargo sharing and cargo reservation protectionist measures as mentioned above and (3) fleets under flags of convenience like Panama and Malta, may show a competitive advantage compared with other fleets trading in the Mediterranean trades. Spain and Germany have also shown that have pursued economics of scale as well as a serious percentage of tonnage was identified in the tonnage class 3000 - 5999 GRT.

The international character of Greek Med. Shipping

In the year under examination (1989) the number of Greek Med. Companies located in Piraeus were about 200. All these companies had a ship in the tonnage range between 500-5999 GRT. The Flag distribution was as given in Table VI.

<table>
<thead>
<tr>
<th>Greek flag</th>
<th>Ships</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Greek flag</td>
<td>195</td>
<td>41</td>
</tr>
<tr>
<td>2. Cypriot flag</td>
<td>81</td>
<td>17</td>
</tr>
<tr>
<td>3. Panamanian</td>
<td>78</td>
<td>16</td>
</tr>
<tr>
<td>4. Maltese</td>
<td>39</td>
<td>8</td>
</tr>
<tr>
<td>5. Honduras</td>
<td>22</td>
<td>5</td>
</tr>
<tr>
<td>6. Vanuatu</td>
<td>17</td>
<td>4</td>
</tr>
<tr>
<td>7. 14 diff. flags</td>
<td>47</td>
<td>9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>479</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Table VI: Flag distribution, (Source: Greek Shipping Directory 1989)

The above data indicates the international structure of Greek Med. Shipping companies and therefore companies' successful course depends not only on the performance of the Greek flag but also of fleet under Cyprus, Panama and Malta to mention the principal host flags.
6 POLICY RECOMMENDATIONS

As we were able to show Greek Med. Shipping despite the deep prolonged crisis that took place between 1981 and 1986 (for Greek tonnage) succeeded to survive mainly by changing flag and it resorted to registries of Cyprus, Panama and Malta. GMS did not improve much either in age or in size nor in technologically advanced types of ships. So, Greece competes other Med. Countries on the basis of the cost at which services are offered in relation to freight rate. Our data has also shown that Countries that have followed for sometime financing and newbuilding schemes (like Italy, Spain, Turkey) and protectionist measures have appeared in the Med. trades in the most frequent way.

Another characteristics of the situation is that Greece being a cross-trader elsewhere (ocean-going), cannot have this advantage in Med. trades for all Med. Countries have a share and a fleet in that trade. Moveover, Med fleets at variable percentages have participation in the State cargoes and State participates in the shipping companies capital. As, said cargo sharing and cargo reservation is exercised in the Med. Trades. Additionally, certain Countries do not appear with their former name as most part of their fleet is now under parallel registries (like e.g. France).

Greece has also to compete Countries adopted protectionist measures in the Med. area outside short sea shipping area, but in influencing trade with E.C. like Egypt, Algeria, Morocco and Tunisia.

G.M.S. functions under the state of the full and pure competition based on the freight rate determined by supply and demand. State of Greece does not participate in any of the Med. shipping companies, did not ever adopted protectionist measures (cargo sharing, cargo reservation, flag discrimination) and provided no financing support to Med. Companies. Greece witnessed some reductions in trade from North Africa in the past, and that trade transported in chemical and product tankers. To the above have to add competition from the Countries mentioned adopting cargo sharing and cargo reservation, and those that have built newer and larger fleets under Governmental Support.

Strong competition from non-EEC Countries adopting monopolistic/oligopolistic practices like Malta (partly), Turkey, Egypt, Algeria, Morocco, Tunisia, Syria and against Europe’s cohesion as the above leads to the reduction of tonnage under Greek flag. Competition without protectionism Greece faces and from Far Eastern fleets, Cyprus, Malta, Bulgaria, Liberia and Panama.

The main policy recommendations that cover from the above analysis is that Greece should pass in a massive renewal of the Med. fleet program providing incentives unfortunately within E.C. shipbuilding legislation with the provision of
financing schemes. At European Union’s level one way is to look forward for the abolition of any protectionist measures adopted by E.C. Countries or their trade partners elsewhere.

This is so for cargo sharing or cargo reservation excludes part of the demand from the market and the interplay of the competitive factors is prohibited with a loss to the final customer paying higher transportation costs than required.
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The Second European Research Roundtable Conference on Shortsea Shipping held on 2-3 June, 1994 in Athens/Vouliagmeni, was inspired by the successful First Conference, which took place on 26-27 November 1992.

Since the First Conference, European policy makers and researchers have increasingly focused on shortsea shipping. Subsequent to the Maritime Industries Forum, many activities have been initiated which will undoubtedly lead to increased efforts in policymaking and research for years to come.

The Research Roundtable Conferences have become a meeting place for maritime professionals. They facilitate dialogue among policy makers from both the private and the public sectors and strengthen the European maritime network. The papers in this volume address all the relevant issues and represent efforts undertaken in various countries.

This Second Conference not only aims to disseminate research on shortsea shipping, but focuses largely on formulating policy recommendations. The Conference's recommendations, the discussions of the Conference's papers and the participants list will be added to the research papers and published as Proceedings.

These proceedings of the Second Conference, and the subsequent volume with the policy recommendations, will constitute required reading for all professionals involved in European shortsea shipping.