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Abstract

Shipbuilding has changed from a "heavy industry" to become a capital- and technology-intensive activity over the last decades. While Japanese, South Korean and Western European yards dominate the merchant shipbuilding market so far, Eastern European yards are increasingly active, in particular in low and medium complex ships. We develop a market analysis and identify the axes of competition in international civil shipbuilding. From there, we analyze the restructuring process of Eastern European yards. Polish yards have proceeded with relatively quick enterprisation, establishing strong links to domestic and international suppliers. Restructuring in Russian and Ukrainian yards is blocked by local obstacles to enterprization, leading to increasing competitiveness gaps with CEE-yards. We conclude that a science&technology policy should be demand-oriented and target only the clearly identified obstacles to enterprization.

JEL-classifications: L62, P51, O38

Zusammenfassung

Die Schiffbauindustrie hat sich in den letzten Jahrzehnten von einer Schwerindustrie zu einer kapital- und hochtechnologieintensiven Branche entwickelt. Neben den marktführenden Werften Japans, Südkoreas und Westeuropas drängen nun auch verstärkt mittel- und osteuropäische Werften auf die internationalen Schiffbaumärkte. Wir identifizieren Marktsegmente und Wettbewerbsachsen und leiten hieraus die aktuelle Situation der osteuropäischen Werften ab, die recht unterschiedlich sind. Polen schaffte es durch eine rasche Unternehmisierung seiner Werften und die Umstrukturierung der Produktionsprozesse, der mit dem Aufbau eines internationalen leistungsstarken Zuliefernetzwerkes einher ging, wettbewerbsfähige Schiffe internationale anbieten zu können. Der Umstrukturierungsprozeß der Werften in Rußland und der Ukraine ist dagegen wegen verzögerter Unternehmisierung und Privatisierung blockiert und führt zu einem zunehmenden Rückstand gegenüber ihren Konkurrenten. Eine Wissenschafts- und Technologiepolitik sollte nachfrageorientiert sein und sich auf die Beseitigung eindeutig identifizierter Hindernisse der Umstrukturierung beschränken.

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1. Introduction

The shipbuilding industry has undergone a drastic change over recent decades; from being a „heavy industry“ it has turned into a high-tech, information-dominated industry, with over 70% of value-added outsourced in hierarchised supplier networks. In the *Western* world, Asian shipyards seem to have definitely taken the lead, with European yards keeping some market niches in the high-end segments. Yet, there is no country that does not *subsidise* its shipbuilding industry, leading to severely distorted markets. In *Eastern Europe*, a new divide is emerging after the collapse of socialist shipbuilding: while Central and Eastern European countries, in particular Poland, are gaining international competitiveness, post-Soviet, i.e. Russian and Ukrainian yards, have not yet succeeded in the process of enterprisation. Nonetheless, the arrival of Eastern European yards has a major impact on the world-wide restructuring of industry, both as regards competition and patterns of co-operation.

In this paper, we carry out an industrial economic analysis of the international shipbuilding industry in the East and West, identify links to the science and technology (S&T) system, and provide an evaluation of the restructuring process of Eastern European shipyards. Our question is: what patterns of co-operation and competition are Eastern European yards engaging in after successful enterprisation, and is there still a rationale in pursuing national S&T policies for shipbuilding?

The plan of the paper is as follows: in section 2, we describe the changing shipbuilding industry in the „West“ as observed over the last 20 years or so. Segmentation of the market has increased (in favour of cargo ships), and so has regional specialisation. Yet, after years of „crises“ and restructuring, overcapacities still abound and productivity gains are crucial for yard survival. The links between shipyards and the S&T system are multiple. In section 3, we carry out a similar analysis for Eastern European countries. Once highly integrated and supplying mainly socialist countries, these yards have all engaged in a radical enterprisation process, more or less watched over and supported by their respective governments. In 1997, the trough is definitely over for the advanced yards in Eastern Europe, that occupy increasing market shares. The question as to whether direct S&T support is necessary is open: at least for the advanced countries, the close co-operation with Western suppliers, yards, and shipping

companies indicates that the integration into the international S&T system is far more important. In section 4, we sketch out policy conclusions.[2]

2. The shipbuilding industry

2.1. Structure of production and links to the S&T system in the shipbuilding industry

2.1.1. Production of a ship

Contrary to popular belief, shipbuilding is no longer a labour-intensive, mainly blue-collar „heavy" industry. Once classified as „engineering-based", shipbuilding has developed to become a capital-intensive, high-technology industry, with a high dependency upon upstream R&D and innovation activities. Its high technology content, rapid pace of product and process innovation, and deep linkages upstream and downstream make it a key industry for many coastal industrialised countries. In this section we show that today, shipbuilding has become an information-dominated, capital-intensive activity, where productivity gains stem mainly from sources of innovation outside the yard.

A ship is more than welded steel, it consists of several sub-systems which must work smoothly together to guarantee a faultless functioning of the complete ship: a ship is a combination of electronics, information technology and several materials, pieced together in a yard in order to fulfil certain functions at sea. There is no such thing as „best practice" in the sense of an optimal mode of production because ships are mostly produced as single unit production or only in small numbers.

The production process can be divided into three steps:[3]

1. Planning phase: project planning, design and construction.
2. Production phase: project co-ordination and production.
3. Finishing phase: finishing, testing and inspection.

[2] As is usual practice, we do not cover the naval, military shipbuilding, for reasons of absence of information. As concerns ship repair, we consider it to be a niche activity within the sector, but which we do not cover separately.

[3] Fritsch (1992), p. 84.

In the planning phase the shipyard has to plan the complete shipbuilding project. This includes outlining the financing of the project, the design and construction of the ordered ship, ordering the required components and material. The second stage, the production phase, can be summarised as follows:

- receipt of materials, storage
- plate cutting
- panelling (welding plates to panels)
- hull construction
- conservation of hulls and sections
- outfitting (electronics, equipment, motors, etc.)

In the finishing phase the final work is done before the ship is delivered to the customer. This phase includes final finishing work, testing and the instruction of the customer[4].

The description shows that the production process requires the co-ordination of several activities where each of them can become a bottleneck if co-ordination fails. The co-ordination becomes more complex, the more components are delivered by suppliers. With a rising outsourcing level, the co-ordination costs also rise. The use of modern information technology in the planning and production phase enables the shipyards to outsource more and more activities. A result of this is the decreasing level of value added within each yard and a rising share of material costs.

2.1.2. Cost structure in shipbuilding

Production costs in shipbuilding depend upon scale and scope economies, the quality of a ship, and the degree of outsourcing. Roughly, the following cost structure can be identified[5]:
- materials (machinery, equipment, steel),
- labour cost

[4] Fritsch (1992), p. 84.
[5] Cf. „The European Shipbuilding Industry“ (1995); unpublished consultant report; and Borla (1995).

- overheads.

While steel is the most important individual cost element, machinery and equipment offer more flexibility in terms of supply strategy. Labour costs are composed of design work, metal treatment and transport, logistics, fitting-out, and other services. Design is the most expensive activity, in part carried out by the yard itself; an average 100,000-120,000 man hours are required for a series of three ships.[6] Overheads account for 80-130% of total labour costs; they include commercial costs (prospecting, negotiation, sales), financial costs, and basic expenses for internal R&D, computer-equipment (CAD/CAM), and the like. Table 1 provides an estimation of the cost structure for different ships.

Table 1: Distribution of cost elements for different types of ships[7]

Type of Ship	Steel	other Material	Labour and overheads	other
VLCC (180,000 t)	20%	37%	39%	4%
LPG-tanker (4,000 t)	5%	60%	29%	6%
Container (3,500 TEU)	11%	44%	40%	5%
Tug	4%	59%	33%	4%

The increase in capital intensity in recent years has also brought about an increase in the use of information technology on ships. This is not only caused by the attempt to reduce the number of crew-members (e.g. through integrated ship control, crew-free engine rooms, computerised cargo surveillance), but also to cope with increasing safety requirements. Thus, not only the production and repair of a ship, but also the running of a ship have become an information technology-intensive activity, where innovation comes as much from the software supplier as from the user.[8]

[6] ibid.

[7] Source: Committee of EEC Shipbuilder's Association.

[8] Typical fields of informatisation on a ship on the way to integrated ship control are the following („The European Shipbuilding Industry", op cit, Exhibit 10):
- high manoeuvrability in port through the integration of control of the main propellor, the rudder and the two sidethrusters into a single joystick rendering tug assistance superfluous;
- programmed sequences facilitating single push-button activation of complete engine room systems;
- voyage management with route planning and automatic course and speed setting to comply with the route plan (for safety reasons, each automatic setting requires acknowledgement by the watch-keeper);
- monitoring from the bridge of systems, machinery, and cargo spaces;
- power management providing automatic operation of electric generators;

- diagnosis system offering assistance in fault-finding and remedy of faults.

2.1.3. Four cost reduction strategies

Given the intensification of competition on the European and international markets, different strategies of diversification and cost reduction can be observed in the yards. Depending upon which strategy (-ies) are chosen by the respective yard, the sources and loci of innovation will vary. One can distinguish at least four different strategies:

i) *Outsourcing* and reduction of „core activities" (so-called „shipbuilding only"-strategy). Just like in automobile or machine production, Western capitalist shipbuilding has adopted the concept of „lean production" over the last decade.[9] Today, over 70% of the value-added of a ship comes from suppliers outside the yard; this tendency is increasing. The shipyard is reduced to purchasing and assembling (so-called „System leader"). Its productivity gain no longer comes from own R&D, but mainly from optimising the assembly procedure through „Simultaneous Engineering".[10] The suppliers organise themselves in hierarchical order, so that the largest suppliers themselves become „system suppliers", including R&D and services. This also implies close information integration between shipyard and system suppliers, and system suppliers and simple suppliers.[11]

ii) *From individual production to „compact shipyards"*. The issue of outsourcing is also directly related to the changing paradigm in shipbuilding: away from individual production towards automated assembly production in so-called „compact yards". The idea is to standardise the production process as much as possible, and to establish half-automated assembly lines. The three most modern shipyards under construction in Europe were conceived as compact yards (Kvaerner Warnemünde, MTW Wismar, Peene Werft Wolgast).

iii) *Specialisation*, in particular between shipbuilders within a larger industrial group. A tendency that is gaining momentum in Europe is the concentration of shipbuilding and the increasing specialisation of production in individual yards.[12] Yard specialisation can improve

[9] VSM (1994), p. 20.
[10] VSM (1994), p. 21.
[11] The 400 German supply enterprises, for example, employ about 70,000 people, and have a turnover of 13 bn. DM (7 bn. Ecu), 60% of which is exported. At the same time, the German shipbuilding industry employs „only" 22,000 people and has a turnover of 5 bn. DM (2.8 bn. Ecu).
[12] Röller; Hirschhausen (1996), p. 19.

productivity and yield economies of scale, both in design and assembly. Also, the take-over of yards may facilitate the gradual reduction of capacity, as the closure of any one yard can be gradually prepared for within a group (it is not an „all-or-nothing“ decision, as in the case of single-yard firms).[13]

iv) *Downstream integration* to assure captive markets. Capital participation in shipping companies may be a means for a shipbuilder to assure captive markets, but also to approach the client's potential demand and technology changes. Capital ownership may be in both directions (i.e. shipyards owning shipping companies, e.g. the 50% stake that Bremer Vulkan held in the shipper Senator/DSR Reederei), or shipping companies owning shipyards (as in the Danish case, A.P. Moeller owning Odense shipyard and J. Lauritzen owning Danyard). Table 2 shows that 11 of the world's largest shipbuilders have a capital forward integration with shipping companies.

[13] The best example for scope economies from concentration is the Norwegian Kvaerner group; others are the concentration process under way in Northern Germany (Thyssen Industrie, combining Blohm+Voss and the Thyssen Nordseewerke, which Preussag's Howaldtswerk Deutsche Werft AG may join) and - until recently - the Bremer Vulkan concentration strategy.

Table 2: Downstream integration of the world's 20 largest shipbuilding groups[14]

Country	**Shipbuilding group**	Rank in world shipbuilding	capacity ('000 CGT)	**respective shipping company**	number of ships	'000 GT	Rank in world shipping
Japan	**MHI Mitsubishi Heavy Industry**	1	970	**NYK, Nippon Yusen Kaisha**	274	11,400	1
Korea	**Hyundai Heavy Industry**	2	797	**Hyundai Corporation**	111	3,000	20
Japan	**Kawasaki Heavy Industry**	3	606	**Kawasaki Kisen**	157	6,000	7
Japan	**Tsuneishi Onomichi**	4	558				
Japan	**IHI**	5	539				
Japan	**Kurushima Hitachi**	6	523				
Japan	**Hitachi**	7	522				
Japan	**Simitomo**	8	486				
Korea	**Daewoo (incl. Shin-Ah)**	9	424				
Norway	**Kvaerner**	10	420	**Bergesen**	46	4,400	10
Japan	**Mitsui Eng.&Shipb.**	11	400	**Mitsui OSK**	259	9,400	2
Germany	**Bremer Vulkan[15]**	12	340	**Senator**	30	919	
Italy	**Fin Cantieri**	13	327	**Finmare Group**	106	2,000	
China	**CSSC**	4	270	**China Ocean Shipping**	588	7,400	3
Korea	**Samsung HI**	15	189				
Spain	**AESA**	16	159	**Comp. Transatl. Esp. SA**	8	100	
Korea	**Corea Shipbuilding & Engineering**	17	150	**Hanjin**	80	2,140	
France	**Chantiers de l'Atlantique**	18	117				
Germany	**HDW Group Kiel**	19	114				
Denmark	**Odense Skpis**	20	102	**Maersk, Möller AP**	179	6,000	6

[14] As of 1993; source: Timmermann, Manfred (1993), p. 23.
[15] Liquidated in 1996.

2.1.4. Different institutional settings of production

Beyond the general tendencies described above, different institutional settings of production exist, which may also imply different links with the S&T system. We distinguish three „ideal types" of linking the process of shipbuilding to the upstream suppliers and downstream clients: i) the individual, non-integrated shipyard; ii) the Danish Maritime cluster; iii) the Japanese model of „co-competition".

i) The *individual, non-integrated shipyard* in Europe has no stable capital or other relations, neither with suppliers nor with clients. Its strategy is mainly cost reduction, production differentiation and specialisation towards the high-end of ships (e.g. gas and chemical tankers, passenger ships). It obtains productivity gains internally through automation of production, externally by integrating its suppliers' innovations. Being a non-integrated shipyard does not imply the total absence of co-operation: the relations between almost all individual shipyards are characterised by some form of „co-competition": while they compete for smaller, individual contracts, they co-operate in larger contracts, for which a single yard is to small. Many Western European shipyards can be characterised as individual, non-integrated.

ii) *The Danish Maritime cluster* is an attempt to institutionalise innovation in a competition-oriented environment.[16] The peculiarity of the cluster is that it is downstream oriented: the driving forces are the shipping companies that have accumulated capital participation of particular shipyards.[17] This does not impede competition between Danish and foreign yards; it does imply, though, that shipper and shipyards co-operate closely in the development of *new technologies* and *new types of ships*. If an innovative order is at stake, a shipper will place the order with „his" shipyards.[18] The Danish maritime cluster furthermore stretches to system suppliers, financial institutions, and the state. The latter subsidises shipping companies with cheap and secured loans; the shippers can then pass on a part of the subsidy to their ship producers (be they Danish or foreign). Further instruments of „clustering" are research

[16] This section is based upon „The European Shipbuilding Industry", op. cit, pp. 11-17.
[17] All but one shipyard in Denmark are owned by a shipping company: Odense Shipyard is owned by the biggest Danish shipping company A.P. Moeller (Maersk Line), while the shipping company Lauritzen owns Danyard, which was formed by a merger of Aalborg, Frederikshaven and Helsingoers shipyards. The only non-integrated shipyard, Burmeister&Wain, went bankrupt in 1996...
[18] An example of such strategic behaviour is the development of very large container ships (Panamax-type), which A.P. Moeller required, and the development of which it gave to its Odense shipyard.

programs, partially financed by the Danish Ministry of Industry, in which shippers, shipyards, suppliers, and other firms participate.[19]

iii) The *Japanese model of state/industry „co-competition"* is based on an important role of pre-competitive research (state-financed, carried out in a „National Institute for Shipbuilding") and a long-term, unwritten co-operation understanding between the state, the yards, and the shipping companies. In times of crises (e.g. the 1976-91 crisis), the state watches over the restructuring of the shipbuilding industry and assures its survival; in expansionary times, the shipyards actually compete with each other. Shipyards usually belong to a larger industrial group („Keiretsu"). In 1993, eight of the world's 11 largest shipyards were Japanese (see above table 2). It seems that the South Korean institutional setting largely resembles the Japanese one.

2.1.5. Links to the S&T system

2.1.5.1. Sources of innovations in the shipbuilding industry

The links to the S&T system are widely spread in the shipbuilding business because large parts of production are outsourced to external enterprises. The sources of innovation are on one hand the internal R&D capacities in the shipyard, and on the other hand external research institutes and the suppliers of the shipyard.

The internal R&D capacities mostly carry out the project and ship design and the construction plans. But sometimes even these tasks are outsourced to external partners. In particular, in Eastern Europe the ship design is often developed outside the shipyard. Other very important sources of innovations are the external partners of a shipyard, which are on one hand, the suppliers, and on the other hand, the external research institutes.

[19] E.g. the „project ship"-programme, initiated in 1986, which was a research programme to develop high-tech ships with modern information technology. The Danish Ministry of Industry financed 20 mn. DKR (out of a total volume supposed to be 45 mn. DKR). The results of the project were indeed significant: integrated ship control (software, system engineering) resulted in the reduction of crew members required on certain ships from 15-16 to 6-7, i.e. by 60% (ibid, p. 14; exhibit 10). This „success" does not at all imply that this research could not have been realized without state support; on the contrary, as the benefits can be easily internalized, and non-participants can be excluded from using the technology, there seems to be no reason why state support was necessary.

The high level of outsourcing implies that the suppliers occupy an important role as sources of innovation in the shipbuilding industry. So the R&D on several components is carried out by the supplying enterprises. This is true for equipment which is built in the ships (e.g. motors radar systems, computers, software etc.) as well as the equipment which is needed for production (e.g. robots, docks, plasma cutting machinery, cranes, etc.).

A third source of innovation in the shipbuilding industry are the external R&D institutes. These institutes are engaged in basic as well as applied research. Almost all basic research is carried out by institutes which are often state financed.

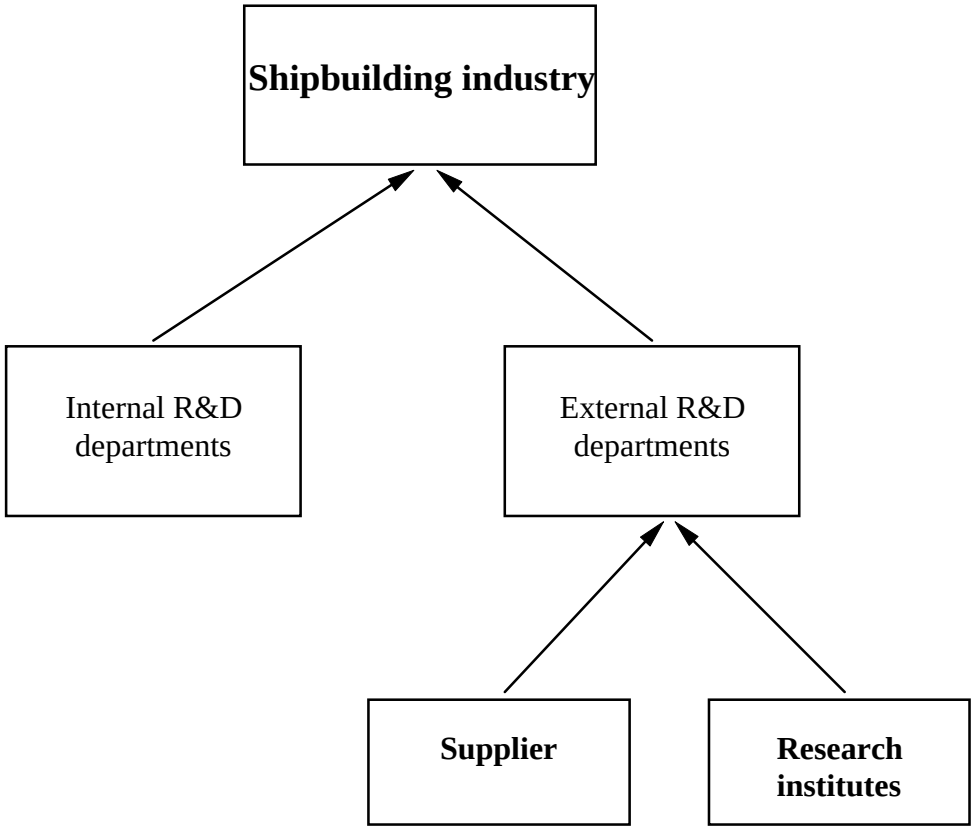


Figure 1: Sources of innovation in the shipbuilding sector

The importance of internal and external sources of innovation shifts with the level of outsourcing/integration. With a rising level of outsourcing (decreasing level of integration) the share of external R&D increases in the shipbuilding industry. With the outsourcing of production, R&D is outsourced as well.

2.1.5.2. The case of Germany

In Germany, shipbuilding has a long tradition and therefore the R&D structure of the shipbuilding industry is well established.[20] The R&D activities in the German shipbuilding industry are mainly focused on six different research fields.[21]

1. Basic research

This research field contains propulsion and resistance, manoeuvre, caviatation, Computational Fluid Dynamics (CFD), movements in swell, loading research, future dimensioning of ships, etc..

2. Production technology

This research field contains shipbuilding design technologies, planning and steering systems (PPS) in production, development of robots and steering of them for welding and bending, conservation and derust technologies, etc..

3. Ice technologies

This research field contains ice mechanics, development of icebreakers, offshore structures for and oil accident combat in ice covered stretches of water, harbour technologies, ice calculation and field measurements, etc..

4. Ship operation technologies

This research field contains development of technologies to increase the reliability, security and economics of ship operations.

5. Fast and unconventional ships

In this research field new vessels with unconventional superseding structures and buoyancy forces are developed.

[20] Roland Berger & Partner GmbH (1993), p. 47.
[21] Fritsche (1992), p. 80-85.

6. Information technology in shipbuilding (ITIS)
In this research field the use of modern information technology in shipbuilding and shipping is developed. Examples are control functions, loading control, computer steered production steps etc..

To fulfil these manifold research tasks a complex R&D structure exists in Germany. The following list should only give an impression of the R&D structure in Germany and is therefore not complete. The following institutes are engaged in basic as well as applied research:

1. Max-Plank-Gesellschaften (mainly basic research),
2. Universities (mainly basic research),
3. Institutes of Fraunhofer Gesellschaften (mainly research for the industry)
4. Arbeitsgemeinschaft industrieller Forschungsvereinigungen (AIF)
5. R&D departments of enterprises (incl. suppliers)

The so-called shipbuilding experimental institutes are specialised in shipbuilding and sea technologies:

1. Hamburgische Shiffbau-Versuchsanstalt GmbH (HSVA),
2. Versuchsanstalt für Wasserbau und Schiffbau, Berlin (VWS),
3. Versuchsanstalt für Binnenschiffbau Duisburg (VBD).

Teaching and research on shipbuilding and ship machine building are carried out at several universities:

1. University of Hamburg, Institute for shipbuilding
2. TU Hamburg-Harburg
3. TU Berlin (shipbuilding)
4. RWTH Aachen
5. TU Hannover
6. Institut für Schiffsbetriebstechnik Flensburg
7. University of Rostock

Alongside these mainly state financed research institutes, the Bundesministerium für Bildung, Wissenschaft, Forschung und Technologie (BMBF) funds research projects. The Germanische Lloyd (GL) is entrusted with the co-ordination and evaluation of these projects.[22] In 1996 the BMBF spent 45 million DM on special research projects for shipbuilding and maritime technology.[23]

One peculiar element of shipbuilding's S&T-system in Europe is the so-called „*Maritime-Forum*". It was institutionalised in Europe, as well as in larger individual countries. It is a „joint discussion forum" between all participants of the maritime industry, from suppliers, research institutions, yards, outfitters, security experts, harbour authorities, and shippers. This corresponds to what the EEC-Commission has called a „horizontal industrial policy" to strengthen the competitiveness of industry.[24] This vertical co-operation is being justified with the argument of economising on transaction costs and spreading technical knowledge between the enterprises. Individual countries have also established national "Maritime Forums" (e.g. Germany, Denmark). It is certainly not clear, however, whether „clustering" under state governance will mislead to a bargaining for more subsidies.

2.2. The shipbuilding markets

2.2.1. Different segments of the shipbuilding market

Contrary to popular belief, shipbuilding is not a homogeneous sector. At first, four main segments of the shipbuilding market can be distinguished: the merchant shipbuilding market, the naval shipbuilding market, the inland shipbuilding market and the ship repair market.
The merchant shipbuilding segment is the largest of the four. Most western coastal industrial countries have a shipbuilding industry which is, in all cases, subsidised by the government. The independence of foreign trade is the most stressed argument for the requirement of a national shipbuilding industry in those countries.

[22] Germanischer Lloyd (1996), p. 69.
[23] VSM (1997), p. 51.
[24] Df. COM (93) 526 final: On the way to conducting a global policy for the maritime industry: first concrete results.

The naval ship market is economically of lower importance but it must be mentioned that all countries with shipbuilding capacities are able to produce naval ships. Only in countries where the state demand for naval ships was so high that the full capacities of complete yards were used, do specialised yards exist solely for naval shipbuilding. Countries with large capacities for naval shipbuilding only are the USA, Russia and Ukraine. After the end of the Cold War, all countries with large naval shipbuilding capacities tried to convert their naval shipyards into civil ship yards. This influences the conditions and capacities of the merchant shipbuilding market. The conversion of naval shipyards leads to an increase in the already existing overcapacities. Furthermore conversion processes are mostly supported by the governments to a large extent, which increases the subsidising problem in the shipbuilding sector.[25] Figures on the development of this market segment and the industry (employment, products etc.) are secret and therefore not available. Because of this, the naval shipbuilding industry will not be analysed in this paper.

Inland shipbuilding plays an important role in countries with large waterways. In particular in Eastern European countries goods are often transported on inland waterways because of the bad condition of the roads. In western countries the importance of the inland shipping decreases because transport on roads is cheaper and quicker than on waterways. In any case , inland shipbuilding is marginal when compared with the maritime shipbuilding industry.

The ship repairing industry contains pure ship repairing enterprises as well as shipbuilding enterprises that also carry out ship repairing to make full use of their yard capacities.

The main focus of the paper is the merchant shipbuilding industry because of its importance for countries in terms of turnover, employment etc.. The S&T policy conclusions would be identical for the other segments, too.

Merchant shipbuilding market segments

The merchant shipbuilding market must be further divided into several segments because these segments differ in their basic conditions, such as complexity of products, production requirements, competition axes etc.. Complex equipment, special material or manufacturing methods, and individual design, for example, increase the technology requirements of a ship

[25] The latest example is the USA, which did not sign the OECD agreement on the reduction of subsidies in shipbuilding, because it would not longer be able to support the conversion process of its naval shipbuilding industry.

yard. Corresponding to the different level of complexity of the ship types, and measured in compensation coefficients, three groups of ships can be distinguished:

1. The first group of low complex ships (LCS) includes the most simple vessels, corresponding to a compensation coefficient of between 0.25 and 1.85. These are type 1 (crude oil tankers (single hull)), 2 (crude oil tankers (double hull)), 4 (bulk carriers (excluding combined carriers)) and 5 (combined carriers) in the OECD classification.[26] This ship group counts for 37.2% of world ship production in terms of CGT.[27]
2. The second group of medium complex ships (MCS) corresponds to intermediate compensation coefficients of between 0.45 and 2.05. This includes types 3 (product and chemical), 6 (general cargo), 7 (reefers), 8 (full container ships), 9 (roros), 10 (car carriers), 11 (LPGC) and 12 (LNGC).[28] This group unites 48.8% of the world ship production in terms of CGT.[29]
3. The third and last group of high complex ships (HCS) contains the remaining ships, including compensation coefficients of between 0.9 and 6.0. This group embodies the types 3 (ferries), 4 (passenger), 5 (fishing) and 16 (other non cargo).[30]14% of the produced CGT in the world belongs to this group.[31]

[26] AWES (1997), p. 27.
[27] AWES (1997), p. 95.
[28] AWES (1997), p. 27.
[29] AWES (1997), p. 95.
[30] AWES (1997), p. 27.
[31] AWES (1997), p. 95.

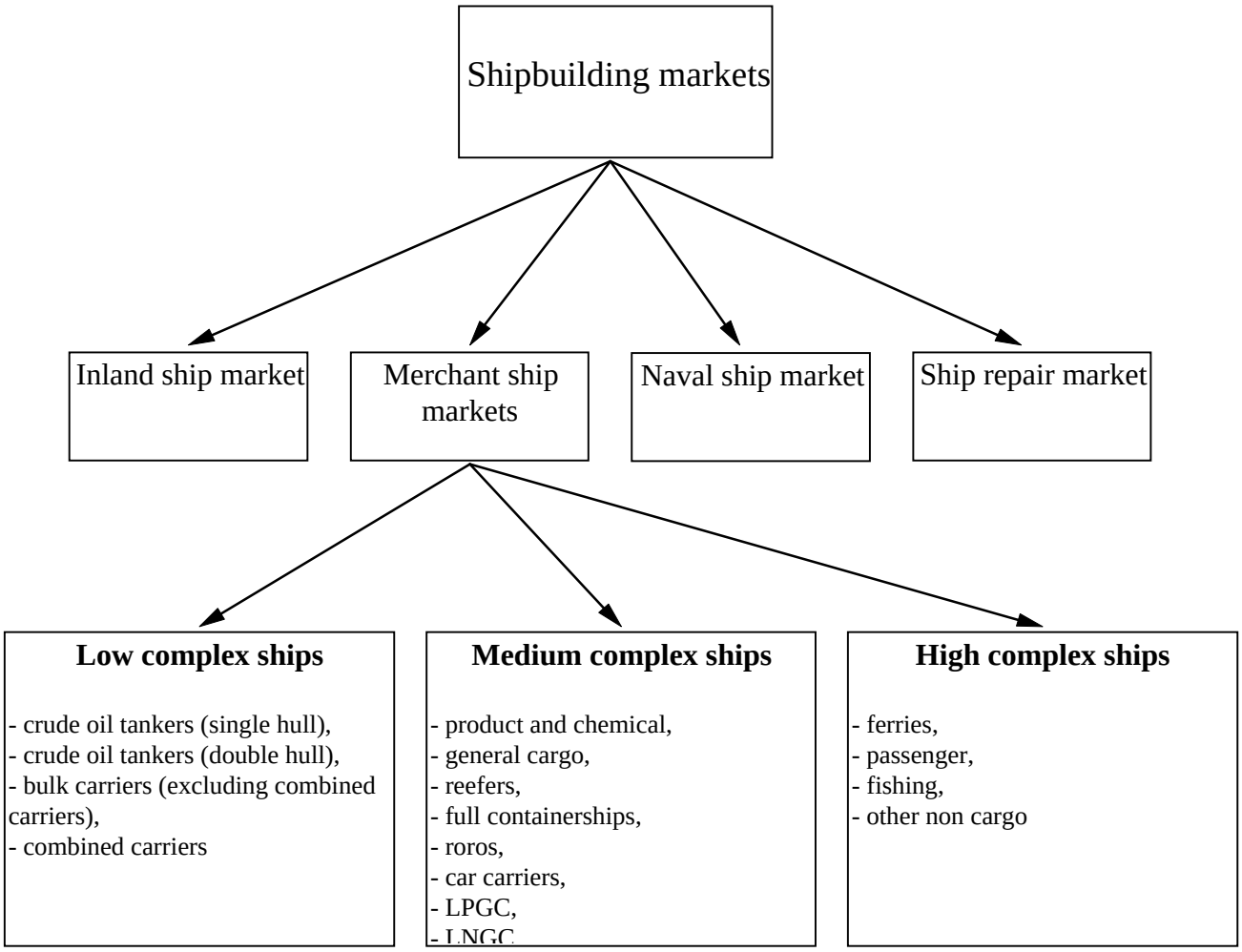


Figure 2: Segments of the shipbuilding market

Each of these segments requires different strategies for success which will be analysed in the next chapter.

2.2.2. Competition on the shipbuilding market

Competition on the shipbuilding market is very strong, because the shipping companies can purchase their ships all over the world in a large number of fairly similar yards. The overcapacities in the world further intensify this situation. The following can be identified as active competition axes:[32]

- price,
- quality,
- product innovation,
- delivery period,
- meeting of deadlines,
- customer service,
- flexibility,
- reputation, and
- financing services.

The striking competition factor in all market segments is the price. In particular, in the segment for LCS, which are produced in greater numbers as standard products, the price is the most important competition axis. With increasing complexity the importance of the price decreases.[33]

In the case of quality the relation between complexity of the vessel and the importance of the competition axis is reversed. With an increase in the complexity, the importance of quality also increases. The complexity of a ship is characterised by the use of complex equipment, special material or manufacturing methods, individual design etc., in the production and equipment of the produced ship. With more complex production methods or required equipment in the ship, the likelihood of errors rises. Therefore the quality is more important than in the case of a LCS.

Product innovations are a key factor in competition on the shipbuilding market. Product innovations in shipbuilding, for example, could reduce the number of crew required, lower maintenance costs, increase load capacities, reduce unloading times etc.. So product innovations play an important role in competition on the shipbuilding market. But not all ship types have the same innovation potential.[34] This depends on the degree of maturity and on the complexity of the ship type. If a ship type has reached a high level of maturity it becomes more

[32] Borla (1995), p. 81-94.
[33] Borla (1995), p. 84-85.
[34] Borla (1995), p. 89.

and more difficult to improve, for example the ship's loading technology. In the case of container ships, the innovation potential is still high because this ship type only originates in the 1980s. On the other hand, oil tankers have existed for longer and therefore an improvement is more difficult. Nevertheless, there is a lot of innovation potential which concerns all ship types, such as like propulsion technology, ship form etc..

Another important competition axis is the delivery period. Shipping companies are interested in reducing delivery periods, because they can then reduce their investment risk. If the ship is delivered very quickly, the risk of changing interest rates and currency changes is reduced. The same is true for the change in shipping demand. When the delivery of a ship takes too long, the situation on the shipping market can have changed immensely so that the ship is not required at the time it is delivered.

The delivery period leads us to the next competition axis mentioned, the meeting of deadlines. For shipping companies it is also important that the supplier holds to the delivery date, because they have planned the use of the ship. Furthermore, delayed delivery increases the interest, currency exchange and shipping demand risk as described above.

The next competition axis is customer service, which includes looking after the customer, not only in the guarantee time, but also beyond this time. This service includes support or offering repairs, modernisation, extension etc..

The flexibility of shipbuilders is very important in the production of HCS. Because these ships are mostly single units, the possibility of influencing the planning and production process of the ship is very important for shipping companies. The flexibility to integrate the wishes of the customer in the planning and even in the production process, is therefore a competition advantage.[35]

As the description of the competition axes above has shown, planning, production and financing of a new ship is a complex task. Therefore, the reputation of a shipyard becomes an important competition axis. If shipping companies have positive experience with a shipyard in terms of delivery period, meeting deadlines, quality etc. the shipyard gains a competition advantage over its competitors.

The purchase of a new ship is a large investment. Therefore questions of financing play an important role for the demanding shipping companies. The offer of assistance or special conditions for the financing of the ship is an important competition axis. In particular, in countries where ship prices are high, such services can constitute a competition disadvantage in

[35] Borla (1995), p. 91.

prices because in the medium and long and long term it works like a price reduction. So it can be seen that financial services play a more important role in the segments for HCS than in the segments for LCS.

2.3. Development of the shipbuilding industry

2.3.1. Demand for new ships

The demand for new ships has to be divided into the replacement demand and the additional demand.

The replacement demand for new ships is influenced by:[36]

- the age structure of the world fleet,
- the development of the returns of shipping,
- the prices for new ships,
- interest rates,
- product innovations,
- and international legislation.

In particular, the age structure of the world fleet is decisive for the replacement demand. To a certain extent the lifespan of a ship can be extended, but repair costs and maintenance costs then increase. The average lifespan for a ship is between 20 and 30 years. The average age of the world fleet in 1996 was 19 years. Measured in GT, 28% of the world fleet was 20 years old or more in 1996. The following figure shows the share of ships over 20 years of age by ship type.[37]

[36] Borla (1995), p. 134-135.
[37] Source: Lloyd's (1996), own calculations.

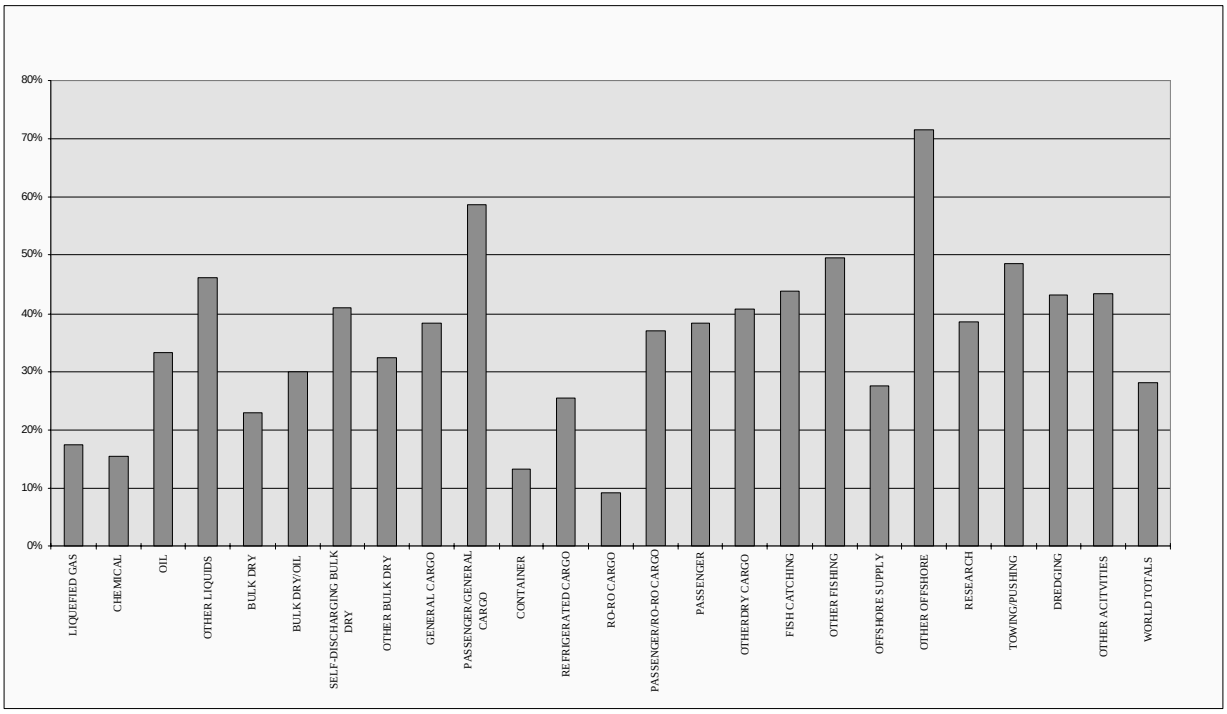


Figure 3: Shares of ships over 20 years old in 1996 by ship types[38]

Low returns of the shipping business are a hampering factor for the purchase of new ships. Because the ship owners have to finance the new ship, which is a large investment, the financial situation of the demanding shipping enterprises is important. Equally important for the decision are the prices of the new ships. The prices differ with the use of shipbuilding capacities and currency developments.

The price leads us to the conditions of financing. The interest rates for financing are of great importance because the purchase of a ship is a large investment. So ship owners defer their ship purchases if interest rates are high. All the above-mentioned influencing factors can lead to the decision to extend the use of a ship instead of buying a new one.

On the other hand, product innovation and the international legislation (IMO) can lead to an increase of the replacement demand. In particular, if the innovations lead to a lower crew number and/or a decrease of maintenance costs, ship owners often choose to purchase new ships instead of modernising old ones. International agreements which lay down the required ship equipment have another positive influence on replacement demand. For example, the tanker accidents of recent years, with their large pollution of the environment, led to an increase in security requirements in shipping and the shipbuilding business. The new regulations for shipping and shipbuilding are internationally laid down by the International

[38] Source: Lloyd's Register of Shipping (1996), own calculations.

Maritime Organisation (IMO). These regulations normally lead in the medium term to the requirement of modernising the equipment of a ship or purchasing of a new one (e.g. double hull tankers).

The additional demand is influenced through:

- the development of seaborne trade,
- product innovations,
- the development of transport efficiency,
- and the development of transport alternatives.

Additional demand is required to serve the steadily growing seaborne trade. So the development of this demand is closely connected to the development of world trade activities and with it the seaborne trade. It is by far the most important influence on the demand for new ships. Sometimes product innovations lead to an increase in the demand for new ships. For example, the introduction of container units leads to an increase in demand for such ships.
The additional demand is negatively influenced by the increase in transport efficiency and an increase in alternative transport possibilities. Developments in logistic management as well as in transportation technology lead to an increase in transport efficiency which lowers the growth rates of additional demand. The increasing importance of alternative transportation forms lowers the demand development of special ship types. Oil and gas tankers, for example, get more and more competition from pipelines; in particular in the growing trade between Western and Eastern Europe, pipelines play an important role as transport medium. Passenger ships are another example: as a result of falling prices for air travel, the demand for passenger transport by ships decreases. Therefore the demand for passenger ships is negatively influenced by this development.

2.3.2. Development of shipbuilding

The development of seaborne trade has the most important influence on the demand for new ships. With a rise in seaborne trade, the demand for transport capacities also rises, with a lag.

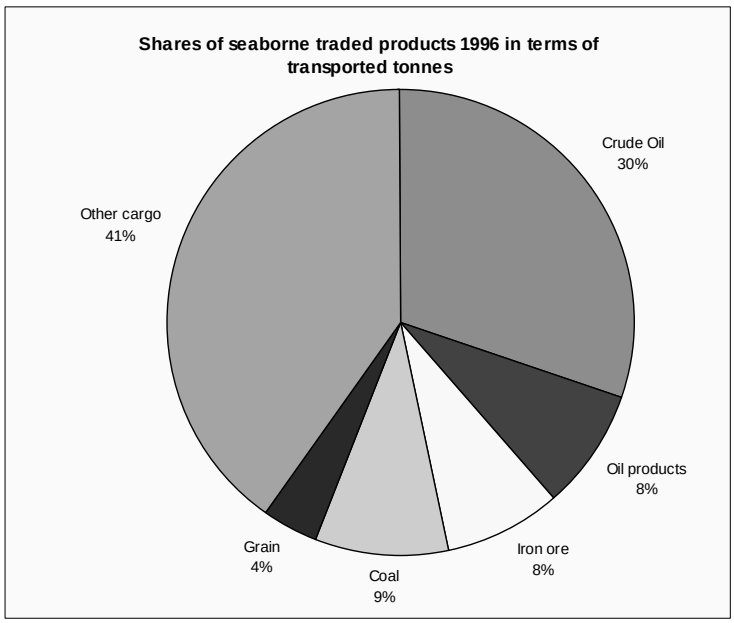
World seaborne trade grew steadily by about 20% from 3,977 million tonnes in 1990 to 4,790 million tonnes in 1996.[39] In the same period, world ship production grew by about 41%.

	1990	1991	1992	1993	1994	1995	1996*
Completions in 1,000 CGT	11,656	11,526	12,116	12,380	12,636	14,325	16,550
Changes in %		-1%	5%	2%	2%	13%	16%
Seaborne trade in million T	3,977	4,110	4,221	4,339	4,506	4,678	4,790
Changes in %		3%	3%	3%	4%	4%	2%

Source: AWES, Annual Report 1996-1997/ Annual Report 1995-1996/ Annual Report 1994-1995
* estimated

Table 3: World ship production and seaborne trade 1991-96 in 1,000 CGT

The largest single transported good is still crude oil, followed by coal, ion ore, oil products and grain.[40]



Source: AWES (1997), p. 106.

Figure 4: Share of seaborne trade by goods 1996.

The different regions of the world participated differently in this increase in production in recent years. Because ship yards all over the world compete with each other, the situation on the world markets has recently changed immensely. Strong shifts between the market shares of different countries can be observed. The push of the post-socialist countries of Central and Eastern Europe on the world shipbuilding markets increases this tendency. The share of the

[39] AWES (1996), p. 57 and AWES (1997), p. 94; Böhme (1997), p. 11.
[40] AWES (1996), p. 57, own calculations.

AWES countries[41] dropped from 28% in 1990 to 23% in 1994.[42] In contrast to this, the market share of South Korea increased from 13.4% in 1990 to 21.4% in 1996. The market leader, Japan, more or less held its market share, which is about 40%. The rest of the world ("others" in the following table), including the USA and China, also almost held their market share. It should be added that the market share of China has risen quickly in recent years.

	1990	1991	1992	1993	1994	1995	1996
AWES*	3,285	3,158	3,396	3,010	2,902	3,705	4,304
Market share in %*	**28.2**	**27.4**	**28.0**	**24.3**	**23.0**	**25.9**	**26.0**
Japan	4,456	4,417	4,379	4,854	5,177	5,644	5,991
Market share in %	**38.2**	**38.3**	**36.1**	**39.2**	**41.0**	**39.4**	**36.2**
South Korea	1,564	1,729	1,995	1,835	2,104	2,887	3,549
Market share in %	**13.4**	**15.0**	**16.5**	**14.8**	**16.7**	**20.2**	**21.4**
Others	2,351	2,222	2,346	2,681	2,453	2,089	2,706
Market share in %	**20.2**	**19.3**	**19.4**	**21.7**	**19.4**	**14.6**	**16.4**
Total	11,656	11,526	12,116	12,380	12,636	14,325	16,551

* From 1995 including Poland

Source: AWES, Annual Report 1996-1997/ Annual Report 1995-1996/ Annual Report 1994-1995

Table 4: World ship production by countries 1990-1996

The top 5 shipbuilding countries in the world are Japan, South Korea, Germany, China and Italy. Together they held a market share of 72.1% in terms of compensated gross tonnage (CGT) in 1996.[43]

Top 5 shipbuilding countries 1996		
Country	**1,000 CGT**	**%**
1. Japan	6,099	35.9
2. South Korea	3,603	21.5
3. Germany	1,123	6.7
4. China	777	4.6
5. Italy	564	3.4
Total	**12,166**	**72.1**
Source: VSM (1996), p. 34.		

Table 5: Top 5 shipbuilding countries

An analysis of the market segments for different ship types shows a specialisation in different regions of the world and countries.

[41] AWES countries are the EC countries plus Norway and Poland.

[42] The increase of the AWES market share in 1995 results mainly from the addition of Poland to the AWES organisation.

[43] VSM (1996), p. 34.

2.3.3. Specialisation of different countries

As described above the complexity of ships differs greatly and with the complexity the requirements from shipyards also rises. With a change in the level of complexity, the shares of labour and material costs shift. The share of labour costs for LCS is higher than in the case of HCS, where the equipment raises the share of material costs. It can be observed that countries with low labour costs, and often also low productivity, are mostly located in the market segment for LCS. Countries with high labour costs try to use their productivity advantages and technological knowledge to compete with the low labour cost countries. Today the productivity advantages are mostly not high enough to compensated the disadvantages in labour costs. Therefore the high labour cost countries are mostly engaged in high complex ship market segments, where the labour costs are of lower importance than in the segments for low complex standard ships.

in %	AWES	Japan	South Korea	Others
Low complex ships	6.1	53.1	27.5	13.3
Medium complex ships	29.9	30.3	22.6	17.1
High complex ships	65.5	11.7	1.2	21.6
Source: AWES (1997), p. 95.				

Table 6: Market shares in different market segments by regions[44]

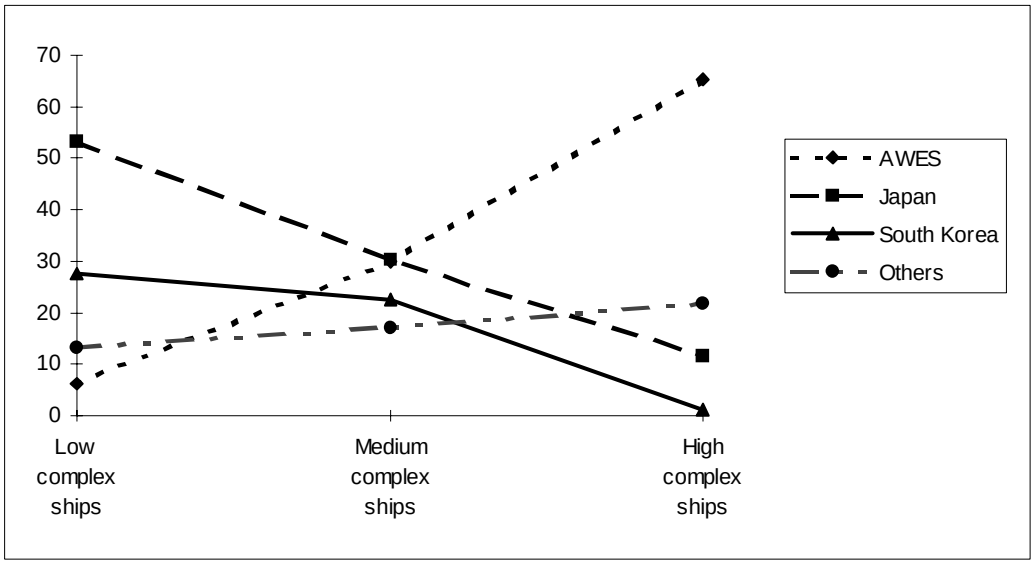


Figure 5: Strategies of specialisation by different regions

[44] Source: AWES (1997), p. 95.

Table 6 and figure 5 above show that Japan (53.1%) and South Korea (27.5%) dominate the market segment for LCS. AWES[45] countries were only able to capture an insignificant market share of 6.1% although this market segment counts for 37.2% of the produced CGT in the world.[46]

In the market segment for MCS, Japan and the AWES countries have nearly the same market share about 30%. They are closely followed by South Korea with a market share of 22.6%. In 1996 the market segment for MCS corresponded to 48.8% of world ship production in terms of CGT.[47]

In the market segment for HCS, the AWES countries are market leaders with 65.5% market share and a large margin to the second. Japan holds only 11.2% and South Korea 1.2% of the market for HCS. The market segment for HCS is the smallest of the three segments of the shipbuilding market with 14% of world ship production in terms of CGT.[48]

The result of the analysis is that the different regions/countries are engaged in different market segments. Japan is mainly engaged in the market segments of LCS and MCS which count for 86% of ship production world wide. As the complexity of the ships increases the market shares of Japan decrease. But in the case of Japan this seems to be a more strategic decision than low competitiveness in the HCS market segment. The same strategy can be observed in South Korea which holds an important market share in LCS and MCS but an insignificant market share of 1.2% in the HCS market segment. The 13 AWES countries are mainly engaged in the more profitable HCS market segment where they hold a market share of 65%. As the complexity of the ships decreases they lose their competitiveness, and, as a result of this, their market share drops to only 6.1% in the market segment for LCS.

2.4. Current public policies in the shipbuilding sector

The development and competition in the shipbuilding industry is greatly influenced by public policies all over the world. As a result of the regional differences in terms of public subsidies

[45] At this point it should be added that the AWES organisation contain 13 countries. This should qualify the comparisons made here.
[46] AWES (1997), p. 95.
[47] AWES (1997), p. 95.
[48] AWES (1997), p. 95.

granted, the shipbuilding industry is characterised by a high distortion of competition. The efforts in the European Union to harmonise the conditions of public support resulted in the Seventh Directive (90/684/EEC) of the EC, which regulates public support in the EC. In contrast to this, the attempt to reach harmonisation in the frame of the OECD (including Japan, South Korea and the United States) failed. The "OECD Agreement on Normal Competitive Conditions in the Commercial Shipbuilding and Repair Industry"[49], which should already have been enforced at the end of 1995, has still not come into force in mid of 1997. Today only the United States has not ratified the agreement and therefore prevents its enforcement.[50]

Public support of the shipbuilding industry in the EC

In order to "minimise" the distortion of competition in the European Union in 1990 the Seventh Directive (90/684/EEC) was passed, which regulates national aid to the shipbuilding industry.[51] The Directive contains two instruments: operating aid and restructuring aid.
Operating aid is granted as a percentage of the contract value before aid. Each year the EC determines a ceiling for public aid, which results from a comparison between the most competitive Community shipyards and their main competitors (mostly from the Far East). In recent years the ceiling was fixed at 9.9%.[52]

Restructuring aid includes investment aid, aid for closures and aid for research and development. The aim for this aid is to narrow the gap between the least and most efficient shipyards. Another aim is the reduction of overcapacities in the industry. Investment aid may not be granted for the creation of new shipyards or the creation of further overcapacities. The implementation of the Seventh Directive is controlled by the European Commission. All aid paid to shipyards must be authorised by the European Commission.

Furthermore, the EC funds research and development programs for maritime technology.[53] In addition to this, every national government in the EC has the possibility of funding further

[49] OECD (1995b).
[50] Böhme (1997), p. 42.
[51] European Commission (1990).
[52] VSM (1996), p. 44-45.
[53] Europäische Kommission (1995a), p. 14.

research and development projects in its own country. In 1996 Western Germany spent about DM 45 million on R&D projects in maritime technology.[54]

Public support of the shipbuilding industry in Japan and South Korea

Information about the financial support granted to the shipbuilding industry is handled very restrictively by the institutions in the Asian countries. In the 1980s the shipbuilding industry had a priority in industrial policy. The development of the sector was financially supported by the Japanese government. The traditional close co-operation of the state, shipyards and the shipping companies in Japan guarantees an institutional framework for the steady development of the shipbuilding industry. The investment risk was reduced by the government's guarantee of supporting the branch in economic crises.[55]
In South Korea the shipbuilding industry was immensely supported by the government through the 1980s and the early 1990s. After the successful international establishment of the industry, government support was reduced and the industrial priority shifted to other branches.

Like the EC, Japan and South Korea support R&D in maritime technology. Both governments fund a national shipbuilding research institute and grant financing of special projects. Further public support for the shipbuilding industry is restructuring aid, aid for export credits and credits for ship owners.[56]

3. The Eastern European shipbuilding industry

3.1. Point of departure: the breakdown of socialist, multifunctional shipyards

Under socialism, shipbuilding was first and foremost a military, strategic activity. Civil shipbuilding was considered secondary. The structure of the shipyards and the modes of production reflected the principles of socialist production: shipyards were multifunctional units, in which the production of ships was but one objective; other functions were the provision of

[54] VSM (1997), p. 51.
[55] Arthur D Little (1993), p. VIII.
[56] Arthur D Little (1993), p. IX-XI.

social services to employees (such as housing, education, culture, access to consumer goods, etc.) and the maintenance of some political activity and control.

With respect to ship production, a socialist shipyard was characterised by enormous production depth, i.e. the in-house fabrication of ship outfits and machinery equipment including winches, steering gear, accommodation, electrical equipment, switchboards, etc..[57] Integration was pushed to the limits in the Krasnoje Sormovo shipyard (Nizhny Novgorod), which had its own steel production and rolling mills.[58]

Employment in socialist shipyards was very high, when compared on a man/CGT-basis. Direct employment was 3-4-times higher than in capitalist, Western European, shipyards in the 1980s.[59] In East Germany, for example, where the restructuring from socialist to capitalist shipyards took place extremely quickly, direct employment in the five largest yards was reduced from 21,000 to about 6,000, with no significant reductions in CGT-output. Consequently, productivity levels of socialist shipyards were low. Table 7 shows average estimates for labour productivity in shipbuilding in the early 1990s (Russia and Ukraine are representative of other post-socialist countries). While the difference between the good world averages and the good European averages is already striking (almost 1:2), post-socialist countries lagged far behind at about 0.05-0.075 employee per CGT.

Table 7: Productivity estimates for shipyards (early 1990s)

Country	Productivity (in employee years/CGT)
Russia/Ukraine	0.005-0,075
Good European	0.022-0.028
East Germany (after restructuring)	0.019-0.024
Good World	0.011-0.017

Sources: AWES, VSM, OECD (1995a)

[57] OECD (1995e), p. 8.
[58] Ibid.
[59] Though given the increasing degree of outsourcing in capitalist shipyards, and the vast non-productive activities in socialist shipyards, this direct comparison has to be interpreted with care.

In contrast to the deep integration of all productive activities, the socialist shipyard had practically no proper design or innovation capacity. Design bureaus were independent units, though they usually belonged to the same Ministry. The design bureaus carried out all stages of work „from initial design to workshop drawings including material take-off and makers list“.[60] The shipyards themselves were reduced to being assemblers. Thus, their capacity for product differentiation or innovation was very limited.[61] The development of own engineering and design capacity will therefore be a crucial element of the post-socialist restructuring strategy.

With the end of socialism, the socialist industrial structures fell apart, too.[62] Monetarisation and the abandoning of the Party-dominated, non-monetary production lead to the implementation of new constraints. Just like all socialist productive structures, the multifunctional shipyards, also, lost their „raison d'être“. Capital constraints and increasing national and international competition required a radical restructuring of the „industrial ruins of socialism“. Indeed, it turned out that none of the socialist shipyards in Eastern Europe would be economically viable as such.

We have called the transformation of socialist industrial combines into capitalist enterprises the process of „enterprisation“.[63] In the following, we shall describe three different patterns of enterprisation that socialist shipyards have undergone so far: i) the East German enterprisation through capitalisation; ii) the Polish rapid enterprisation process (which is representative for other CEE-countries, such as Romania or Croatia); iii) the Russian and Ukrainian hampered enterprisation with significant state intervention. Our hypothesis is that each of the restructuring strategies implies different modes of innovation.

3.2. The capitalisation of the East German shipbuilding industry [64]

We consider the East German case because of the radical nature of the restructuring process; it will later serve as a benchmark for evaluating the reform process in other post-socialist

[60] OECD (1995e), p. 7.
[61] There may be differentiation between Soviet Union shipyards and Eastern European ones; the latter, e.g. GDR and Pland, already exported some ships to the West, and thus had to have some capacity of design adaptation.
[62] Hirschhausen (1996).
[63] Bomsel (1995), v.Hirschhausen (1996).
[64] This section draws on case studies carried out by one of the authors, as reported in Röller and v.Hirschhausen (1996, pp. 13-21).

countries. The restructuring of the East German shipbuilding industry was a radical case of enterprisation, as the socialist shipyards had become economically unviable the very day of monetary union with West Germany, i.e. 2. July 1990. The East German case is, off course, a case of post-socialist restructuring, albeit a very peculiar case. The necessity of radical restructuring became evident, once the yards were struck by the price shock of July 1990; deprived of their former clients in the Soviet Union, all seven yards ran substantial losses in 1990 and 1991 (amounting to several hundred million DM).

The only way to maintain some shipbuilding capacity - and thus some employment in the depressed shore-region of the Baltic Sea (Mecklenburg-Vorpommern) - was to inject massive investments and to create - practically from scratch - new shipyards. This meant that the Treuhandanstalt (THA), the German Ministry charged with restructuring East German industry, had to provide massive subsidies to attract external shipyards to take over some of the remnants of the East German yards, and to invest in new capacity. Under the post monetary union conditions, enterprisation in East Germany could only work with massive capital inflows; for this reason, it has been called the process of „capitalisation“.[65]

Table 8 shows a typical, representative case of capitalising an East German shipyard. The socialist Mathias Thesen Werft VEB („factory of the people“) employing 6,000 for a capacity of 135,000 socialist CGT, was closed down. On the same site, a new shipyard is being built, mainly financed by state subsidies; it will be one of the most modern „compact yards“ in Europe, featuring an entirely new product range. The new MTW Werft GmbH will employ about 1,200 people directly; another 900 jobs may be permanently created in 26 new small and medium enterprises around the site (e.g. in anti-corrosion, construction, concrete, part assembly; rigging (takelage); mechanical works, craftsmen, etc.). Only the following types of activities were kept as „core business“ within MTW: shipbuilders, welders, mechanical engineering; pipe builders; electricians, equipment people.

Table 8: Capitalisation of the socialist Mathias Thesen Werft VEB to the MTW Schiffswerft GmbH: - A case of creating "new" capacities[66]

	Under Socialism (1989)	**After Restructuring (1997/98)**
Name	Mathias Thesen Werft VEB (factory of the people)	MTW Schiffswerft GmbH

[65] Lazarus, (1993); Bomsel (1995).
[66] Röller; Hirschhausen (1996), p. 32.

Owner	Schiffbau-Kombinat Rostock, controlled by the Communist Party and its "Plan"	Taken over by the BvS (ex-Treuhandanstalt) and the Land of Mecklenburg-Vorpommern, after the liquidation of the former owner, the Bremer Vulkan Group
Berths	2 small open building berths for shipsizes 87x25 m (5,000 t) and 206x32 m (8,000 t)	New dry dock, 340x67 m; "compact yard 2000"
Product Range	Fishing vessels and refrigerator ships; multi-purpose transport vessels; container ships	Very large crude carriers, specialized container vessels, passenger vessels, chemical tankers
Maximum Size Ships	40,000 dead weight tons	300,000 dwt
Markets, Competition	Bartered with USSR; competition: none	Mainly European markets, competition with West European, and, increasingly, Polish shipyards
Employment	6,000 (including social functions)	1,388
Capacity	**135,000 CGT "socialist" capacity**	**ca. 100,000 CGT "new" capacity**
Treuhand-anstalt expenditures before privatization		686.5 mn. DM
THA State aid (falling under Art. 92)		997.4 mn. DM
private investment		ca. 50 mn. DM

In the other four shipyards, capitalisation proceeded similarly. As a result, five new shipyards are about to be created in East Germany, with - once finished - a nominal capacity of 327,000 CGT, but capable of producing well beyond 400,000 CGT. When accounting THA-expenditures and Art. 92-State aid, total expenses amount to 6.3 bn. DM (ca. 3.5 bn. Ecu)! About 350 mn. DM private investment was attracted, and about 6,000 permanent jobs created in the shipyards.[67] As all five yards were taken over by a West German or Western European group, they were all rapidly integrated into existing production and sales networks. This resolved the issue of a particular S&T or innovation policy. Innovation in the capitalised yards comes from the same sources as innovation in any Western yard. In the East German case, the only „S&T policy“ was to facilitate the unbundling of the former combines, and the creation of specialised SMEs.

3.3. Situation in the Eastern European shipbuilding industry 1996/97

[67] The restructuring of the shipyards that belonged to Bremer Vulkan (MTW, Volkswerft) was temporarily halted in 1996, after the liquidation of Bremer Vulkan. However, the Federal and Regional States have made it clear that they wish to continue financing the construction of the compact yards.

Before analysing the modes of enterprisation in post-socialist countries, we provide a general overview of national production figures. As a rule of thumb, with the end of socialism and the Cold War, the figures of Eastern European ship production dropped in all Eastern European countries. Some years after this breakdown production usually rises again, and today Poland, and to some extent Romania and Croatia, are serious competitors on the world ship market; Russia and Ukraine may become competitors in the near future.[68]

Eastern European ship production 1988-96

in 1,000 CGT broken down by countries

Production - Ships completed		1988	1989	1990	1991	1992	1993	1994	1995	1996
BULGARIA		n.a.	n.a.	n.a.	71	62	71	79	77	86
POLAND		344	238	177	223	306	264	345	474	480
ROMANIA		n.a.	n.a.	n.a.	126	147	72	22	150	149
USSR		56	227	482	365					
	RUSSIA					22	156	91	82	145
	UKRAINE					119	153	210	158	183
YUGOSLAVIA		230	328	293	240					
	CROATIA					238	104	165	97	257
EASTERN EUROPE		630	793	952	1,025	894	820	912	1,038	1,299

Sources: AWES Annual Reports 1992-1997, EEC Report of the Commission to the Council on the state of the shipbuilding industry, COM (95) 38 final, table 5a

Table 9: Eastern European shipbuilding production 1988-96

In 1996 Poland, which is the largest ship producer of the East European countries, held a market share of 2.9% in terms of world-wide CGT production. It is followed by Croatia, Ukraine, Romania, Russia and Bulgaria. In the last 3 years, these countries were all able to keep their market share stable. Together they account for about 7% of the CGT produced world-wide.

Market shares as a % of world-wide production	1992	1993	1994	1995	1996
BULGARIA	0.51	0.57	0.63	0.54	0.52
CROATIA	1.96	0.84	1.32	0.68	1.55
POLAND	2.53	2.13	2.77	3.31	2.90
ROMANIA	1.21	0.58	0.18	1.05	0.90
RUSSIA	0.18	1.26	0.73	0.57	0.87
UKRAINE	0.98	1.24	1.68	1.10	1.10
EASTERN EUROPE	7.38	6.62	7.31	7.25	7.85

Sources: AWES Annual Reports 1992-1997.

Table 10: Market shares of Eastern European shipbuilding countries 1992-96

[68] AWES (1996), p. 49.

The development of new orders in Eastern Europe shows that the shipbuilding industries are becoming competitive. The order stock in Eastern Europe grew by about 15% in 1994-95 which was higher than the world average of about 10% (see Appendix A).[69]

3.3.1. Situation in Poland

In 1990-91 the main market for the Polish shipbuilding industry, the Soviet Union, vanished. Production dropped by about 1/3 in this period. Today the Polish shipbuilding industry has finished its reorientation to western markets and has reached almost complete independence from the Russian market. About 95% of its production is exported, most of the orders coming from Germany.[70] Polish shipyards had 4.5% of the world wide order book stock in 1996 and they were able to capture 6.5% of new orders in terms of CGT. In the segment for container ships the Polish shipyards had a market share of 10.5% of the world-wide order stock in March 1997.[71] As the division of the orders shows, Poland is highly specialised in MCS ships which come to 71.61% of all captured orders. In particular, container ships are the speciality of the Polish shipyards. They alone cover 66.24% of the orders received. The production in the HCS segments will be in the nexte years insignificant because only 6.21% of Polish order books contain orders for passenger ships.

Poland

	Orderbook in March 1997 in 1,000 CGT	**Share of complete orderbook stock in %**
Oil	67,813	5.02
Bulk dry	231,660	17.16
LCS	**299,473**	**22.19**
Chemical	53,580	3.97
General Cargo	18,848	1.40
Container	894,160	66.24
MCS	**966,588**	**71.61**
Passenger	83,800	6.21
HCS	**83,800**	**6.21**
Total	**1,349,861**	**100**

Source: Lloyd's Register of Shipping (1997), own calculations.

[69] AWES (1996), p.53, own calculations.
[70] O. V. (1995b), p. 1-2.
[71] Lloyd's Register of Shipping (1997), own calculations.

Table 11: Order book stock of Polish shipyards in March 1997 and their division by ship types.

3.3.2. Situation in Russia

Global developments in Russia are not as rosy as in other East European countries. In 1990, the Russian government had announced that it would guarantee the existence of 20% of Russian shipbuilding capacity to secure the required supply of the state. But even for this aim the required Rouble fund was not made available. In July 1991 the Russian parliament passed the first version of the Russian Privatisation Law, but so far only 2 of the 16 existing shipyards have been privatised. The main reason for the slow privatisation is the high percentage of military production capacities, because they are still seen as being strategically important.[72]

These obstacles aside, Russia was able to attract 0.87% of world-wide ship production in terms of CGT in 1996. The order books of Russian shipyards accounted for 1.7% of world-wide stock in 1996, measured in CGT. But the new orders only accounted for 0.5% of new orders world-wide, also in terms of CGT.

Russia

	Orderbook in March 1997 in 1,000 CGT	**Share of complete orderbook stock in %**
Oil	50,264	15.85
Bulk dry	100,800	31.79
LCS	**151,064**	**47.64**
Chemical	8,662	2.73
General Cargo	138,115	43.55
Refrigerated Cargo	18,375	5.79
Ro-Ro Cargo	7,200	2.27
MCS	**165,152**	**52.08**
Passenger	900	0.28
HCS	**900**	**0.28**
Total	**317,116**	**100**

Source: Lloyd's Register of Shipping (1997), own calculations.

Table 12: Order book stock of Russian shipyards in March 1997 and their division by ship types.

[72] OECD (1995e), p. 5.

The division of the orders attracted shows a strong orientation to the LCS and MCS market segments. Together these two segments cover 99.72% of the captured orders in March 1997. Furthermore, the figures show that ship types with low complexity dominate future production in Russia.

3.3.3. Situation in Ukraine

As in Poland, the Ukrainian shipyards reoriented their economic activities to Western markets. By far the largest part of production is exported. The largest customer is Greece, followed by Russia which is still an important customer for Ukraine ships.[73]

In 1996 Ukraine held a market share of 1.1% of world-wide production in terms of CGT. In terms of world wide order storage, measured in CGT, it had a share of 1.7% in 1996. In the same year Ukraine was only able to attract 0.5% of new orders world-wide, measured in CGT.[74]

Despite this positive development in production and new orders attracted the main bottleneck of the Ukrainian shipbuilding industry is the medium and long term financial funding of production (see below).[75]

Ukraine

	Orderbook in March 1997 in 1,000 CGT	**Share of complete orderbook stock in %**
Oil	238,919	53.35
Bulk dry	114,000	25.46
LCS	**352,919**	**78.81**
General Cargo	14,000	3.13
Refrigerated Cargo	80,903	18.07
MCS	**94,903**	**21.19**
HCS	**-**	**0.00**
Total	**447,822**	**100**

Source: Lloyd's Register of Shipping (1997), own calculations.

Table 13: Order book stock of Ukrainian shipyards in March 1997 and their division by ship types.

[73] Lichter (1996).
[74] AWES (1996 and VSM (1996).
[75] vwd (1996), p. 5.

The order stock of Ukrainian shipyards shows they were mainly active in the LCS market segment, which covers 78.81% of captured orders in Ukraine. In the HCS segment they were not able to attract a single order.

3.3.4. Conclusions

As the production and captured orders show, Poland is the most successful shipbuilding nation in Eastern Europe. With its rapid reorientation to western markets, Poland was able to reach competitiveness in some segments of the shipbuilding market. In 1996 it was able to attract 10% of world-wide orders in the container ship segment.

Russia and Ukraine have similar developments in terms of production and attraction of orders. With world market shares of 0.87% and 1.1%, in terms of CGT, of world production, they are of lesser importance in the shipbuilding market.

The production of the three countries shows further different structures. Whereas the Polish shipyards are mainly active in the MCS market segment, Ukraine's shipbuilding industry is mainly active in the LCS segment. Russia's shipbuilding industry focuses mainly on LCS and MCS, where both segments have a similar importance. Similar for all Eastern European countries is the insignificant attraction or even the absence, as in the case of Ukraine, of orders for HCS.

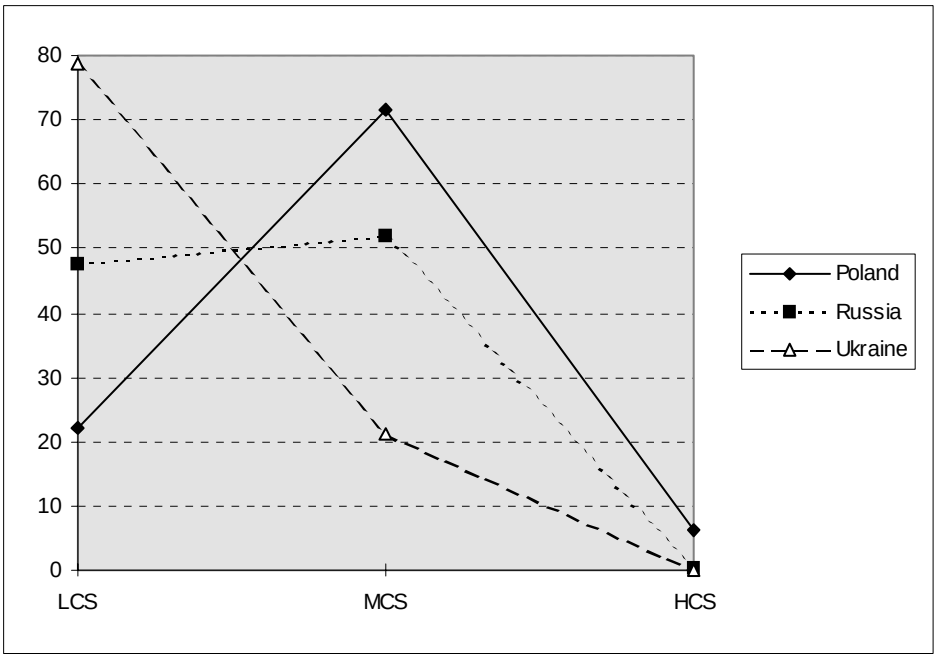


Figure 6: Division of the order stock of Poland, Russia and Ukraine in March 1997

3.4. Enterprisation, restructuring and public policies in Eastern Europe

In Eastern Europe, one can distinguish two fundamentally different paths of restructuring: Poland represents for relatively quick enterprisation, while Russia and Ukraine represent hampered and largely unachieved enterprisation. In this section, we sketch out the major trends in these countries.

3.4.1. Enterprisation of the Polish shipyards

The Polish shipbuilding industry is a good example of a promising turnaround that took place after enterprisation of the yards. In 1989, the three main shipyards (Szczecin, Gdynia, Gdansk) still produced mainly for Polish and Soviet Union clients.[76] Product specialisation was low, but so, too, were the maximum sizes of the ships (30,000 dwt maximum, at Szczecin). Exports to non-socialist countries already existed, but their absolute volume was limited (around 20%).

[76] We are concentrating on those three large shipyards that will be internationally relevant. Among the four other yards that we do not deal with, two are currently attempting conversion to civilian shipbuilding (Stoczina Polnocna S.A. in Gdansk and Stocznia Marynarki Wojennej in Gdynia), one was already enterprized by family businesses 8Stocznia Wisla) and one was closed down (Stocznia Ustka). Their radius of activity is only local.

Just as in other socialist countries, the degree of integration was high, including some (underdeveloped) design capacities.

Monetarisation in 1990 forced all three shipyards to adopt market- and capital-oriented restructuring strategies. Common elements of the process of enterprisation were the following:

- *product specialisation*; once all-rounder, the Polish yards sought to become competitive in the low-end segments, mainly container ships, general cargo vessels, and tankers. Sixty percent of Polish production is in this segment, where Polish yards have obtained a world market share of 11%; in the segment of 900-1,750 TEU container ships, Polish yards are even said to hold 35% of the world market!;[77]
- *outsourcing* could not proceed as quickly as in the East German case, but the Polish yards started to emulate the Western strategy of concentrating on core business. For example, Szczecin increased the external value added to 16% (1995) and rising, the other two increased to 10%.[78] The unbundled enterprises became independent economic entities, though generally they remained the sphere of a larger „holding" company for some time;[79]
- *labour shedding* was not as radical as in East Germany, but remained significant nonetheless. In the 1980s, employment in shipbuilding was about 40,000; in 1996, direct employment fell to about 22,000 in 1997 (of which: Szczecin: 6,000; Gdynia: 6,000; Gdansk: 7,000), to which a few thousands have to be added in subcontractors;
- *computerisation* and *process automation* was an integral part of the adaptation process. Computer hardware and software was purchased to enhance design and optimise production, but also for Management Information Systems (MIS);
- solving the issue of *debts and credits outstanding* was the major non-technical obstacle to obtaining liquidity for new investment. While the Polish government officially claimed not to support its shipbuilding industry, it did subsidise their development - indirectly - through the generous take-over of debts (that amounted to several tens of mn. USD).[80]

Though all three shipyards have embarked upon the enterprisation train, results are mixed. Only Szczecin has clearly established itself as a specialised, profitable shipyard and is increasingly competitive. The future of Gdynia depends on its capacity to attract investment, be

[77] BfAI (1996).
[78] OECD (1996c), p. 5.
[79] For example, the holding company that emerged in Szczecin comprised the whole range of a „maritime cluster", including shipbuilding, shipping, financial and insurance services, fuel company.
[80] O. V. (1995b).

it domestic (Szczecin is said to be interested) or foreign (e.g. the Norwegian Kvaerner group). As regards the most traditional Gdansk yard, it may surge like a phoenix from the ashes after its liquidation in 1997, depending upon the new owner's strategy.

The largest problem of the Polish yards is not the technical competitiveness but the high level of debts. The reasons for these debts are found in socialist times where contracts were signed for much too low prices and have to be carried out today with heavy losses. On the other hand large debts were accounted to the shipyards from the socialist governments which also have to be paid off today. So in some cases the government takes over the debts of the shipyards to secure their existence. Other support for the shipyards was not granted in the period 1990-95 by the Polish government.[81] In September 1994 the government decided to grant guarantees for credit extended by a bank to the Gdansk Shipyard for the first time.[82] In October 1995 the government further decided to grant financial support for US $ 600 million for increasing the competitiveness of their shipyards. This is granted in the form of allowances and credit guarantees.[83] It remains to be seen whether the Polish government adopts the same (bad) habits as shipbuilding nations around the world.

In any event, in 1997, the Polish shipbuilding industry seems to have overcome the worst traps of post-socialist restructuring, and embarked upon an ambitious catching-up process. Order books are increasing, and so is the ranking of Poland in international competition, in particular in Europe. Polish yards serve mainly German, French, and British clients (Germany alone buys about 40% of Polish ships, with Szczecin selling almost 2/3 to Germany).

3.4.2. Case study: enterprisation and new network at the Szczecin shipyard, 1990-97

The enterprisation of the Szczecin shipyard is the best example of how rapid enterprisation and the reorientation of production can lead to international competitiveness in post-socialist shipbuilding. On the verge of bankruptcy in 1991, Szczecin shipyard has emerged as the most competitive Eastern European yard, and is becoming an international benchmark in container shipbuilding.

After monetarisation in 1990, all Polish yards had to reorganise both production and the portfolios of ships. In socialist times, the Szczecin yard was the most backward of the three

[81] OECD (1995c), p. 6.
[82] OECD (1995), p.6.
[83] BfAI (1996).

large Polish yards, and could only produce medium-size ships. It was largely oriented towards Eastern European clients, most of whom cancelled their orders after 1990 or did not pay for finished ships. Hence, in late 1991, bankruptcy was considered as the only solution. Only the fact that it was still state-owned and was the major employer in the region guaranteed its survival.

The turnaround came with specialisation on a small segment of low value-added ships (mainly container vessels), the development of new, Western clients, and increased outsourcing and co-operation with multiple suppliers. The key operation may have been acquiring an extremely long series of contracts for the B-183 container vessel (1,000 TEU), for which the first order was received in 1989. Since 1991, no less than 30 (!) vessels of this type were built, enabling the shipyard to organise efficient production structures, cut new building times, and reduce costs.[84] Following up on this success story, Szczecin has become a major international player in container shipbuilding.

As concerns the organisational structure, outsourcing and the development of new supplier relations meant that Szczecin specialised in shipbuilding and abandoned some of its former activities (e.g. software production, which is now imported). Investments were made in automation, capacity increase (the new Odra-Nowa Slipway permits the construction of ships with a hull width of 40 m, including modern Panamax bulkers up to 50,000 dwt and container vessels up to 2,500 TEU), and increasing technical and production capabilities.

Figure 7 shows the emerging network of the Szczecin-shipyard, both with regard to suppliers and clients. We estimate that most of the sources of innovation are external (though the precise links to the many Polish research institutions have yet to be clarified). *Upstream*, Szczecin was able to support the modernisation of the motor supplier HCP and the conversion of the FAMAK Machines and Appliances Factory (Kluczbork), a former mining supplier. Interestingly, the Polish yard employs 200 Russian welders, who demand low wages at equal quality. *Downstream*, Szczecin's integration with the Polish shipping company PZM shipping can only marginally offset its dependence upon Western European clients; two thirds of the final demand is accounted for German shipping companies. On the horizontal axis, participation in its equity (30%) of two large banks (Polski Bank Rozwoji and Bank Handlowy) and the purchase of an insurance company have strengthened Szczecin's financial capabilities.

[84] Jaszowski (1994), p. 25.

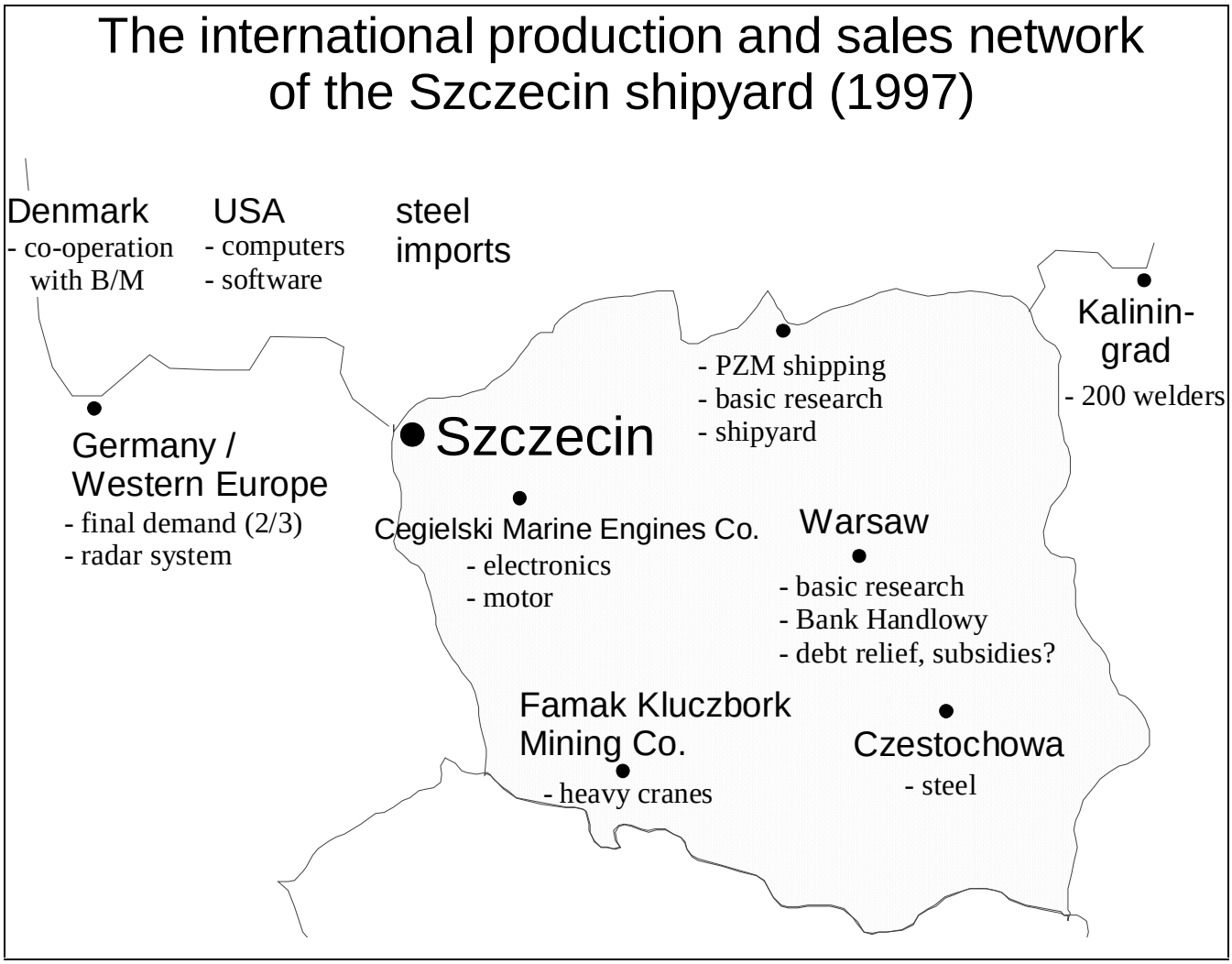


Figure 7: The international production and sales network of the Szczecin shipyard

Today, having succeeded but not having consolidated its enterprisation process, Szczecin has two basic options: either to proceed along the path of product specialisation and concentrate on shipbuilding, or to diversify into an industrial group in which shipbuilding plays only a minor part. Given the success story of the last five years in shipbuilding, the former strategy seems to be a more realistic choice. In that case, outsourcing would have to be continued, specialisation pushed further, and the current situation as a strong niche-player be maintained. However, it seems that the Szczecin yard - and along with it the Polish government that is still stuck with some ownership - prefers the creation of an industrial shipbuilding group. In that latter case, the group would also have to take care of suppliers (e.g. HCP engines) and, eventually, even the Gdynia yard.[85] In that case, though, the Szczecin yard and the Polish

[85] Kapoor (1997), AWES (1997).

government would forego a unique opportunity: to prove to the rest of the world that shipbuilding*can* be a profitable activity that does not have to be permanently subsidised.

3.4.3. Enterprisation and state industrial policy in Russia and Ukraine

In Russia and Ukraine, the enterprisation of the shipyards has started, but the process is quite different from the Polish and other CEE-countries' cases:

- enterprisation is slower;
- in Russia, there is only one geographical area that concentrates over 75% of the country's shipbuilding activities (Leningrad oblast), which has led to a very peculiar post-socialist „cluster";
- the state continues to pursue an active, vertically-oriented industrial policy, in particular Ukraine, trying to preserve the unpreservable socialist industrial structures.

Given these particularities, it comes as no surprise that the restructuring process of the Russian and Ukrainian shipyards is much less advanced and more open than in Poland, Romania, or Croatia.

As concerns the organisation of production, the structure of Russian and Ukrainian shipyards has not changed fundamentally.[86] The production depth remains high; shipyards assure outfitting, and machinery fabrication as well as hull fabrication and assembly. Pre-fabrication of system elements is inflexible. As it is still carried out within the yard, few incentives exist for productivity increases or diversification. Design capacities are still largely outside the yards, and the interconnection between design and production is insufficient. The level of informatisation is low, in particular as regards CAD, work preparation, and production control. However, the obstacles to restructuring are not mainly technical, but *commercial* and *organisational*. On the commercial side, shipyards have not been able to specialise their offers, and largely depend on foreign trade organisations, such as „Sudoexport" and „Sudoimport" (though some concentration on bulk carriers and crude oil tankers exists). Production is constrained, not so much by lacking orders, but by lacking liquidity to purchase material and machinery. As only 50% of the value of a ship is usually paid in advance, yards have to find liquidity for the remaining 50%. Given the quasi-absence of commercial or bank credits, this is not an easy task. Another basic obstacle to deep restructuring is the absence of applicable

[86] Cf. OECD (1995a), upon which this section is partly based.

legislation on critical issues of enterprisation: examples are the issue of inter-enterprise arrears, treatment of old debts, and the partitioning of local infrastructure (e.g. water, electricity, heat). In contrast to Poland and other CEE-countries, the Russian and Ukrainian governments have taken an active role in the restructuring of industry at large, and in shipbuilding in particular. Instead of pursuing a horizontal industrial policy that could facilitate enterprisation locally, both governments developed substantive support programs for the shipbuilding industry:

Russia

In *Russia*, conversion programs were developed under the auspices of the „Russian Federation Committee of Defense Industries". The so-called „conversion" can go both ways: medium-sized shipyards should convert their military production to civil products; larger Russian yards also have to convert to naval shipbuilding (which was formerly concentrated in the Ukrainian Socialist Republic, e.g. cruisers and destroyers, aircraft carriers). Another element is the „state fleet modernisation programme", that is supposed to support the modernisation of the Russian merchant marine fleet, and even to extend it. For the conversion of military capacities in non-military capacities the government grants financial support, which is controlled by the "Russian Federation Committee of Defence Industries". Financial support is granted for product development, adaptation of production facilities and for bridging labour costs during necessary peak times.[87]

The renewal and extension programme influences the shipbuilding industry only indirectly. In this programme, the government grants a budget of US$ 9 billion until the year 2000 for building 3,000 seagoing and river vessels, of which a substantial part of them are built abroad. Nevertheless the Russian shipbuilding industry will benefit from this programme if it carried out. Today, however, it is already obvious, that the programme will not be achieved because neither the necessary Rouble funds, nor the foreign currency are available for the domestic shipyards and building abroad, respectively.

Ukraine

Compared to Russia the economic situation in *Ukraine* is worse. The extreme shortage of financial resources prevents any governmental support for the state owned shipyards. Therefore, all efforts are oriented to promoting the export of ships. In Ukraine, similar

[87] Concrete information about the relationship of direct financial support and grant of credits, as well as the volume of the programmes, is not available.

programs were defined for conversion and development („National Program for the Development of the Shipbuilding Industry“ under preparation). The state Prominvestbank will be obliged to issue credits to certain shipyards. Import tariffs should be reduced for „strategic“ parts purchased abroad.[88] It is highly questionable whether this „planned“ restructuring process has a chance of success.[89]

As regards privatisation, neither country has achieved substantial progress: in *Russia*, the attempts to privatise the shipyards were carried out very slowly. So in 1995, only two of the 16 Russian shipyards were privatised. The high percentage of military production capacities is one of the main hampering factors for privatisation because such shipyards are still regarded as strategically important. Foreign investors are hard to attract because the basic conditions are still unfavourable for foreign direct investments in the shipbuilding industry. So it has so far not been possible to buy the ground over which the yards extend.[90]
In *Ukraine*, the government had announced a privatisation programme, like Russia, but they disassociated all shipyards together from this programme. The result is that all 32 (15 new construction and repair shipyards, 9 river yards and 8 yards for fishery vessels) Ukrainian shipyards are still state owned.[91] This situation also prevents the attraction of foreign direct investment in the Ukrainian shipyards.

In contrast to Poland, the enterprisation of shipyards in Russia and Ukraine is foremost a *regional* problem. This is particularly the case for the Leningrad-Oblast, where 16 shipyards, several design bureaux, and a host of suppliers are concentrated (see figure 8).

[88] Lichter (1996).
[89] The phenomena of state-planned restructuring programmes is certainly not limited to shipbuilding, cf. Hirschhausen, Christian von (1996): Industrial Restructuring in Ukraine - From Socialism to a Planned Economy? DIW-Discussion Paper No. 144; November.
[90] OECD (1995), p. 17-18.
[91] OECD (1995), p. 18-19.

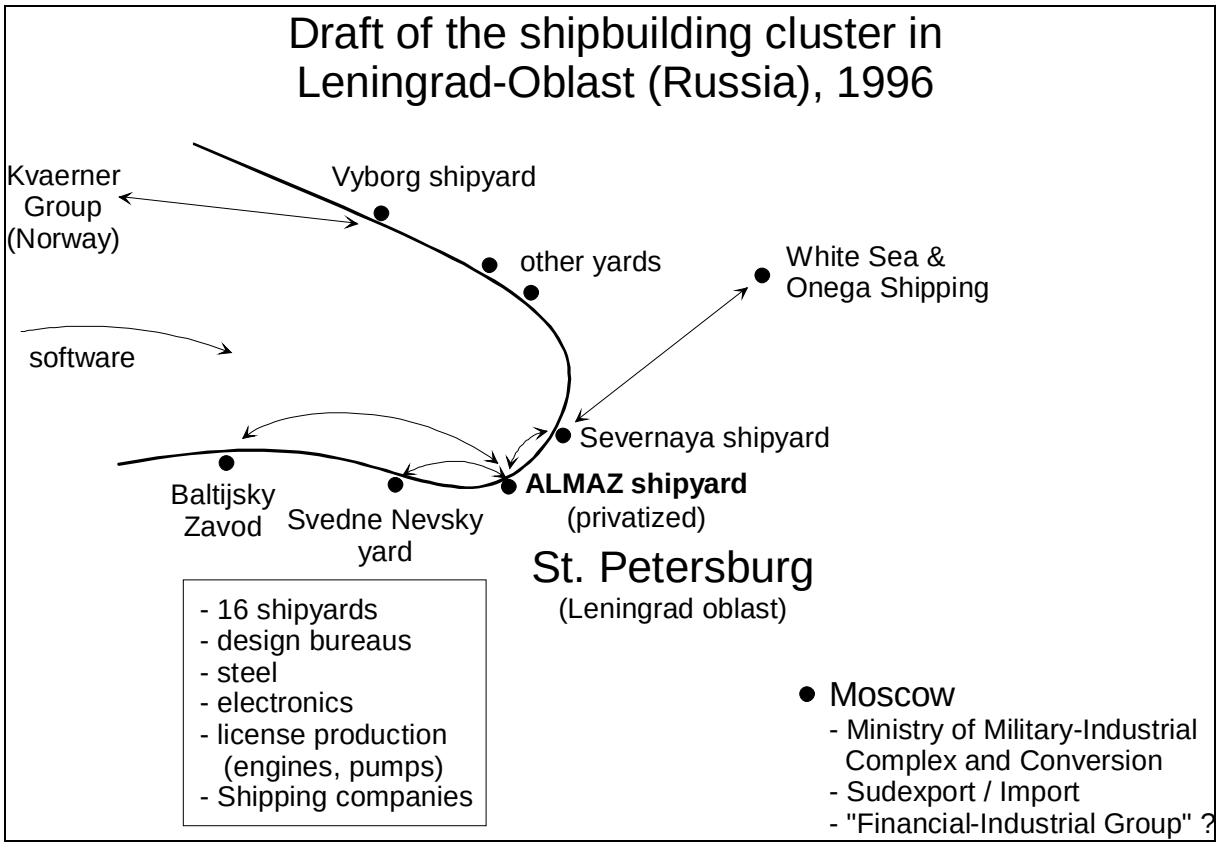


Figure 8: Shipbuilding cluster in Leningrad-Oblast

It seems that the privatised ALMAZ-shipyard is becoming the centre of a regional shipbuilding cluster. Whether this will lead to real capitalist economic activity or some form of post-socialist Financial-Industrial Group is still open.

Within this *opaque* enterprisation process in shipbuilding , there is hardly any rationale for an S&T policy. Innovations are mainly a result of co-operation with foreign enterprises, be they system suppliers or clients. Design capacities and informatisation have to be increased in the yards, but this is possible without substantial state support. Finally, increasing the absorptive capacity of the yards is mainly a question of pushing enterprisation forward, and unbundling suppliers, thus making them more flexible and capable of diversifying their production spectrum.

3.5. A taxonomy of East-West co-operation in shipbuilding

The breakdown of the CAEM and the restructuring of post-socialist yards (including China) have given a major impetus to international co-operation in shipbuilding. Co-operation between „developing“ and „developed“ shipyards is rising; motivation is bi-directional: developing shipyards need the technology transfer, design and access to markets that developed shipyards can offer. In the other direction, developed shipyards are looking for opportunities to outsource parts of production, or even the bulk of the production process. The proximity between Eastern and Western European shipyards, the relatively high level of capabilities in Eastern European yards, and the EU-CEE wage differential imply that East-West co-operation is bound to increase.

The term „co-operation“ means regular business contacts between two or more shipyards (horizontal), or between suppliers, shipyards, and customers (vertical), that are to some extent institutionalised. It is evident that suppliers and yards in East and West are always in some state of co-competition (see above). In the following, we propose a classification of co-operation:[92]

1. *regular supply of components* means regular or exclusive agreements with suppliers and/or shipyards of another country. In general, the „components“ should be of a certain value or technological content, such as entire hull sections, outfitting, electronics, or motors;

2. *sub-contracting* and *licensed production* become more intense once the technological level of the developing shipyards is rising. Examples are labour-intensive steel work, diesel engine production, but also shared production of entire ships;

3. *technological co-operation and training* can be done by exchange of personnel and/or codified knowledge, such as blueprints of design or software. One common strategy of „catching-up“ for developing shipyards is to participate in the production of a prototype ship in a developed shipyard, and to „copy“ the design and production process with its own means thereafter. Developed yards have an interest in this „second-best“ co-operation, as competition between them for markets and sub-contractors in developing countries is fierce;

4. *Capital participation* and *joint ventures* are the most explicit forms of co-operation, with one partner taking direct influence on the other. Joint-ventures are by far the most

[92] The typology of co-operation and the concrete cases in this section are taken from OECD (1996).

developed type of co-operation, as transaction costs are lower than for capital participation. This is particularly the case in countries where the legal framework is unstable or non-existent.

The following list shows how fast East-West co-operation has developed in the 1990s: almost non-existent in socialist times, Eastern European shipyards today account for 40% of all registered co-operation of OECD-shipyards; when considering only the European OECD-yards, this ratio is as high as 63%.

Table 14: Emerging patterns of co-operation between OECD and Eastern European shipyards

"Western" shipyard	"Eastern" shipyard	type of cooperation				remarks
		1. supply of components	2. sub-contracting/ licensed production	3. technological co-operation	4. capital particip./joint-ventures	
Astilleros de Huelva (Spain)	Baltija Shipyard, Klaipeda (Lithuania)		x			sub-contracting of outfitting works
Kvaerner Group (Norway)	Severnaya Shipyard (Russia)	x				licensing production
Fosen Mek. Verkst. A/S (Norway)	Galatz (Romania)	x	x			
Damen B.V., Gorinchem (Netherlands)	Sev-Mash Predpriyatiye, Severodvinsk (Russia)	x				hull production in sev-Mash
Estaleiros Navals (Vianayard (Portugal)	Yards in Russia and Ukraine	x	x			subcontracting of hulls, licensing production
HDW, Kiel (Germany)	shipyard in Poland	x	x			supplier of components
Lloyd Werft, BHV (Germany)	Pregol-yard, Kaliningrad (Russia)	x			x	shiprepair
Mützelfeldtwerft, CUX (Germany)	Romanian shipyard	x	x			subcontracting of hulls
FATA, Torino (Italy)	Kershon Shipyard (Ukraine)	x				build fast ferries (?)
Mariotti (Italy)	Okean Shipyard (Ukraine)	x	x			hull-production in Okean
Fassmer&Co, Mothen (Germany)	Yantar Shipyard, Kaliningrad (Russia)		x			aluminium construction
several smaller yards	Poland		x			
several smallller yards	Romania		x			
British marine equipment suppliers, London (Great Britain)	Ukainian shipyards		x			technology transfer, equipment
Vulkan, Bremer (Germany)	Severnaya, St. Petersburg (Russia)			x	x	small vessels
Kvaerner Group (Norway)	Sever Shipyard, Archangel (Russia)			x	x	conversion to civilian production
Daewoo (Korea)	Romanian shipyard; Mangalia (Romania)			x	x	know-how training
Arminus Werke (Germany)	Withe Sea&Onega Shipping Co., St. Petersburg (Russia)				x	"Onega Arminus Shipbuilders"
Arminus, Stinnes (Germany)	North Western Shipping Cor., St. Petersburg (Russia)				x	"New Newskij Shipyard"
Cassens yard (Germany)	Volgo-Don Shipping Co., Rostov/Don (Russia)				x	"Don Cassens shipbuilders"
Elbewerft Boizenburg (Germany)	Zelenodolsk, Tatarstan (Russia)				x	joint construction/operation
H. Peters, Wewelsfleth (Germany)	Slip Shipyard, Rybinks (Russia)				x	design by Peters, built in Rybinks
Mittelst. Serienschiffbauges. (MSG) (Germany)	shipyard ventures (Russia)				x	outsourcing
Kvaerner Group (Norway)	Vyborg Shipyard, St. Petersburg (Russia)				x	direct investment
Odense Staalskibsvaerft (Denmark)	Loksa shipyard, Tallinn (Estonia)				x	purchased for hatchcover production
Mc Dermott (U.S.)	MacAmur (Russia)				x	

4. Conclusions

As the paper has shown, shipbuilding is a complex and logistically intensive production process. In the Western world, the largest part of a ship is nowadays developed and produced outside of the shipyard. The supplier network therefore plays a crucial role in the development and the production of a ship. The suppliers are highly specialised and therefore able to develop and produce even the essential parts of the ship, like the engine, the navigation system, the electronics, the computer equipment etc. without the participation of the shipyard. With the emergence of "compact yards", the shipyard is reduced to an "assembly line". The Eastern European yards will have to take this development into account.

There is no such think as a single “world market“. Instead, the merchant shipbuilding markets can be divided into the segments for low complex ships, medium complex ships and high complex ships. Production requirements, competition axes and market participants differ between these segments. Any competition analysis has to be adopted to this segmentation.

With the collapse of socialism, the socialist mode of ship production collapsed, and the Eastern European countries lost their traditional clients, i.e. mainly the Soviet Union. They had to reorient their activities to world market conditions and compete with Western capitalist shipyards. Therefore the restructuring from highly integrated shipyards towards non-integrated production structures with an efficient supplier network is the basic condition for a successful restructuring. This non-integrated production structures further enables the Eastern European shipyards to compensate their disadvantages in high tech equipment through the purchase of required parts from western producers. The use of modern maritime technology is a prior condition to participate in the competition on world markets.

Innovation in the Eastern European shipbuilding industry comes from internal (e.g. design bureaux, R&D departments, etc.) as well as from external (e.g. suppliers, research institutes, etc.) sources. Through their suppliers the Eastern European shipyards use the domestic and foreign S&T systems. In particular, foreign suppliers and with it their S&T system are used by the Eastern European shipyards to access to modern maritime technologies. The result is that the shipbuilding industry in Eastern Europe is not longer solely dependent on national S&T systems.

While shipbuilding is a subsidised activity in all producing countries around the world, it is not certain that Eastern European countries should emulate this tendency. Dept relief and restructuring aid may be justified, whereas production aid seems to be a bad choice. National S&T-policies have

to be reviewed critically, using a demand-oriented perspective, and targeting the most critical obstacles to restructuring and enterprization. While in Poland the restructuring of the industry is rather advanced, in Russia and Ukraine, an acceleration of the enterprization process is needed if shipbuilding is to have a future.

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Appendix A

New orders and orderbook by country 1992-1996 in 1,000 CGT								
Countries	1993		1994		1995		1996	
	New orders	Oderbook*	New orders	Oderbook*	New orders	Oderbook*	New orders	Oderbook*
BELGIUM	17	134	54	118	3	96	1	28
DENMARK	390	698	382	596	109	299	269	651
FINLAND	515	791	277	961	178	855	384	881
FRANCE	227	569	240	678	66	513	111	448
GERMANY	1.029	1.600	1.034	1.591	1.714	2.290	799	1.952
GREECE	7	44	0	104	1	13	0	1
IRELAND	0	0	0	0	0	0	0	0
ITALY	511	1.039	345	1.029	1.081	1.860	662	1.843
NETHERLANDS	305	386	343	442	460	600	542	811
NORWAY	252	371	263	411	235	360	293	389
PORTUGAL	6	46	44	76	64	112	98	156
SPAIN	360	476	404	668	378	735	345	668
SWEDEN	1	0	0	0	12	25	99	99
UNITED KINGDOM	66	321	39	212	107	192	86	182
TOTAL WESTERN EUROPE	3.686	6.475	3.425	6.886	4.408	7.950	3.690	8.108
BULGARIA	42	142	64	149	134	199	40	148
CROATIA	153	511	270	466	58	430	321	505
POLAND	191	1.014	678	999	1.085	1.685	491	1.455
ROMANIA	150	861	140	944	203	972	104	761
RUSSIA	358	779	170	887	81	770	101	550
UKRAINE	291	426	397	702	191	737	90	554
EASTERN EUROPE	1.185	3.733	1.719	4.147	1.752	4.793	1.147	3.973
OTHERS	57	318	154	413	196	493	245	571
EUROPE	4.928	10.526	5.298	11.446	6.356	13.236	5.082	12.652
CHINA	437	1.257	547	1.262	837	1.446	1.226	1.924
JAPAN	4.681	6.256	6.688	8.000	5.898	8.173	6.294	8.480
KOREA	3.673	4.793	3.088	5.867	4.114	6.845	3.744	6.872
Subtotal ASIA	8.791	12.306	10.323	15.129	10.849	16.464	11.264	17.276
REST OF WORLD	807	1.960	1.132	2.384	1.227	2.361	1.159	2.295
TOTAL WORLD	14.526	24.792	16.753	28.959	18.432	32.061	17.505	32.222
*At 31.12. of the named year.								

Source: AWES, (several issues).

Appendix B

DEVELOPMENT OF COMPLETIONS BY REGION AND TYPE OF SHIP 1991 TO 1996

Absolute figures in 1,000 CGT market shares in %

	Year	AWES**		Japan		South Korea		Others		Total*	
		CGT	%	CGT	%	CGT	%	CGT	%	CGT	%
Dry Cargo	1991	1,186	34.3	1,082	31.3	462	13.4	726	21.0	3,456	30.0
Ships	1992	1,249	33.1	1,243	32.9	484	12.8	799	21.2	3,775	31.2
incl.	1993	984	29.2	1,257	37.3	324	9.6	805	23.9	3,369	27.2
Boxships	1994	1,339	32.0	1,494	35.7	605	14.5	747	17.8	4,185	33.1
	1995	1,292	29.0	1,697	38.1	835	18.8	625	14.0	4,449	31.1
	1996	1,838	34.9	1,342	25.5	1,401	26.6	682	13.0	5,264	31.8
Bulk	1991	176	9.7	936	51.5	436	24.0	268	14.8	1,816	15.8
Carriers	1992	170	10.6	491	30.6	603	37.6	339	21.1	1,603	13.2
incl.	1993	84	42.0	823	41.0	597	29.8	502	25.0	2,006	16.2
Combined	1994	132	4.1	2,002	61.7	587	18.1	523	16.1	3,244	25.7
Carriers	1995	305	7.2	2,435	57.3	941	22.1	573	13.5	4,253	29.7
	1996	221	4.8	2,656	57.2	988	21.3	776	16.7	4,641	28.0
Oil	1991	93	5.7	753	46.4	539	33.2	239	14.7	1,624	14.1
Tankers	1992	263	10.2	1,327	51.3	688	26.6	310	12.0	2,588	21.4
	1993	429	17.3	1,270	51.1	512	20.6	274	11.0	2,486	20.1
	1994	193	12.7	639	42.2	423	27.9	259	17.1	1,514	12.0
	1995	269	17.0	551	34.9	694	43.9	67	42.0	1,581	11.0
	1996	153	10.1	614	40.5	705	46.5	44	2.9	1,515	9.1
Gas/Chem.	1991	418	18.2	1,213	52.9	251	11.0	409	17.9	2,291	19.9
and	1992	516	24.0	1,031	48.0	210	9.8	389	18.1	2,146	17.7
Product	1993	352	15.1	1,249	53.8	384	16.6	338	14.5	2,322	18.8
Tankers	1994	310	15.2	782	38.4	479	23.5	465	22.8	2,036	16.1
	1995	422	20.5	770	37.5	392	19.1	471	22.9	2,054	14.3
	1996	572	20.4	1,107	39.4	426	15.2	702	25.0	2,807	17.0
Fishing	1991	264	36.0	164	22.3	34	4.6	272	37.1	734	6.4
Vessels	1992	324	57.9	64	11.4	8	1.4	164	29.3	560	4.6
	1993	128	21.3	52	8.6	15	2.5	404	67.5	598	4.8
	1994	213	53.3	58	14.5	1	0.3	129	32.3	400	3.2
	1995	110	42.0	51	19.5	4	1.5	97	37.0	262	1.8
	1996	167	54.0	29	9.3	2	0.5	112	36.2	309	1.9
Others	1991	1,021	63.7	270	16.8	7	0.4	306	19.1	1,604	13.9
	1992	877	60.7	223	15.4	2	0.1	343	23.7	1,445	11.9
	1993	1,033	64.6	204	12.8	3	2.0	358	22.4	1,599	12.9
	1994	714	56.8	203	16.2	9	0.7	330	26.3	1,256	9.9
	1995	1,308	75.8	140	8.1	22	1.2	255	14.8	1,725	12.0
	1996	1,354	67.2	243	12.1	27	1.3	390	19.4	2,014	12.2
Total	1991	3,158	27.4	4,417	38.3	1,729	15.0	2,222	19.3	11,526	100.0
	1992	3,396	28.0	4,379	36.1	1,995	16.5	2,346	19.4	12,118	100.0
	1993	3,010	24.3	4,854	392.0	1,835	14.8	2,681	21.7	12,380	100.0
	1994	2,902	23.0	5,177	41.0	2,104	16.7	2,453	19.4	12,636	100.0
	1995	3,705	25.9	5,644	39.4	2,887	202.0	2,089	14.6	14,325	100.0
	1996	4,304	26.0	5,991	36.2	3,549	21.5	2,706	16.3	16,550	100.0

*Diferences are due to roundings

**Since 1995 including Poland

Source: AWES, (several issues).