

Diverting developments – the Danish shipbuilding and marine equipment industries, 1970-2010

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Over the last couple of decades, the shipbuilding and marine equipment industries in Denmark and elsewhere in Europe have been exposed to strong competition from new and rapidly expanding maritime nations in Asia. In the 1970s, Denmark had a stronghold in both industries, which have been closely related and which have both derived demand from the volatile shipping industry. They also have clear mature characteristics. To a large extent Danish companies in both industries have had to address the same types of challenges caused by the emergence of dynamic, low-cost competitors. Nevertheless developments in the two industries have diverted after 1970. All the large and medium-sized Danish shipyards have ceased, whereas several equipment suppliers have endured and some have built up strong positions within their respective fields. Focusing on corporate strategies in shipbuilding and marine equipment manufacturing, this article examines the diverting developments of the two industries and asks what has caused this divergence?

Introduction

Over the last couple of decades, the Danish shipbuilding and marine equipment industries have been exposed to the strong forces of global competition. On a general level, the emergence of new and increasingly dynamic players from Asia, most notably Japan, South Korea and China, have changed the rules of the game in both industries. The shipbuilding and marine equipment industries have always been closely related (one supplying the other with equipment to install in new vessels), and both have ultimately derived demand from the highly volatile shipping industry. Hence, to a large extent both industries have faced similar market conditions and have had to address the same types of business challenges. Nevertheless, in a Danish context, developments in the two industries have diverted after 1970.

In the 1970s and 1980s, Danish shipbuilders delivered approximately 3 percent of all new ships and Denmark had more than ten medium-sized or large shipyards and numerous suppliers of marine equipment. A wave of shipyard closures, however, started in the 1980s and the whole Danish shipbuilding industry contracted rapidly around the turn of the new millennium. In 2012, the last large shipyard, the Odense Steel Ship Yard, seized and only small niche yards, specialized in the building of small vessels, remain in Denmark.¹ Several Danish manufacturers of marine equipment, on the other hand, have managed to redefine their strategies in the same period and they have endured. Some of them have built up strong positions within their respective fields.

The changing fortunes of the Danish shipbuilding and marine equipment industries were clearly revealed in a change of name made by the Shipbuilders' Association ("Skibsværftsforeningen") in 2003. Traditionally, recruiting its main members among the Danish shipyards, the

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association was facing a rapid contraction in its group of members around 2000. In order to maintain a critical mass, it decided to expand its membership group to include several manufacturers of marine equipment. To reflect the changing focus of the association, it changed its name to Danish Maritime (“Danske Maritime”).²

Generally, Danish marine equipment suppliers were more successful than shipbuilders in addressing the challenges posed by the new maritime economies in Asia. Focusing on corporate strategies, this article examines the diverting developments of the two Danish industries and asks why developments diverted?

Industry definitions and methodological challenges

Both in the Danish and international, economic historiography, the shipbuilding industry has tended to attract considerable attention.³ In contrast, suppliers of marine equipment have not gained the same level of academic interest.⁴ This is perhaps not surprising, given the large shipyard work forces and the large local or regional importance of shipbuilding in many European cities. Moreover, shipyards have often had central locations in ports and shipbuilding has usually been a very visible (and sometimes noisy) activity. At times, public discussions on the future of shipbuilding have also been very intense in several European countries.⁵

The marine equipment industry, on the other hand, is more difficult to identify and thus also to analyze. No such thing as a marine equipment industry exists in the most commonly used industry classification schemes and hence it does not exist in official statistics.⁶ Suppliers of equipment to shipyards are grouped in various other industry categories. For instance, manufacturers of life-saving equipment are grouped as manufacturers of rubber products and manufacturers of hull paints belong to the category of paint manufacturing. Hence, industry statistics are not readily available for marine equipment manufacturers. Furthermore, in a Danish context, the marine equipment industry did not have its own industry association before 2003, when the Shipbuilders’ Association changed its name to Danish Maritime and admitted more equipment manufacturers as members. Still the association does not include all Danish companies, which supply shipbuilders with equipment.⁷ Moreover, the industry does not have clear boundaries and some companies, which supply equipment to shipyards, may not perceive themselves as belonging to a marine equipment industry. This could be the case, when a manufacturing company’s main customers are non-maritime and supplies to shipbuilding only generate a small share of total revenue.⁸ For the same reason, it is very difficult to precisely estimate the number of employees, turnover, revenue etc.

The above reservations, however, do not render the concept of a marine equipment industry meaningless nor does it mean that the industry has been an insignificant source of employment and revenue in Denmark. On the contrary, a government study based on statistics from Statistics Denmark estimated that approximately 20,000-22,000 people were employed in the industry between 1990 and 2002.⁹ While such numbers are very rough estimates, they do demonstrate that the marine equipment industry has been a significant employer, also in a comparison with shipbuilding, where employment fluctuated between approximately 16,000 and 6,000 people from the mid-1970s to the early 2000s (Figure 1).

What the above reservations do mean, however, is that the study of the marine equipment industry is more difficult than the study of shipbuilding or the textile, clothing and furniture industries, which generally conform more closely to traditional industry definitions.¹⁰ An overview of the marine equipment industry cannot be made from publications or reports from the industry association and Danish and international maritime journals have tended to focus more on technical aspects of new marine equipment rather than the suppliers and their corporate strategies.¹¹

Market cycles

In order to understand the nature of the shipbuilding and marine equipment industries, a few words on market cycles in shipping are pertinent. As said before the two industries derive demand from shipping, which is a highly volatile and cyclical business. Fluctuations in shipping are caused by the fact that demand for seaborne transportation can change rapidly, while supply can only adapt slowly, and shipping has experienced several booms and busts since 1970. Generally shipbuilding and in some cases also the marine equipment manufacturers have been slow in adjusting to changes in demand. Long adjustments periods in shipbuilding and equipment manufacturing have been caused by the time lag from new vessels are ordered to the time of delivery, which is often more than two years, as well as government interventions.¹² Shipbuilding and equipment industry cycles are thus derived from shipping market cycles, but there is often a considerable lag from the time shipping freight rates are reduced until a contraction in shipbuilding activity takes place.

The main market for marine equipment comes from construction of new vessels (i.e. shipbuilding), but repair, service and retrofit of existing tonnage can also generate income for suppliers. For ship-owners, it is important to minimize vessels' off-hire time and therefore reliable equipment is important.¹³ In most cases, however, the new-building market is the largest market for suppliers. The market for marine equipment is governed by marine rules agreed by member states in the UN International Maritime Organization (IMO), and changes in regulation, e.g. with regard to emission levels or safety standards, can represent a business opportunity for some companies.¹⁴ For example in a Danish context, this is relevant for companies such as Viking Life-Saving Equipment or Alfa Laval Aalborg. The latter has recently introduced scrubbers to exhaust gas cleaning in response to new environmental regulation on maritime emission levels.¹⁵ For this reason new regulation can also cause changes in market conditions in the equipment industry in addition to the cycles caused by the cyclical shipping industry.

Erosion of European competitiveness in shipbuilding

Since the nineteenth century, Europe dominated global shipbuilding completely. Europeans owed their position to early industrialization and a strong political position and built more than 90 percent of the world's merchant ships around the year 1900 and continued to hold this position into the Post World War II period. However, in the latter half of the twentieth century a spectacular collapse in the competitiveness of European shipbuilding took place. Between 1950 and 2010, the European market share fell from approximately 80 percent below 10 percent, and shipbuilding is one of the most striking examples of global shifts in production patterns in recent decades.

The shift from European to Asian dominance was caused by multiple factors. Asian governments focused strongly on building up shipbuilding competencies, supporting yards with various subsidies in the early stages of development. Shipbuilding was generally a labour intensive activity and already in the post-war period it had the characteristics of a mature industry, which could relatively easily be emulated by late-movers.¹⁶ Japan became the world's largest shipbuilder in 1956, only eleven years after the country's defeat in World War II. South Korea emerged in the 1970s and 1980s and built up a competitive and dynamic industry despite a slump in shipping markets. Brazil, another developing economy, also attempted to build up a strong shipbuilding industry during this period but it failed despite considerable government subsidies.¹⁷

In the early 1990s, after the fall of the Iron Curtain, several Eastern European shipyards, notably in the former German Democratic Republic and Poland, which had considerable experience in supplying merchant ships to the Soviet Union and its allies, entered the international shipbuilding markets. They were able to gain orders from Western European ship-owners and generally benefitted from lower costs than Western European yards. However, recently, the development in

Eastern European shipbuilding has been characterized by yard closures and a contraction of market share.¹⁸ Other countries such as Turkey, Vietnam, the Philippines and India have recently established shipbuilding activities, but still only account for a minor part of the total market. The most striking feature of the development after 2000 was China's ascent in shipbuilding. It took China only little more than one decade to become the largest shipbuilding nation. Today the world shipbuilding scene is dominated by China, South Korea and Japan.¹⁹

Traditionally, shipbuilding has received considerable attention from policy makers and during the long period of decline in the Western European shipbuilding industry, policy makers have made various attempts to support the industry. Indeed, the economy of shipbuilding was clearly a political one, where market forces and political intervention interacted closely and often created global overcapacity.²⁰ The political interest was attributable to the regional significance of shipbuilding. In several port cities, e.g. Glasgow in Scotland and Uddevalla in Sweden, shipbuilding and the related equipment industry employed a very large share of the local work force. In Denmark this was also the case in Frederikshavn and Nakskov.²¹ From the 1960s to the 2000s, various subsidy schemes and other support measures (e.g. government orders) were used by European governments to counteract the effects of Japanese and South Korean shipbuilding policies and subsidies. While ultimately preferring a free market without subsidies, the Danish Shipbuilders' Association supported subsidies from the Danish government in a defense against other countries' subsidies.²² In the 1990s, South Korea in particular was alleged of destructing the global shipbuilding market, but Danish shipbuilders also feared unfair competition from other European countries, notably in the former German Democratic Republic, caused by various national support schemes.²³

In contrast to shipbuilding, the marine equipment industry did not experience the same level of international controversy after 1970. Probably because of the industry's heterogeneity, Danish marine equipment manufacturers did not rally or lobby on a large scale for government support schemes and debates about market distortions or subsidies did not reach the international political agenda for equipment suppliers.

Endurance and erosion of Danish competitiveness in shipbuilding²⁴

Shipbuilding was an important activity in Denmark. In the mid-1970s, between five and six percent of the industrial work force was employed in shipbuilding, and this was a higher percentage than in any other European country except for the Netherlands.²⁵ Direct employment in shipbuilding (including ship repair) was approximately 20,000 people in 1975 (Figure 1).

Denmark was also peculiar in another sense. To a very large extent, Danish shipbuilding was internalized into Danish shipping groups. The J. Lauritzen group owned yards in Elsinore, Aalborg, Frederikshavn and Aarhus and A.P. Moller and the East Asiatic Company (EAC) owned the Odense Steel Ship Yard and the Nakskov Yard, respectively. Only the B&W shipyard in Copenhagen was relatively independent from the main shipping companies for most of the period.²⁶ Vertical integration was also practiced elsewhere in Europe, but Denmark was the most extreme example of this. This peculiarity can partly explain both the endurance of Danish shipbuilding into the 1990s and the ultimate erosion of competitiveness after 1995.

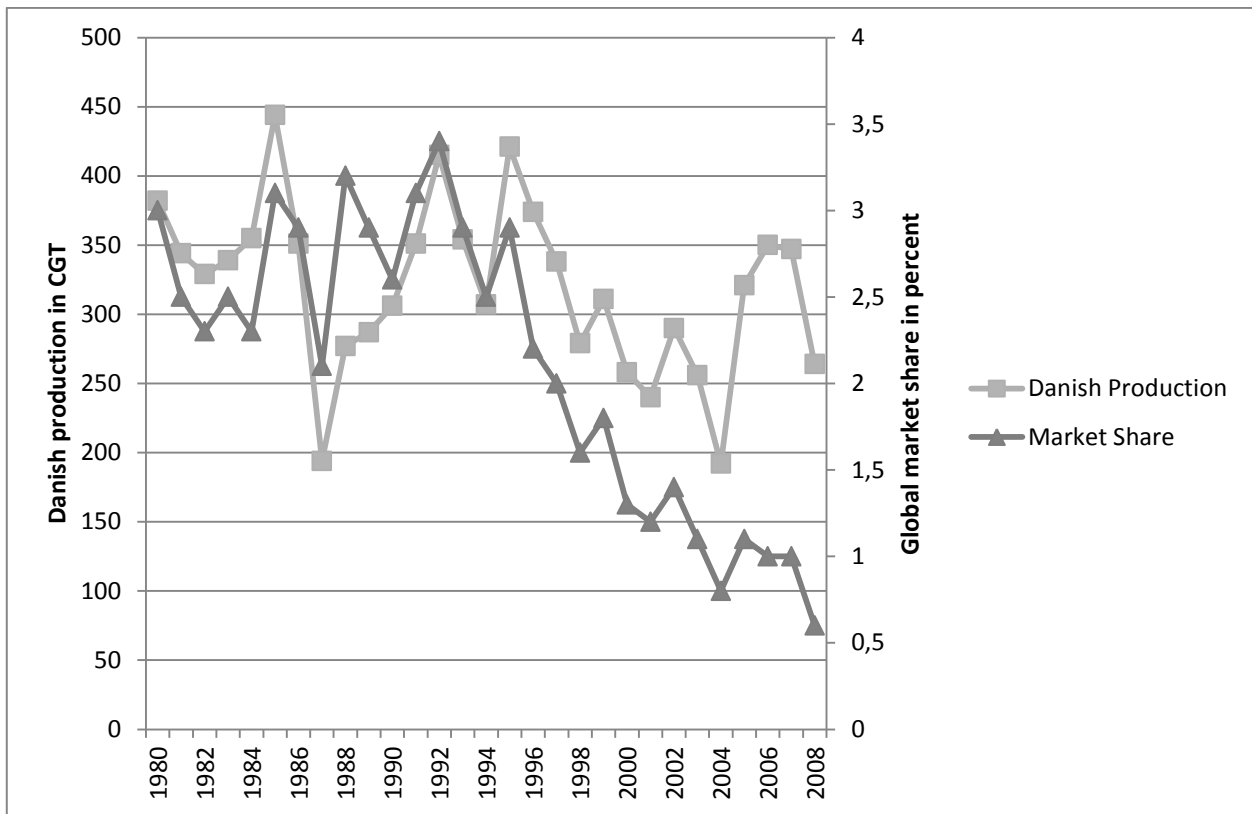


Figure 1. Production in Danish shipbuilding (in CGT) and Danish market share, 1980-2008.²⁷

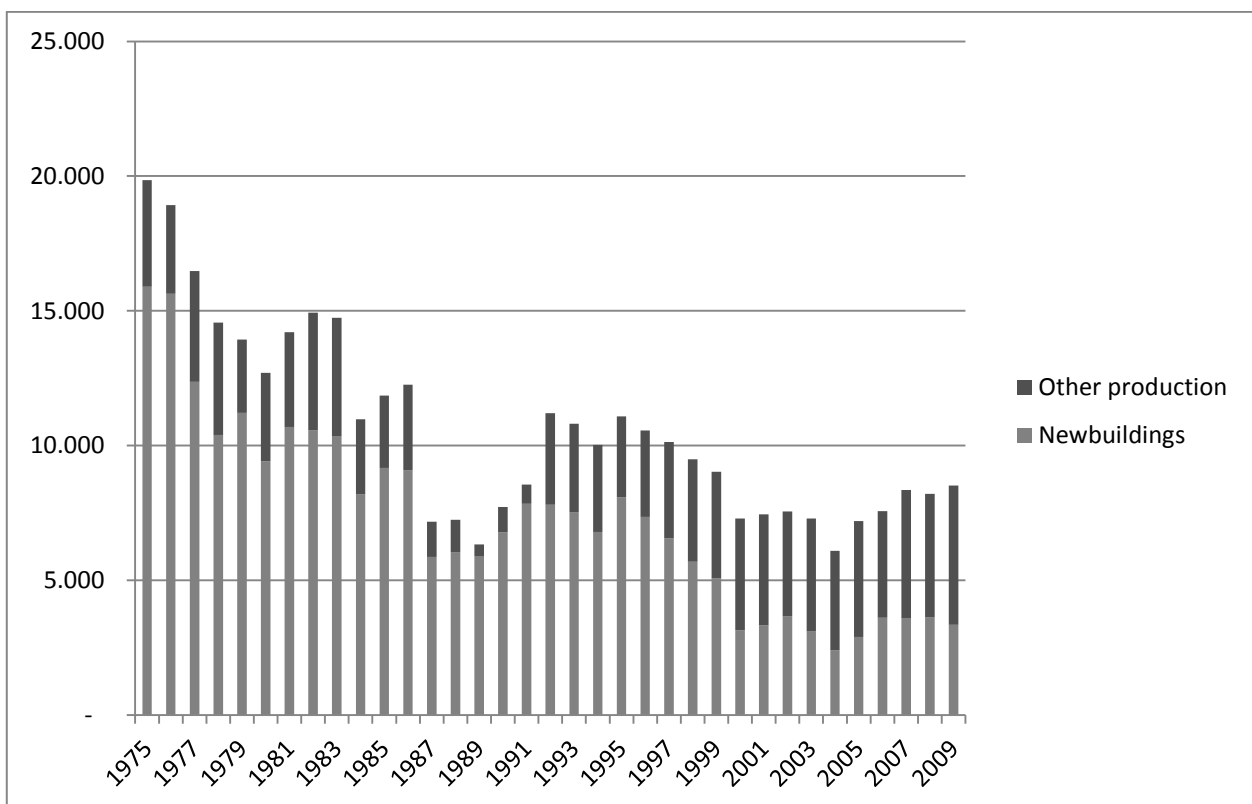


Figure 2. Number of employees with members of Danish Maritime/Shipbuilders' Association, 1975-2009.²⁸

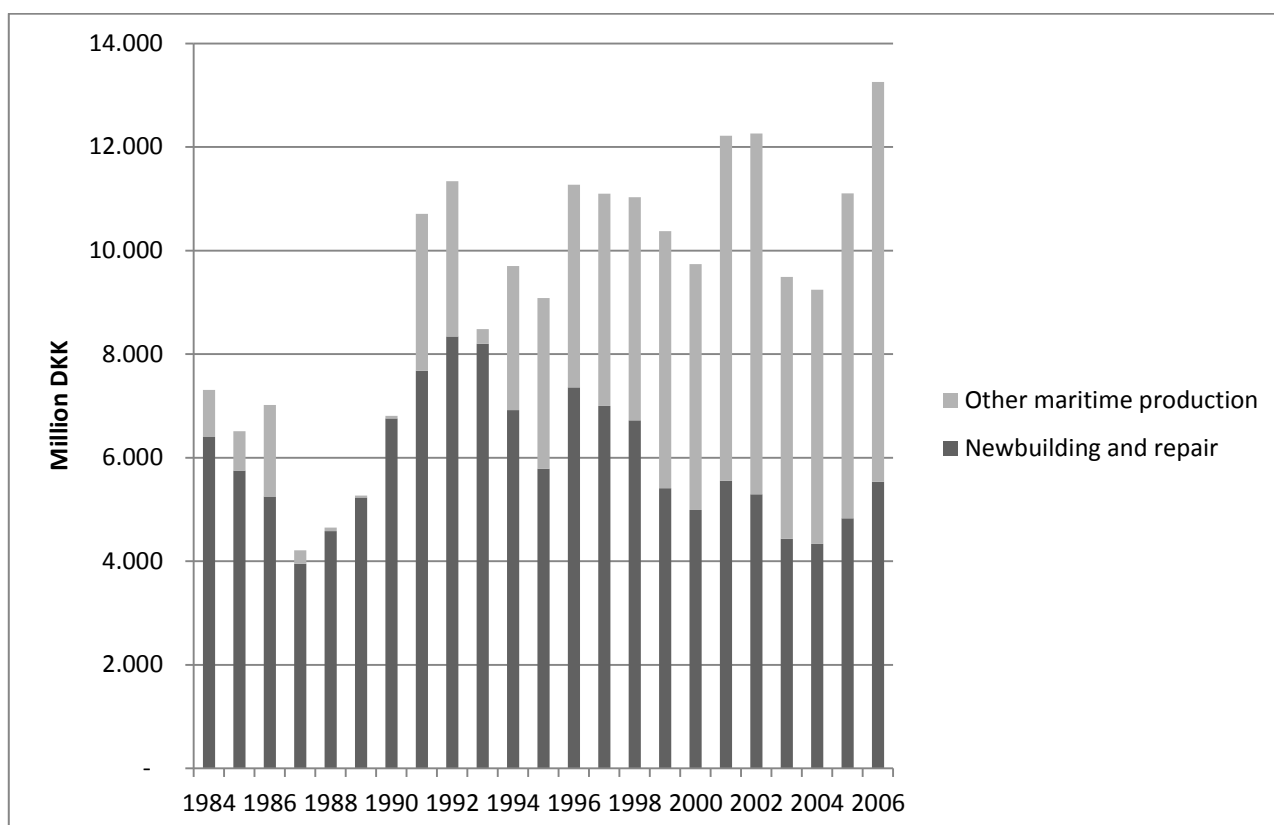


Figure 3. Turnover of members of Danish Maritime/Shipbuilders' Association, 1984-2006.²⁹

The 1950s and 1960s were a period of growth for Danish shipbuilding, as new yard facilities opened. Automation strategies were increasingly used in these facilities, as shipbuilders turned to section building methods and started to deliver larger vessels in long series. The expansion of Danish shipbuilding was enabled and supported by Danish shipping companies, which aimed at building up a strong position both within shipping and shipbuilding.

In 1973, a major drop in tanker freight rates caused a fifteen year-long crisis in shipping and this cascaded into European shipbuilding. In the 1970s and 1980s, several European shipbuilders had to seize despite considerable government efforts to restructure or save the industry. Danish shipbuilders, on the other hand, endured for longer and maintained their global market share of approximately three percent until 1995. Multiple causes explain the endurance of Danish shipbuilders. Danish yards built advanced vessel types, such as reefers, passenger and container vessels and chemical tankers, which were not hit as hard by the shipping crisis as more standard types (mainly oil tankers or dry bulk ships). For some time emerging shipbuilding nations in Asia also focused on standard tonnage such as dry bulk vessels and tankers and thus left the more advanced vessels for European shipbuilders. Moreover, Danish yards generally had a versatile production capability, which enabled them to shift more easily between vessel types, than many other European shipbuilders could. Owners, i.e. the shipping companies, were also patient and placed orders in their own yards and supplied additional capital, when the yards made large losses. Finally the government bolstered demand for Danish built tonnage with state-orders and a favourable taxation regime for shipping investors. The three factors – yard capabilities, owners' support and government support – worked together to sustain the industry and the structure of the industry remained intact into the late 1990s.

Despite the endurance of Danish shipbuilding into the late 1990s, structural weaknesses became increasingly evident. A global overcapacity in shipbuilding and relatively modest growth in demand for new ships caused problems for Danish shipbuilders both in the 1980s and 1990s. In the mid-1980s and again from the mid-1990s, large losses in shipbuilding required ship-owners to supply more capital to yards, which shipping companies would or could not provide in the long run. Moreover, Danish yards increasingly relied on the home market, which was a clear sign of weakness. In most years in the 1980s and early 1990s, less than 10 percent of orders came from foreign customers. This contrasted with the marine equipment industry. In the years around 2000, the Danish Ministry of Business estimated that Danish marine equipment suppliers had an average export ratio of over 80 percent.³⁰ The internationalization of the equipment manufacturing industry has never been properly examined before, but it is reasonable to assume that suppliers' international market penetration generally made them less vulnerable than shipbuilders, and at least in part this difference can explain the divergent developments of the two industries.

Danish shipbuilding declined for the same reasons as Western European shipbuilding contracted. Costs were too high and competitors in low-cost countries in Asia and Eastern Europe, which were supported by government subsidies, proved long-lived. Moreover, learning curves in the new shipbuilding nations in Asia were steep, and in some countries, notably Japan and South Korea, new yards built up expertise for sophisticated vessel types. In at least two Danish cases, customers defaulted on the payments of tonnage ordered in the yards, and this contributed to a drain of the yards' resources.³¹

In 2002, shipping markets and demands for new ships started to pick up and a large boom lasted for the following six years. By 2002, however, most Danish shipbuilders had seized and, with the notable exception of Odense Steel Ship Yard, Danish companies could not use this opportunity for growth. Marine equipment suppliers from Denmark, on the other hand, were better positioned to reap the benefits of the growing demand for new vessels and equipment after 2002.³²

Players and products in marine equipment industry

The decline of European and Danish shipbuilding is a well-known story, but the development of equipment suppliers to the shipbuilding industry remains more elusive. Before an in-depth study of the marine equipment industry can be undertaken, a basic identification of players and products in the industry is required. In the following a sketch of the contours of the industry in Denmark is made, with the goal of answering three basic questions: Which companies manufactured marine equipment? What equipment did they produce? And to what extent did the group of players and the product range change from the 1970s to the 2000s?

As mentioned above, industry association sources are not available for the main part of the period and maritime journals and newspapers have tended to focus on technical aspects of new equipment rather than the companies, which produced it. The Danish newspaper "Søfart", however, can provide valuable information on the companies and their products. From the 1970s to 2002, Søfart presented most new-buildings delivered from Danish shipyards.³³ Newspaper articles with a typical length of two to four pages included suppliers' or makers' lists for equipment installed in the vessels. Danish yards had a very diverse portfolio in terms of the vessel types, which they were capable of building.³⁴ Therefore it is reasonable to assume that equipment installed in vessels from Danish yards from the 1970s to the early 2000s give a fair representation of the equipment types, which were installed in the world merchant fleet. Moreover, according to several studies, Danish marine equipment manufacturers generally had strong positions in the Danish home market.³⁵ For these reasons, it is feasible to identify Danish players and equipment from the makers' lists published in Søfart.

When most Danish yards stopped production around 2000, Søfart discontinued the practice of publishing makers' lists. Therefore it is impossible to identify the companies, which supplied international shipyards with marine equipment, from this source after 2002. However, member list for Danish Maritime, the former and enlarged Shipbuilders' Association, and Danish Marine Group, an export association promoting Danish equipment manufacturers abroad with more than 140 members in 2010, can make up for this lacuna.³⁶ Member ship lists from the two associations give a comprehensive view of the companies which engage in the marine equipment industry.³⁷ Data in Table 1 are based on these sources.

Propulsion	Main engines	MAN Diesel & Turbo (1843)
	Boilers	Alfa-Laval Aalborg (1919)
	Engine monitoring systems	Selco (1984)
	Fuel and engine room pumps	DESMI (1833)
	Fuel filters	C.C. Jensen (1953)
	Gen-sets	Deif (1933)
	Waste water treatment	Gertsen & Olufsen (1945)
Navigation	Navigational equipment	Iver C. Weilbach & Co. (1759)
	Satellite communication	Thrane & Thrane (1981)
	Bridge control systems	SAM Electronics-Lyngsø Marine (1950s)
Safety	Life-saving equipment	Viking Life-Saving Equipment (1960)
	Fire-fighting equipment	Novenco Fire Fighting (1947) and Danfoss Semco (1955)
Cargo-handling	Cargo pumps	Hamworthy Svanebjerg (1928) and DESMI (1833)
	Refrigeration	Johnson Controls
	Inert gas systems	Alfa-Laval Aalborg (1919)
	Valves and venting systems	Pres-Vac Engineering (1952)
	Paint	Hempel (1915)
Other	Cranes	Acta
	HVAC	Novenco (1947) and Johnson Controls (1895)
	Ballast water treatment	Alfa-Laval Aalborg (1919)
	Incinerators	Atlas Incinerators
	Fresh water distillers	Atlas, APV (1910)
	Windows	C.C. Jensen (1953)
	Ceilings	Dampa (1951)

Table 1. A selection of Danish, marine equipment suppliers, which were active in 2010: Product range and founding year.³⁸

Table 1 gives an indication of the breadth of the product range for Danish marine equipment manufacturers in 2010. A comparison of the product ranges, which appeared in the "Søfart" makers' lists from 1975-2002 and the Danish Marine Group member list of 2010, indicates a high

degree of continuity in the industry. Most products, which were sold in 2010, have been on the portfolios of the companies for decades. Only a few additions, notably satellite communication, scrubbers and ballast water treatment systems, have entered the list between 1970 and 2010. They are related to the emergence of electronic navigation and increasing demands for environmental protection. On the other hand, no major types of products, which were produced in the 1970s, have disappeared from the portfolio of the group of Danish companies and this underlines the general picture of stability. It is also noteworthy that Danish manufacturing companies were capable of producing a very broad range of products and they continued to hold these positions in 2010.

Several Danish companies, which supplied equipment to shipbuilders in 2010, have a history which predates 1970, in many cases by several decades, and only few players have entered the business after 1970 according to the “Søfart” makers’ lists. In other words, several companies have survived despite the global shift in shipbuilding and marine equipment industry and this sets them apart from Danish shipbuilders. From Table 1 it is evident that the group of companies is a very diverse one. It consists of large industrial companies which have their main customers onshore, and only generated a minor part of their revenue by supplying equipment to shipbuilders.³⁹ For instance, through its 60 percent shareholding in Danfoss Semco A/S, the large Danish industrial group of Danfoss A/S is involved in the production of fire extinguishing systems both for maritime and onshore industrial customers.⁴⁰ The group of companies also includes dedicated marine equipment suppliers, e.g. Hempel A/S, which has gradually expanded into onshore businesses as a supplement to the maritime activities. Today, Hempel’s paint is also sold to the wind turbine industry, container industry etc.⁴¹ Finally the Danish group of companies contains enterprises which continue to rely almost entirely on maritime activities, e.g. Pres-Vac Engineering.

During the period 1970 to 2010, a number of companies have managed to expand, and develop dominating position within their respective fields. Most notably this is the case for Alfa-Laval Aalborg (marine boilers), Hempel (marine paint), MAN Diesel (design of two-stroke main engines), Viking Life-Saving Equipment (life-vests and inflatable life-rafts), Thrane & Thrane (satellite communication) and Pres-Vac Engineering (valves and venting equipment for tanker shipping).⁴² It is noteworthy that two of the largest and most successful companies within their respective fields are spin-offs from distressed shipyards. These are MAN Diesel and Turbo, which was previously part of the B&W shipyard, and Alfa Laval Aalborg, which originated from Aalborg Yard.⁴³

An important comment should be made to the definition of “Danish”. In the case of the shipbuilding industry, a Danish industry, defined as companies with Danish shareholders, Danish head-quarters and main operations located in Denmark, makes perfect sense. In contrast, such a definition is less feasible for the marine equipment suppliers. If the analysis only focuses on companies with Danish head-quarters, main operations in Denmark and Danish shareholders, it will gradually lose its unit of analysis between 1970 and 2010. This was due to the fact that ownership structures changed and operations became increasingly international. Hence, towards the 1990s and 2000s a more imprecise or “vague” definition of “Danish” is required, in order for the analysis to make sense. If companies have maintained their main offices (including considerable research and development, human resource management and at least some strategic management functions) in Denmark, they are included in this analysis. Owners may be foreign now and considerable production activities may take place abroad.

In the 1970s, many supply companies were controlled by families or family funds⁴⁴ or owned by shipping companies⁴⁵, but gradually these types of ownership have changed. Several companies, including some of the main suppliers, were acquired by foreign industrial groups during the 1990s and 2000s.⁴⁶ The German MAN group had already acquired the engine division of the B&W shipyard in 1980 and continues to own it.⁴⁷ Likewise, Hamworthy, an international provider of

equipment to shipbuilders, the offshore industry and other industrial customers, acquired the Danish pump manufacturer Svanehøj International A/S in 1993. Recently Hamworthy, including the Svanehøj activities, was acquired by the Wärtsilä group, with had a global workforce of more than 18,000 people in 2012.⁴⁸ Sabroe Refrigeration A/S, the large supplier of maritime refrigeration, is another example. It was once part of the J. Lauritzen shipping and industrial group, which sold it to York International in 1999, in order to focus on shipping. In 2005 resold to another foreign industrial group, Johnson Controls, the company is still active in the Danish marine equipment industry, despite the foreign ownership.⁴⁹ Aalborg Industries, the leading marine boiler manufacturer with 2,600 employees in 2010, was set-up by the J. Lauritzen group following the closure of yard in Aalborg in 1987-88. The yard had produced boilers since 1919. In 2011, Aalborg Industries was acquired by the international manufacturing group Alfa-Laval and renamed Alfa-Laval Aalborg.⁵⁰ Exactly how changes in ownership structures and foreign acquisitions have affected corporate strategies is difficult to assess, and it probably differs from case to case. However in several companies, activities have remained in Denmark in what were formerly the companies' head-quarters.⁵¹ Value chains, however, have been reconfigured in many cases and this has often caused many activities to move abroad.

Value chain strategies

In the textile, clothing and furniture industries, a redefinition of value chain strategies proved important to sustain corporate competitiveness after 1970 (see the other articles in this yearbook). The concept of value chain, as developed by Michael Porter, splits value adding into a number of sequential activities, from inbound logistics over operations to marketing, sales and services. In this paper a value chain strategy is defined as the top managers' decisions on the company's position within the value chain. A value chain strategy answers to important questions: The first one concerns which activities the company should engage in and which it should outsource (make or buy-decisions). The other one concerns locational issues (where the various activities should be located and how the individual activities should be controlled and integrated into a coherent value chain).⁵² It is relevant to examine to which extent changing value chain strategies have influenced the developments in shipbuilding and the marine equipment industry and in the following a first attempt to answer this question is presented.

Automation in shipbuilding and marine equipment industry

In mature industries, where competitive pressures on costs increase, automation is a typical corporate response. Companies' aims are to reduce costs by replacing an expensive input (i.e. labour) with capital (i.e. new and more efficient equipment) and improve productivity. This was attempted in the textile and furniture industries, and this was also done in shipbuilding and marine equipment manufacturing. In many cases capital requirements in shipbuilding and marine equipment manufacturing with large production sites were higher than in the textile and clothing and furniture industries, but often automation strategies were insufficient to sustain competitiveness in the long run. Ultimately companies reached the limits of what could be automated.

In the 1950s and 1960s, several Danish shipyards expanded, and new facilities tailored for section building of ships in long series along more rational lines were opened. These investments were based on a rationalization paradigm, which also played a role in the marine equipment industry.⁵³ Companies such as Atlas, Sabroe, Hempel and Nordisk Ventilator Co. (later renamed Novenco) built new production facilities in Denmark, which were ideal for automated production processes. At the same time several companies moved from central city locations to the suburbs to utilize the full potential of automation and more rational production site layouts.⁵⁴

Automation strategies continued to play a role after 1970. In shipbuilding, the automation strategy was most evident in the case of Odense Steel Ship Yard which continued to focus on productivity improvements and pioneered the use robot technologies for welding purposes until its closure in 2012.⁵⁵ In the marine equipment industry, Maersk Container Industry, established by the A.P. Moller group in Tinglev in Southern Jutland in 1991, also pioneered automation strategies in container manufacturing.⁵⁶ Despite high productivity levels in the Danish site, production of dry cargo containers was moved to China in 1999-2000 where production costs were lower. Moreover, the locations of the Chinese sites were more rational for positioning empty containers near customers (i.e. for shipment of Chinese exports). A few years later the production of more advanced reefer containers was also moved to China. At the time of writing, global headquarter global sales office and main R&D centre, service, and sales have remained in Denmark.⁵⁷

Outsourcing and offshoring in shipbuilding

Few if any shipyards or marine equipment manufacturers relied solely on automation as a competitive strategy. They often combined it with outsourcing or offshoring and for the same reason, boundaries between the two industries moved between 1970 and 2010. Danish shipyards increasingly outsourced manufacturing activities to third parties. In this way, yards become more focused on assembly of ships, leaving the manufacturing of individual components for the ships to supplier companies.⁵⁸ In some cases, construction of hull sections was also outsourced from Danish shipyard to Danish suppliers in the 1980s and 1990s.⁵⁹

Based on experience with outsourcing in a Danish context in the 1980s and the early 1990s, Danish yards were well positioned to utilize new international outsourcing opportunities which emerged after 1990. In this regard they experienced changes which were similar to the textile, clothing and furniture industries. The fall of the Iron Curtain produced both new competitors and new opportunities for low-cost production in countries relatively close to Denmark. The same happened for the shipbuilding and marine equipment industry.

Several Eastern European countries had a long experience in shipbuilding. Polish yards, famous for the shipyard worker's role in the formation of the "Solidarity" movement in the 1980s, were large and proved competitive in global markets after rationalizations were made. Based on lower costs than Western European levels and government support, they were able to penetrate the international shipbuilding markets. Similarly, a transformation process in the former German Democratic Republic's shipyards was initiated in the reunited Germany, where the government supported modernizations. Danish shipyards criticized the German government for unfair competition and a production limit was established before the European Union accepted government support to the rationalization of East German shipyards.⁶⁰

Danish yards soon grasped the new sourcing opportunities in Eastern Europe. The welding of hulls was generally a labour-intensive stage in the building of a new vessel and it required large groups of blue collar workers. In this stage of the building process, the Danish work force had problems maintaining competitiveness. This step could relatively easily be outsourced to low-cost shipyards in Poland, the Baltic countries or Romania. The more demanding building stages of vessel design and outfitting were kept in Denmark. From the 1990s, hulls or hull sections were often welded in Eastern Europe, tugged to Denmark and outfitted there.⁶¹ Several small or medium-sized yards used this strategy, including Ørskov Yard in Frederikshavn and Karstensen's Yard in Skagen, which outsourced hull-welding for ferries, offshore and fishing vessels. This was not a particular Danish strategy, but it was also used by other nations' shipyards, for instance in Norway.

Offshoring in shipbuilding occurred in only one case: The Odense Steel Ship Yard, which by far was the largest Danish yard. In the 1990s and 2000s, it build long series of container vessels for its owner. In 1994 and 1997, respectively, A.P. Moller group acquired the Loksa shipyard in Loksa,

Estonia, and the Baltija shipyard in Klaipeda, Lithuania. Construction of hatch covers, superstructures and various hull sections were performed in Estonia and Lithuania. From the Baltic sites, sections were tugged on barges to Odense, where assembly took place. A former GDR shipyard in Stralsund was also acquired, but it did not supply sections to the Odense yard. The production strategy of Odense was basically similar in nature to the strategy, employed by the smaller yards, but those yards did not have the resources to acquire production sites in Eastern Europe. The A.P. Moller group (from 2003: A.P. Moller-Maersk) on the other hand was financially strong, and it could.⁶²

Despite the savings made from outsourcing, Danish shipyards experienced hard times in the late 1990s and accumulated large losses. Outsourcing proved insufficient to save Danish shipbuilding, and yards in Svendborg, Frederikshavn (Ørskov and Danyard), Aarhus, Ringkøbing and Copenhagen closed after heavy losses. The outsourcing strategy, however, remains in use by Danish, niche shipbuilders, still in existence in Hvide Sande, Assens and Skagen.⁶³ The Odense yard started to post large losses in the 2000s, and despite efforts to improve productivity and reduce costs, it was decided to close the yard, which delivered its last vessel in 2012. The A.P. Moller-Maersk group also sold its Baltic and German yards and exited the shipbuilding industry as the last Danish shipping company.

Moving Danish shipbuilding companies abroad was never on the agenda. High sunken costs in Danish facilities and the Danish work-force may have caused inertia in this regard, but it is also reasonable to assume that a move to the emerging markets in Asia was simply unrealistic and impossible. It was possible for the A.P. Moller-group to acquire facilities in the Baltic Countries and in the former German Democratic Republic, but Danish shipbuilding companies could not establish yards in South Korea or Japan. The main South Korean and many Japanese yards were part of South Korean or Japanese industrial groups, and no European shipbuilders transplanted to these settings.⁶⁴ In this regard shipbuilders were more restricted in their strategic options than several marine equipment suppliers, which tended to offshore when Danish costs proved too high.

Outsourcing and offshoring in the marine equipment industry

After the turn of the millennium, manufacturing activities in the Danish marine equipment industry were increasingly moved abroad. Several Danish companies established their own production sites in emerging economies, mainly in Asia. The practice of moving production abroad however was older and Danish and other European companies had previously pursued the opportunities for production in Asia in various ways. Unfortunately, the study of outsourcing and offshoring strategies in the marine equipment industry is a difficult task, because published sources, such as maritime newspapers and industry association reports, have tended to focus on the equipment itself rather than the manufacturing companies and their strategies. For the same reason, this article can only provide a first sketch of outsourcing and offshoring practices in the marine equipment industry. More in-depth studies of individual companies are required in order to do this topic full justice.⁶⁵

When Asian countries entered the international shipbuilding scene, new markets for marine equipment suppliers emerged and often local production in Asia was worthwhile for European suppliers. In the Japanese case of the 1950s, the country was generally missing equipment suppliers for the yards and the South Koreans and Chinese generally faced similar challenges, when they built up their shipbuilding industries two and four decades later.⁶⁶ In some cases, licenses were granted by Danish equipment suppliers to Asian companies. In fact, B&W Diesel & Turbo (later MAN Diesel & Turbo) got its first engine licensee in Japan as early as 1926.⁶⁷ Such arrangements lowered transportation costs and enabled Danish companies to build up their brands in Asian shipbuilding nations. Moreover, such arrangements were generally supported by Asian governments' industrial

policies, which aimed at supporting local production. Of course the Danish companies ran the risk of helping future competitors to build up substantial businesses, but generally European suppliers could not obstruct new entrants to the industry.⁶⁸

An archival case study on Novenco, a Danish manufacturer of ventilation and air-conditioning equipment to maritime and onshore industrial customers, has demonstrated how rationales for offshoring in the Danish marine equipment industry have changed over time.⁶⁹ Novenco established foreign production sites from the 1960s to the 1980s in order to gain access to foreign markets. Local production was a means to counteract effects of protectionism in various countries and to reduce transportation costs. Most notably Novenco established a joint-venture, Hi-Pres Korea Ltd., with South Korean interests in 1988. The South Korean venture set up South Korean production of ventilation and air-conditioning for the South Korean shipbuilding market, based on a license agreement with Novenco. After 2000, cost considerations and proximity to Asian shipyards became the main strategic drivers for Novenco's offshoring and Novenco set up its own production site in China in 2007 for this reason. In 2013, Novenco's marine activities were acquired by Hi Air Korea Co. Ltd. from South Korea. The new, South Korean owner originated from the Hi-Pres Korea Ltd., which Novenco had set up in the 1980s. The changing ownership structure of Novenco thus also demonstrates how the centre of gravity in the marine equipment industry has moved from Europe to Asia.⁷⁰

Novenco was not unique in regard to the establishment of foreign production sites. The main players with the Danish industry, notably Alfa Laval Aalborg, Hempel, Viking Life-Saving Equipment, Novenco, Maersk Container Industry and DESMI have all set up considerable production activities abroad within the last decade. At least in the case of Hempel research and development (R&D) is now also performed abroad.⁷¹ In this way Danish companies have been able to utilize opportunities for cost reductions. China has been the preferred destination, but Thailand and Brazil has also attracted attention from Danish companies. Danish companies seem to have preferred offshoring to the outsourcing of activities to third parties.

Activities in Denmark have also been influenced by the foreign expansions and the offshoring of activities, but the long-term effects remain to be seen. Some companies have clearly reduced manufacturing activities in Denmark. MAN Diesel & Turbo is one such example, but the company has maintained a large R&D department in Copenhagen.⁷² Danish Maritime has warned against a loss of manufacturing capability in Denmark, if production is not maintained in Denmark. Danish Maritime has argued that development follows production. The association sees Danish reason for concern in the case of an accelerated offshoring or outsourcing. Said Danske Maritime:⁷³

It is a common misunderstanding that physical production is not longer desirable nor possible in Denmark due to the increasing importance of service and 'soft' trades. As a matter of fact, it is not an either/or question. The increasing importance of production knowledge, and technical expertise and product development are closely related to production and the products.

Conclusion

From 1970 to 2010, Danish shipbuilders and marine equipment manufacturers were exposed to the same forces of intensified global competition, which followed from the emergence of Asian maritime economies. In the 1970s, Denmark had a stronghold in both industries with more than ten medium or large shipyards as well as several equipment suppliers, which manufactured most types of marine equipment. Despite the fact that both industries derived demand from the same source, the shipping industry, their developments started to diverge in the 1980s. Shipyards started to close and the Danish market share dropped sharply after 1995, but in many cases equipment suppliers endured and some built up strong positions within their respective fields. What were the causes for

the observed difference in survival rates in shipbuilding and marine equipment industries? How can we explain the divergent developments of yards and equipment suppliers in a Danish context? The causes of decline in Danish shipbuilding are well-known: Intensifying foreign competition was caused by the entrance into a mature industry of several dynamic players from Asia and Eastern Europe. A global overcapacity in shipbuilding and numerous foreign subsidies also made life very hard for Danish shipbuilders as did high Danish costs and defaulting customers. Danish yards built state-of-the-art vessels and they were willing to revise strategies when markets changed, but they did not endure the competitive pressure after 1995.

Several marine equipment suppliers fared better. Danish yards relied heavily on the home market, but data indicates that Danish equipment manufacturers had considerably higher export ratios. This probably made them less vulnerable to market changes. Danish yards' reliance on Danish shipping companies for orders and capital proved to be the Achilles' heel of the industry in the long-term.

Different value chain strategies may also have influenced the divergent developments of the two industries. To some extent shipbuilders and marine equipment manufacturers applied similar value chain strategies in response to the challenges of intensified competition from abroad after 1970, but suppliers were in a more favorable position to utilize new alternatives for low-cost production. Automation was a typical response to intensified competition both in shipbuilding and marine equipment manufacturing, but often it proved an ineffective competitive strategy in the long run. The automation strategy reached its limits during the period. In both industries companies were also willing to utilize the low-cost production opportunities abroad. Production activities were relocated mainly to Eastern Europe or Asia after 1990, through outsourcing or offshoring. Generally the surviving companies in the marine equipment industries have tended to prefer offshoring, whereas most yards with strained budgets gravitated towards outsourcing. The yards were more grounded than equipment suppliers. Sunken costs in shipbuilding facilities in Denmark were high and relocation to Asia was not possible for Danish companies. In Japan and South Korea governments focused on building up national players in shipbuilding and equipment suppliers also had some problems establishing businesses in Asia. Offshoring, however, proved to be a more viable strategy for several equipment manufacturers, and many companies established their own production sites in Asia after 2000. This allowed them to benefit from a reduction in transportation and production costs and allowed them to move closer to their main shipbuilding customers. While Danish and European companies have clearly lost momentum in shipbuilding, the development of the Danish equipment suppliers after 1970 demonstrates that the development of manufacturing often is a non-linear process.

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¹ In Skagen, Hvide Sande, Assens and Søby. In addition, ship repair is performed in Odense and Frederikshavn, in former shipbuilding sites.

² Danske Maritime annual report 2003/04, p. 1. See also Figure 2 and 3 below for a very rough indication of the different fortunes of the two industries.

³ In a Danish context see Lange 1995; Hyldtoft 1996; Rasmussen, Rønne and Johansen, 2000; Jeppesen, Andersen and Johansen, 2001; Lange 2001; Lange 2002; Hyldtoft and Johansen, 2005; Søndergaard et al.

2007; Christensen et al. 2011; Poulsen and Sornn-Friese 2011. On European shipbuilding studies see: Kuuse 1983; Stråth 1987; Bohlin 1989; Lorenz 1991; Todd 1991; Heide 1993; De Voogd 1993; Johnman and Murphy 2002; Jamieson 2003; Johnman and Murphy 2005; De Voogd 2007; Stopford 2009.

⁴ For exceptions see Starkey and Murphy 2008; Poulsen and Sornn-Friese 2009; Poulsen, Wæhrens and Nielsen 2012; Slaven and Murphy 2013.

⁵ This article focuses on shipbuilding only, not ship-repair. Several Danish yards both engaged in shipbuilding and repair, but market structures differed in the two activities. Shipbuilding has a very cyclical nature, following the cycles of the freight markets. Fluctuations in ship-repair tend to be less pronounced. Even in times of low freight rates, when demand for new ships is low, the existing fleet needs ship-repair and maintenance. Ship-owners may even prefer to schedule vessel maintenance to periods with low freight rates, because vessel off-hire is less costly at that time. The development of Danish ship-repair remains under-researched.

⁶ For instance, the North American Industry Classification System (NAICS) does not distinguish maritime manufacturing as a separate industry category. On Danish industry codes see Henrik Sornn-Friese, *Navigating Blue Denmark: The Structural Dynamics and Evolution of the Danish Maritime Cluster* (Copenhagen, 2003), 44-5.

⁷ See list of members of Danske Maritime, which counted 24 companies in 2010, in Danske Maritime annual report 2009/10, p. i. See also list of members of Danish Marine Group, 2010.

⁸ For instance, Grundfos is well known for its pumps for onshore use, but the company has also supplied shipbuilders with pumps for maritime use.

⁹ Økonomi- og Erhvervsministeriet 2006, p. 77. The statistics are based on data sets from Statistics Denmark (so-called input-output data). The methodology used to assemble the data set and the sources of uncertainty are described in Sornn-Friese 2003. In 1995, Erhvervsministeriet (p. 13) estimated that 11,000 people were employed directly in the marine equipment industry and the large difference between the estimates in the two reports clearly indicates the difficulties of counting the number of employees precisely.

¹⁰ Although the Danish textile and clothing industry has recently transformed in a way that cause some of the most dynamic companies to fall outside the traditional industry definition.

¹¹ This is the case both for the leading Danish newspaper "Søfart" and the international technical journal "The Motor Ship". The international, commercial newspaper "Lloyd's List" has its main focus on shipping companies.

¹² See e.g. Stopford 2009; Wijnolst and Wergeland 2009.

¹³ For equipment, which is key for a vessel's seaworthiness, after-sales are important to reduce expensive off-hire periods for owners. This is most notable for marine engines. MAN Diesel Primeserv homepage on after-sale services for marine engines: <http://mandieselturbo.com/primeserv> accessed on March 13, 2012. See also Pyndt and Pedersen 2006.

¹⁴ Stopford 2009, pp. 655-93; Wright 2012.

¹⁵ Bastiansen 2001; Poulsen, Wæhrens and Nielsen 2012; Aalborg Industries, annual report, various years.

¹⁶ Amsden 1989; Chida and Davis 1990; Todd 1991; Stopford 2009; Bruno and Tenold 2011.

¹⁷ de la Pedraja 1999

¹⁸ Stopford 2009, p. 624.

¹⁹ Chida and Davies 1990; Stopford 2009; Bruno and Tenold 2011; Jiang and Strandenes 2012.

²⁰ Stråth 1987; Chida and Davies 1990; Todd 1991; Erhvervsministeriet 1995; Bastiansen 2001; Bruno and Tenold 2011. Skibsværftsforeningen, annual reports various years; Danske Maritime, annual reports, various years.

²¹ Olesen 2012.

²² Danske Maritime annual reports, various years.

²³ Danske Maritime annual reports; Erhvervsministeriet 1995.

²⁴ This article is based mainly on Poulsen and Sornn-Friese 2011.

²⁵ Stråth, 1987, p. 183.

²⁶ Poulsen and Sornn-Friese 2011. Although several large Danish shipping companies did own shares in the yard in the 1960s. For a discussion of ownership structures in B&W see Lange 1995, Lange 2001, Olesen 2012.

²⁷ Production is measured in Compensated Gross Ton, which takes into consideration the fact that production of some shiptypes (e.g. passenger ships, reefers and chemical tankers) are more advanced and labour intensive than others (e.g. crude oil tankers and dry bulk carriers). After 2000, Odense Steel Ship Yard's production of large container ships concealed the decline of other Danish shipbuilders in the statistics. Odense Steel Ship Yard delivered its last vessel in 2012 and Danish production and global market share has declined accordingly.

²⁸ Danske Maritime home page, accessed on April 16, 2010. More recent data, from the period after the closure of the Odense Steel Ship Yard, are not yet available, but the layoffs from Odense counted the majority of the remaining workers in newbuildings.

²⁹ Danske Maritime home page, accessed on April 16, 2010.

³⁰ Økonomi- og Erhvervsministeriet 2006, pp. 74-76. This is generally also supported by figures calculated in Bastiansen 2001.

³¹ This was the case in Ørskov and Aarhus Flydedok.

³² For a status of the equipment suppliers in Denmark around 2000 see Bastiansen 2001.

³³ "Portræt af en nybygning", 1975-2002, published in Søfart and referred to as Søfart makers' lists in the following.

³⁴ Poulsen and Sornn-Friese 2011.

³⁵ Industriministeriet 1991; Erhvervsministeriet 1995.

³⁶ Danske Maritime, annual report for 2009/10; Danish Marine Group, *Who is who 2010*.

³⁷ Danish Marine Group also included non-manufacturing companies, including ship-designers, maritime consultants etc.

³⁸ The list contains a selection of companies and their product range. It is based on makers' lists for Danish newbuildings, published in Søfart 1975-2002. Companies which have exited the industry during the period are excluded. Data on founding years comes from company websites.

³⁹ See also Bastiansen 2001 for a status of the industry players around 2000.

⁴⁰ Company web page, accessed on March 12, 2012.

⁴¹ Skaaning 1980; Hempel A/S annual reports, various years.

⁴² Danske Maritime annual reports, various years; Company web-pages.

⁴³ Olsen 2012.

⁴⁴ E.g. Nordisk Ventilator Co. (later renamed Novenco), C.C. Jensen, Viking Life-Saving Equipment and Hempel.

⁴⁵ E.g. Svanehøj International, Sabroe Refrigeration and Atlas.

⁴⁶ Bastiansen 2001, p. 40.

⁴⁷ Lange 2001; Pyndt and Pedersen 2006; Olesen 2012.

⁴⁸ Company webpage, <http://www.hamworthy.com>, accessed on March 12, 2012.

⁴⁹ Lange 1995; Eriksen 1997; Company webpage, <http://www.johnsoncontrols.dk>, accessed on March 12, 2012.

⁵⁰ Olesen 2012.

⁵¹ MAN Diesel and Alfa-Laval Aalborg are such examples.

⁵² Porter 1986. See also Coe, Dicken and Hess 2008; Gereffi, Humphrey and Sturgeon 2005.

⁵³ Hyldtoft 1996; Rasmussen, Rønne and Vedsted 2000, pp. 33-48; Hyldtoft and Johansen 2005; Christensen, Hasstrup, Sørensen and Thøgersen 2011; Hyldtoft and Johansen 2005.

⁵⁴ Rasmussen 1995; Hyldtoft 1996; Eriksen 1997; Nielsen 2003; Hyldtoft and Johansen 2005; Poulsen, Wæhrens and Nielsen 2012.

⁵⁵ A.P. Møller annual reports; Christensen, Hasstrup, Sørensen and Thøgersen 2011.

⁵⁶ Of course in a strict sense, containers are not marine equipment installed onboard ships but rather cargo handling equipment.

⁵⁷ A/S D/S Svendborg and D/S af 1912 A/S, annual reports, 1991-2003; A.P. Møller-Mærsk A/S annual report 2004-12; <http://www.mcicontainers.com/>, accessed on March 13, 2012.

⁵⁸ Erhvervsministeriet 1995, p. 13, 28, 41.

⁵⁹ Olesen 2012.

⁶⁰ Danske Maritime, annual reports, various years; Skibsværftsforeningen, annual reports, various years.

⁶¹ Søfart list of Danish newbuildings various years; The Motor Ship various years.

⁶² A.P. Møller annual reports.

⁶³ Søfart various years; Danish Maritime annual reports various years.

⁶⁴ Amsden 1989; Chida and Davies 1990; Bruno and Tenold 2012. See Poulsen, Wæhrens and Nielsen 2012 on a Danish equipment supplier's difficulties in setting up production in these markets. In 2007, The South Korean STX group acquired a number of European shipyards, including major yards in Norway, France and Finland, which specialized in ferries, cruise and offshore vessels. The South Korean group did not experience the same entry barriers in Europe as the European companies had experienced in Asia. The South Korean venture in European shipbuilding, however, proved problematic following the 2008 financial crisis and the drop in shipbuilding demand. Some of the European assets have now been sold off from the STX Group. See Eason 2007; Lin 2013.

⁶⁵ Kuuse 1983 has examined the development of Swedish marine equipment suppliers, but only during the period when Sweden had a major shipbuilding industry. Thus the period after the closure of the shipyards remains under-researched.

⁶⁶ Amsden 1989; Chida and Davies 1990; Bastiansen 2001; Bruno and Tenold 2011; Poulsen, Wæhrens and Nielsen 2012.

⁶⁷ On MAN Diesel see: Pyndt and Pedersen 2006. See also Eriksen 1997 on Sabroe Refrigeration and Poulsen, Wæhrens and Nielsen 2012 on Novenco.

⁶⁸ Poulsen, Wæhrens and Nielsen 2012.

⁶⁹ Poulsen, Wæhrens and Nielsen 2012.

⁷⁰ http://www.novenco-marine.com/sitecore/content/Group/About_Novenco_Group/Novenco_in_brief.aspx?sc_lang=en, accessed on October 2, 2013.

⁷¹ Aalborg Industries, Hempel, DESMI annual reports various years.

⁷² MAN B&W Diesel and MAN Diesel annual reports various years.

⁷³ Danske Maritime annual report 2008/09, p. 2. Author's translation.