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Creative destruction or just destruction?

The transformation of Danish shipbuilding 1980-2013

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1. Introduction

The second half of the twentieth century saw a major shift in global shipbuilding from Europe to East Asia. From 1977 to 1985 the market share of European shipyards dropped from 41 % to 18 % while shipyards in Asia increased the market share from 46 % to 70 % (Stopford, 2009). A combination of modern production facilities, low wages, and massive state support allowed shipyards in Japan and Korea to successfully outcompete the European shipping industry (Amsden, 1989; Chida & Davis, 1990; Bruno & Tenold, 2011).

The decline of European shipbuilding has been studied thoroughly in the past decades (Stråth, 1987; Bohlin, 1989; Todd, 1991; Lorenz, 1991, Burton, 1994; De Voogd, 1995, 2007; Johnman & Murphy, 2002; Poulsen and Sornn-Friese, 2011). However there is a lack of studies that examine the long term consequences of the shipyard closures (exceptions are Andersen and Storrie, 1996; Olesen, 2012, 2013, 2016; Larsen, 2016; Holm et al., 2017). The lack of focus on the time after the delivery of the last ship has led to an incomplete picture of the shipyard closures that emphasize the story of decline.

This paper argues that the closure of the Danish shipbuilding industry should be interpreted as a story of transformation. The paper examines the closure of four Danish shipyards: Burmeister and Wain in Copenhagen (closed in 1980), Nakskov Shipyard (closed in 1986-87), Aalborg Shipyard (closed in 1987-88), and Danyard Frederikshavn (closed in 1999). The paper addresses four research questions: (1) what activities were continued from the four shipyards? (2) How have these activities evolved after the shipyard closures? (3) What happened to the redundant shipyard employees? And (4) what factors have contributed to the transformation of the Danish shipbuilding industry?

The theoretical outset of this paper is Joseph Schumpeter's theory of creative destruction and entrepreneurial profit (Schumpeter, 1934, 1939, and 1943). Schumpeter identified the creative destruction process where old firms vanish and new firms will appear as the engine of the capitalist system. The process is driven by innovative entrepreneurs who in the pursuit of entrepreneurial profit tear down old structures and make new combinations. Schumpeter points to five innovative processes through which the entrepreneur can obtain entrepreneurial profit: (1) the introduction of a new and more efficient method of production, (2) development of new or better products, (3) accessing new markets, (4) introducing new raw materials or semi-finished products that makes the end product cheaper, and (5) through the establishment of a new industrial organization. The advantage that the entrepreneur will gain is however short lived, as competitors will quickly copy the initiative. This means that entrepreneurs will have to continuously be innovative.

The paper identifies 27 spin-off firms that continued activities from the four shipyards. By 2013 twelve of these spin-offs remained. These firms had used the resources from the shipyards to develop new products, access new markets, and establish new industrial organizations. Several of the spin-offs had evolved into global market leaders in the areas of marine engine design, marine boilers, inert-gas systems, thermal fluid systems, diesel power plant contracting, and software systems for shipyards. The paper also finds that between 60 and 70 % of the 9,399 shipyard workers had found employment three years after the closures. And in the seven years that followed the closures 81-92% had been reemployed at some point.

The paper is structured as follows: Section 2 describes the decline of the Danish shipbuilding industry. The establishment and development of the spin-off firms is analyzed in section 3. Section 4 presents the quantitative study of the shipyard workers, and section 5 discusses how various factors contributed to the transformation of Danish shipbuilding.

2. The decline of the Danish shipbuilding industry

During the first half of the 20th century global shipbuilding was completely dominated by countries in Western Europe. Great Britain was by far the largest shipbuilding nation in the world but Danish shipyards also played an important role in global shipbuilding. The first Danish steel shipyards were established in the 19th century. Among these were B&W in Copenhagen (established in 1843) and

Frederikshavn Shipyard (1870). The early 20th century saw a second wave of new shipyards including the shipyards in Aalborg (1912) and Nakskov (1916) (Olesen, 2016).

Most of the large Danish shipyards were established and owned by the leading Danish shipping companies including A.P. Møller, DFDS, J. Lauritzen and the East Asiatic Company. This allowed the shipyards to get support from the owners – either through orders or cash injections – in depressed markets (Poulsen & Sornn-Friese, 2011). B&W was, however, not owned by a shipping company and was thus dependent on goodwill from the banks and the Danish government (Lange, 2001).

After the Oil Crisis in 1973 the European shipbuilding industry began to experience serious problems caused by the low demand for new ships and increased competition from shipyards in Asia. Economic support from the Danish government and the owners and attempts to streamline the production was not enough to turn things around. In November 1980 B&W in Copenhagen was declared bankrupt. This marked the beginning of a series of Danish shipyard closures in the 1980's and 1990's. Elsinore Shipyard was closed in 1983 followed by Nakskov Shipyard (1986-87), Aalborg Shipyard (1987-88), the reestablished B&W Shipyard (1996), Nordsøværftet (1997), Svendborg Shipyard (1999), Aarhus Flydedok (1999), and Danyard Frederikshavn (1999). In 2012 the last major Danish newbuilding steel shipyard at Lindø was closed (Olesen, 2016).

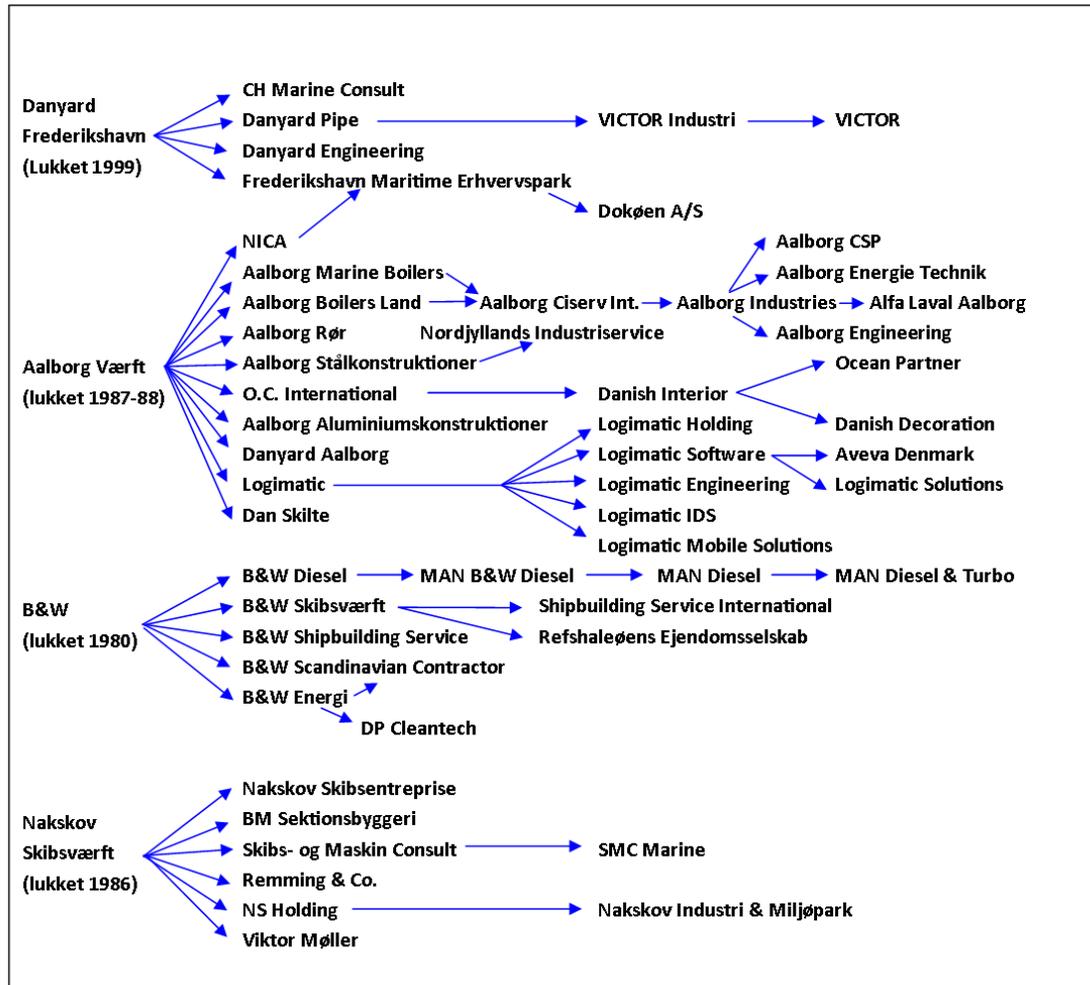
3. The establishment of new firms from the closed shipyards

The closure of the Danish shipyards forced the owners, workers and managers to consider how to use the competencies and production facilities at the shipyards in new ways. During the closures at least 27 new firms were spun out from the shipyards (figure 1). Spin-offs are in this case defined as new firms where the majority of employees were previously hired at the shipyards.

During the 1980 closure of B&W the management spun out and sold a number of divisions and offices as independent firms. The engine division (spun out as B&W Diesel) was the second largest developer of two stroke ship engines in the world. The steam division (B&W Energy) produced boilers to the industry and power plants. The Contractor division (B&W Scandinavian Contractor) contracted turn-key power plants, and the design office was spun out as B&W Shipdesign. In 1981 a new shipyard

(B&W Skibsværft) was made by the management, and in 1983 the shipyard site was spun out in a real estate firm (Refshaleøens Ejendomsselskab) (Olesen, 2016).

Figure 1: Spin-off from the four Danish shipyards



When Nakskov Shipyard closed in 1986-87 the management spun out the design activities (Skibs og Maskin Consult), a blacksmith firm (Remming & Co.), and a maritime business consultancy firm (Viktor Møller). A group of local businessmen established a repair shipyard (Nakskov Skibscentreprise) and acquired the steel production facilities (BM Sektionsbyggeri). And finally the owner, the East Asiatic Company, converted the shipyard site into a business park (Olesen, 2016).

In 1987-88 the owner (J. Lauritzen) and the management in Aalborg Shipyard spun out the boiler division (Aalborg Boilers Land and Aalborg Marine Boilers), which designed and produced boilers for

industry, power plants and ships. The owner and the management furthermore spun out the steel production activities (Aalborg Stålkonstruktioner), the pipe factory (Aalborg Rør), and transformed the shipyard site into a business park (NICA). The shipbuilding activities were reestablished by the management as two separate firms: Danyard Aalborg made warships in fiberglass and Aalborg Aluminiumskonstruktioner made lightweight aluminum catamaran ferries. A local businessman established a firm which was specialized in outfitting passenger ships (O.C. International and later Danish interior). Finally, three firms were established by the shipyard workers: A sign workshop (Dan Skilte), a blacksmith firm (Nordjyllands Industriservice), and a consulting engineering firm (Logimatic) (Olesen, 2016).

In Frederikshavn the management spun out the pipe factory (Danyard Pipe) and parts of the design office (Danyard engineering). The owner (J. Lauritzen) turned the site into a business park (FME), and the neighboring shipyard (Ørskov Christensen Steel Shipyard) rented and later bought the dock area. Finally, a maritime consultant engineering firm (CH Marine Consult) was established by an engineer from the design office (Olesen, 2013).

As outlined above, the activities in the spin-off firms were initially very similar to the activities of the closed shipyards. The new firms were mainly engaged in (1) reconstructed shipbuilding activities, (2) as suppliers for other shipyards (ship engines, marine boilers, steel sections, pipes etc.), (3) in power plant activities (contracting and boiler systems), (4) as (maritime) consultant engineering firms, and (5) as business parks where the production facilities at shipyard site was rented to other firms. It is thus evident that the shipyard closures did not see any immediate creative initiatives. Rather it took a few years before the spin-off firms began to experiment with different types of innovation.

3.1 Spin-offs with the same challenges as the shipyards

In 2013 – almost 35 years after the closure of B&W – 15 of the original 27 spin-offs had disappeared. Most of the spin-offs that had vanished had failed to transform themselves. They had continued the shipbuilding activities or had become suppliers for the remaining Danish shipyards (see table 1). As a consequence they also faced the same challenges as the closed shipyards: B&W Skibsværft continued to produce bulk carriers and product tankers until its bankruptcy in 1996. BM Sektionsbyggeri made steel sections for B&W Skibsværft and went out of business when the shipyard closed. Aalborg

Stålkonstruktioner and Aalborg Rør delivered pipes and steel sections to Danyard in Frederikshavn. When Danyard was closed in 1999 both firms went out of business. All of these spin offs failed to develop new products, identify new markets, or make new organizational setups. They kept on doing what the shipyards had done and as a consequence they went out of business in the 1990's or 2000's.

Table 1: Spin-off from the Danish shipyards were closed				
Spin-off firm	Parent	Activity when established	Activity when closed	Closed
B&W Skibsværft	B&W	Shipbuilding	Shipbuilding	1996
Danyard Aalborg	Aalborg	Shipbuilding	Shipbuilding	2009
Aalborg Aluminiumskonstruktioner	Aalborg	Shipbuilding	Shipbuilding	1996
Nakskov Skibsentreprise	Nakskov	Ship repair	Ship repair	2006
Skibs og Maskin Consult/ SMC Marine	Nakskov	Ship repair Consulting engineers	Ship repair Consulting engineers	1994
Remming & Co.	Nakskov	Blacksmith	Blacksmith, electrician and plumbing firm	2008
BM Sektionsbyggeri	Nakskov	Steel constructions	Steel constructions	1996
Aalborg Stålkonstruktioner	Aalborg	Steel constructions	Steel constructions	1998
Aalborg Rør	Aalborg	Pipe factory	Pipe factory	1997
Danyard Engineering	Danyard	Consulting engineers	Consulting engineers	2003
Shipbuilding Services Int.	B&W	Consulting engineers	Consulting engineers	2009
Viktor Møller	Nakskov	Management consultants	Management consultants	2001
O.C. International	Aalborg	Ship interior	Ship interior	1992
Danish Interior	Aalborg	Ship interior	Ship interior	2008
Source: Olesen, 2016				
Note: It has not been possible to track B&W Shipbuilding Service after it was sold to DFDS in 1980				

3.2 Development of new products

While some spin-offs were unable to transform their business model other were more successful in adapting to the changing conditions. By 2013 several of the 12 remaining spin-offs had used the competencies and knowhow from the shipyards to develop new products (see table 2).

Among the best example of product innovation is the spin-off firm Logimatic which was established in 1987 by four electrical engineers from the automation department at Aalborg Shipyard. The entrepreneurs wanted to form a maritime consultant engineering firm. In order to support this activity they developed an inventory management system called MARS. MARS was initially only intended for internal use but it proved to very efficient for managing the flow of materials at shipyards. In the early 1990's the system was further developed in close collaboration with the Danish shipyard Aarhus Flydedok and Kværner Masa Yards in Finland. With the world's largest producer of cruise ships on the

reference list the firm got its global breakthrough, and today MARS is used by shipyards all over the world. Logimatic has furthermore developed the MARS platform to target other customer groups. Today the firm offers waste management systems, retail store inventory management systems, and maintenance systems for shipping companies. In 2010 Logimatic Software was sold to Aveva which is the world's leading provider of software systems to the shipbuilding industry (Olesen, 2016).

Table 2: Remaining spin-offs by 2013			
Spin-off firm	Shipyard	Activity when established	Activity in 2013
MAN Diesel & Turbo	B&W	Production and development of ship diesel engines	Development of ship diesel engines (production has been outsourced – mainly to license takers in Asia)
B&W Energy	B&W	R&D and production of boiler systems for coal power plants	Development of boiler systems for biomass- and coal power plants. Production has been outsourced.
B&W Scandinavian Contractor	B&W	Contracting of diesel power plant	Contracting, financing, operation and maintenance of biomass and diesel power plants
Alfa Laval Aalborg	ÅV	Development and manufacturing of boilers for industry, power plants, and ships.	Development and (offshored) production of marine boilers, thermal fluid systems, Inert-gas systems and industrial boilers
Logimatic	ÅV	Consulting engineers	Software developers Consulting engineers
Dan Skilte	ÅV	Production of signs	Production of signs
NIS	ÅV	Steel and shipbuilding activities	Steel and shipbuilding activities
VICTOR	DY	Pipe production	Pipe production and cooling systems
CH Marine Consult	DY	Consulting engineers	Consulting engineers
FME	DY	Business park	Business park
Refshaleøens Ejendomsselskab	B&W	Property management	Property management
Nakskov Industri- & Miljøpark	NS	Business park	Business park

Source: Olesen, 2016

B&W Scandinavian Contractor is another example of a shipyard spin-off that has developed new products. When the firm was spun out from B&W it contracted diesel power plant. In the late 1980s, however, the management saw a business opportunity in offering lifetime operation and maintenance service on the power plant that were contracted. This has later developed into the most important activity of the firm. In the 1990 the firm also expanded into the biomass plants in order to meet the demand for green energy solutions. And in 2013 it began to offer financing solutions on the power plant projects (Olesen, 2016).

3.3 Identifying new markets

Apart from developing new products, a number of firms have successfully been able to target new markets. Spin-offs such as Dan Skilte, Nordjyllands Industriservice, CH Marine Consult and Danyard Pipe have identified local or regional niches where they have established themselves as craftsmen or service providers. These firms were all relatively small spin-offs established by former shipyard employees (Olesen, 2016).

Another group of shipyard spin-offs have developed in a completely different direction. These firms have managed to establish themselves as global players that generate their main revenue abroad. Among these firms are some of the largest spin-offs including B&W Diesel, Aalborg Boilers, B&W Scandinavian Contractor, B&W Energy, Logimatic, and Aveva Denmark. Most of these firms were shipyard divisions that were identified by the shipyard management. They are characterized by a much larger turnover and employment compared to the local and regional spin-offs mentioned above. B&W Diesel, Aalborg Boilers and Aveva Denmark are all suppliers to the shipbuilding industry. For these firms, the global dislocation of the shipbuilding industry in the past decades has meant that the main customers are today situated in Asia. They furthermore have after-sales activities all over the world. A similar pattern can be identified in the power plant segment where B&W Scandinavian Contractor has customers in the Caribbean and Asia, while B&W Energy has been dependent on the European market.

3.4 Growth through new industrial organizations

In addition to creating new products and developing new markets, Schumpeter argues that entrepreneurs can innovate through new industrial setups. In this regard we have seen that the largest shipyard spin-offs have undergone profound changes in the past three decades. The Danish shipyards were characterized by very concentrated value chains, where all activities from research and development to production and after sales activities were located in Denmark. This was initially also the case for most of the firms that were established from the shipyards. Today, however, all of the major spin-offs have established global value chains. This change has partly been made to reduce production costs, but also to be close to the customers. The manufacturing activities have increasingly been dislocated to low-wage countries near the customers, while more value-added activities such as R&D has been kept in Denmark (Olesen, 2016).

B&W Diesel is a good example of this development. When the firm was spun out in 1980 the production facilities were located in Copenhagen. The dislocation of shipbuilding activities to Asia however saw a declining demand for ship engines in Europe, and in 1987 the factory in Copenhagen was closed. This was followed by the closure of the production sites in Holeby and Frederikshavn in 2005 and 2010. Today MAN Diesel & Turbo (the former B&W Diesel) has no manufacturing activities of significance in Denmark, and the two stroke ship engines are mainly produced by licensees in Asia. B&W Scandinavian Contractor and B&W Energy have also outsourced all manufacturing activities while Alfa Laval Aalborg (the former Aalborg Boilers) has offshored these activities to China.

The firms have also undergone a significant change in terms of ownership structure. The Danish shipyards were all owned by Danish firms. By 2013, however, all of the largest spin-offs were owned by multinational firms with headquarters abroad. B&W Diesel was acquired by the German company MAN in 1980. B&W Scandinavian Contractor was owned by the Swedish firm Götaverken from 1980 to 1990 and is today owned by the Japanese firm Mitsui. B&W Energy was sold in 1980 to F. Lentjes in Germany. Aalborg Boilers was sold to a group of capital funds in 2000 before being acquired by the firm was acquired by the Swedish firm Alfa Laval in 2011. And finally, Logimatic Software was sold to the UK based firm Aveva in 2010 (Olesen, 2016).

The ability to develop new products, identify new markets and form new industrial setups has, however, not been any guarantee for success or even survival. Several of the firms that have disappeared attempted to adapt to the changed conditions. Danyard Aalborg used the production facilities and the employees' knowhow on fiberglass to develop new luxury yachts but went out of business in 2005. Aalborg Aluminiumskonstruktioner developed a groundbreaking aluminum catamaran ferry design, but was unable to compete with shipyards in Australia. O.C International, Skibs og Maskin Consult, and SMC Marine found new customers abroad. However, they went bankrupt when these customers failed to meet the terms of payment. And finally, Nakskov Skibsentreprise and Danyard Aalborg created a new organizational setup where they reduced the fixed organization to a minimum and relied on subcontractors that were hired in for each task. None of these attempts were, however, successful (Olesen, 2016).

3.5 Status in 2013: Fewer employees and more value added

In the creative destruction process entrepreneurs combine the existing factors of production in new and more viable ways. In this regard it is relevant to compare the activities at the shipyards with the activities in the spin-off firms. Table 3 shows the employment, turnover and results of the four shipyards in 1975 when the tonnage deliveries peaked. Table 4 shows the same information for the spin-offs by 2013. Some reservations have to be made when comparing these numbers. Logimatic Software and Aalborg Boilers were acquired by multinational enterprises in 2010 and 2011 and integrated in the new organization. This makes it difficult to trace the original activities in 2013. I have therefore included the key figures from the last year before the acquisitions. A second reservation has to be made regarding the key figures from MAN Diesel & Turbo. Here the latest available data is from 2007 when the shipbuilding and ship engine markets experienced a hitherto unprecedented upswing. In comparison 2013 was characterized by depressed market conditions. With these reservations in mind, however, it is possible to compare the activities in the spin-off firms with those of the shipyards.

	Employees	Turnover (DDK)	Result (DKK)
B&W	7.838	1.767 million	25,1 million
Nakskov Skibsværft	2.245	337,2 million	-3,2 million
Aalborg Værft	2.766	467,7 million	14 million
Danyard Frederikshavn	1.112	230,8 million	2,5 million
Total	13.961	2,8 billion	38,4 million

Sources: Annual reports from the four shipyards in 1975

First, I find that there has been a drastic reduction in the employment when comparing the shipyards and the spin-offs. The four shipyards employed 13,961 workers in 1975. In 2013 the 12 spin-offs employed approximately 3,000 people. We have also identified a change in the composition of employees. At the shipyards approximately 75 % of the employees were blue-collar workers and 25 % white collar workers. Today this balance has tipped in favor of employees with academic backgrounds. In 2011 61 % of the employees at B&W Scandinavian Contractor had a bachelor degree, a master degree or a PhD degree (Olesen 2016).

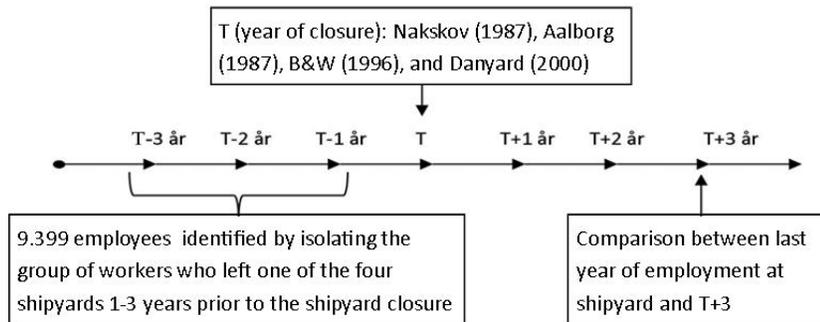
Table 4: : Employment, turnover and result og result for the spin-offs in 2013			
	Employees	Turnover (DKK)	Result (DKK)
MAN Diesel & Turbo	DK: 1.916 (2013)	DK: 7.5 billion. (2007)	DK: 1 billion (2007)
BWSC	DK: 296 (2013) Total: 450 (2013)	DK: 1.3 billion (2013) Total: 1.5 billion (2013)	DK: 59 million (2013) Total: 65 million (2013)
BWE	DK: 140 (2013)	DK: 327 million (2013)	DK: 3 million (2013)
Alfa Laval Aalborg	DK: 465 (2013) DK: 524 (2010) Total: 2.523 (2010)	DK: 1 billion (2013) DK: 1.3 billion (2010) Total: 2.6 billion (2010)	DK: 86 million (2013) DK: 332 million (2010) Total: 332 million (2010)
Logimatic	Total: 68 (2013) Total: 131 (2009)	Total: 59 million (2013) Total: 128 million (2009)	Total: 6 million (2013) Total: 13 million (2009)
Dan Skilte	DK: 9 (2013)	-	DK: 78,000 (2013)
NIS	DK: 35 (2013)	-	DK: 1 million (2013)
CH Marine Consult	DK: 18 (2013)	-	DK: 4,8 million (2013)
VICTOR	DK: 65 (2013)	-	DK: -4 million (2013)
FME	DK: 10 (2013)	DK: 18 million (2013)	DK: 0.84 million (2013)
Refshaleøens Ejendomsselskab	DK: 10 (2013)	DK: 32 million (2013)	DK: 2.5 million (2013)
Nakskov Industri- & Miljøpark	-	-	-
Source: Navne & Numre Database (for MAN Diesel & Turbo: Annual report for 2007, s.7) Note: For MAN Diesel & Turbo the latest key figures are from 2007. For Logimatic and Alfa Laval Aalborg I have added the key figures for the year prior to their merger with Aveva and Alfa Laval (2009 and 2010) to give an impression of the size of these activities before they were acquired.			

Second, the spin-offs deliver far higher profits than the shipyards. In 1975 the four shipyards delivered a result of 38.8 million DKK (169 million DKK in 2010 prices) from a turnover of 2.8 billion DKK (12.3 billion DKK in 2010 prices). In 2007 the Danish activities in MAN (the former B&W Diesel) made a profit of 1 billion DKK from a turnover of 7.5 billion DKK (1.07 billion DKK and 8.04 billion DKK in 2010-prices). If you add the key figures from Logimatic and Aalborg industries the last year before they were acquired (in 2009 and 2010 respectively), and the 2013 key figures from the remaining firms we reach a profit of 1.5 billion DDK from a turnover of 12 billion DKK. If we only include the Danish activities the numbers are 1.15 billion DKK from a turnover of 10.5 billion DKK (in 2010 prices). Despite the fact that these are rough numbers and that certain reservations have to be taken, it clear that the spin-offs were far more profitable than the shipyards. It may be more surprising that by 2013 the turnover of the spin-off firms equaled that of the shipyards in 1975 (corrected for inflation).

4. The workers at the Danish shipyards

This section examines what happened to the 9.399 employees that lost their jobs when the four shipyards closed. The study is based on quantitative data from the Danish Workforce Database (IDA) which is provided by Statistics Denmark. Every November since 1980 data Statistics Denmark has collected register data on each individual worker and workplace in Denmark. By connecting the individual worker and workplace it is possible to study movements in the Danish labor market over time.

Figure 2: Data collection for study of redundant shipyard employees



First, I have identified all the workers that left the four shipyards three years prior to the closure. Second, I examine what had happened to this population of workers three years after the closure (figure 2). As the data does not allow me to examine the closure of B&W in 1980, I have included data from the 1996 closure of B&W Shipyard, which continued the shipbuilding activities from B&W.

	Naskov		Aalborg		B&W		Danyard	
Data collection period	1984-1986		1984-1986		1993-1995		1997-1999	
Employees who left the shipyards	1,382		4,599		2,042		1,376	
Re-employed after 3 years (in percent)	855	(61.9)	3,189	(69.3)	1,443	(70.7)	884	(64.2)
Re-employed worker has... (in percent)								
... higher education	37	(4.3)	228	(7.1)	109	(7.6)	47	(5.4)
... moved to other municipality	140	(16.4)	407	(12.8)	279	(19.3)	78	(8.8)
... higher hourly wage	663	(87.5)	2,286	(86.0)	665	(49.8)	457	(55.8)
... higher taxable income	460	(53.8)	1,753	(55.0)	508	(35.2)	313	(35.4)
... employment in i top-5 firm	269	(31.5)	1,390	(43.6)	142	(9.8)	205	(23.2)

Source: Statistics Denmark, IDA database
 Note: Top-5 firms are the five firms where most shipyard employees were hired.

Table 5 shows the employment characteristics of the shipyard workers three years after the closure. The first row shows the data collection period while the second row show the number of employees that left the individual shipyard in that period. The third row shows the number of employees that found new jobs after three years and the percentage of reoccupied workers for each shipyard (e.g. 1,382 workers left Nakskov. 855 were reoccupied after three years. This amounts to 61.9 percent of all the workers who left Nakskov). The following rows show the retraining, mobility, income, and dispersion of the re-employed workers (e.g. of the 855 re-employed workers from Nakskov 37 had obtained a higher level of education after they left the shipyard. This amounts to 4.3 % of the 855 re-employed workers from Nakskov. The same employee can appear several times (e.g. if a worker has taken a higher education and has moved the worker will appear in both rows).

Table 6: Migration to other sectors (in percent)				
Shipyard and year of closure	Nakskov (1987)	Aalborg (1987)	B&W (1996)	Danyard (2000)
Workers employed three years after closure	855	3,189	1,443	884
Primary sector total	2.0	0.5	0.1	1.9
Manufacturing of...				
... food and textiles	3.0	1.9	1.3	5.8
... wood and paper	0.4	0.5	1.2	0.7
... chemistry and plastics	5.7	3.9	3.7	1.9
... steel and machinery	33.7	38.4	18.2	19.2
... electronics	4.6	1.9	3.5	6.0
... transportation (shipbuilding)	5.9	19.2	1.9	17.7
Secondary sector total	53.3	65.8	29.8	51.3
Supply service (e.g. in the energy sector)	2.5	2.4	1.4	0.1
Construction	8.4	7.2	13.1	15.8
Trade, hotels, and restaurants	6.4	4.9	11.2	5.4
Transport (e.g. bus driver or taxi driver)	8.4	3.5	11.4	4.0
Business service (e.g. banking)	9.0	6.1	14.4	8.6
Public sector service	8.0	9.0	12.1	8.6
Other services	2.0	0.6	6.4	4.2
Service sector total	44.7	33.7	70.0	46.7
Total	100.0	100.0	99.9	99.9
Source: Statistics Denmark				

Table 5 shows that between 62 % (Nakskov) and 71 % (B&W) of the redundant shipyard workers found new jobs. And during the seven years that followed the closures 81 to 92% had been employed at some point in time (Holm, Østergaard and Olesen, 2017). Table 5 also shows that the level of retraining was very low (between 4 % and 8 %) and that the hourly wage increased more than the taxable income. This suggests that many shipyard workers became employed part-time (e.g. in the construction sector). Table 6 shows where the workers went. Most went to job in manufacturing of steel products and machinery (18 to 38 %) or shipbuilding (2 to 20 %).

From table 5 and 6 it is evident that there are clear differences from shipyard to shipyard. These differences between the individual shipyards can be traced to the location of the shipyards (table 7).

Shipyard and year of closure	Nakskov (1986)	Aalborg (1987)	B&W (1996)	Danyard (1999)
Location and inhabitants	Nakskov (16.000)	Aalborg (180.000)	Copenhagen (470.000)	Frederikshavn (24.000)
Related industry in region (manufacturing of steel, machinery or transportation)	Weak	Strong	Weak	Strong
Service jobs in region (service sector)	Weak	Strong	Strong	Weak
Job creation in shipyard spin-offs	App. 300	App. 2.800	App. 10	App. 30

Nakskov Shipyard was located in a town of 16.000 inhabitants. The region was characterized by a very weak industry structure with few job opportunities in related industries as well as in service jobs. In 1980 only 23 industry firms in the region employed more than 6 people and 51 % of all industry workers in the region worked at the shipyard. The spin-offs from Nakskov Shipyard only created around 300 jobs. The weak industry structure and the small spin-offs explain the low rate re-occupation rate of 61 %. It also explains why more than 16 % of the workers had to move to other municipalities to find jobs.

Aalborg Shipyard was located Aalborg which was the fourth largest city in Denmark with 180.000 inhabitants. The region (Northern Jutland) was characterized by a strong cluster of related industries including shipyards (e.g. Danyard, Ørskov and Karstensen) and shipyard suppliers (e.g. Wärtsilä and MAN Diesel). The spin-offs from the shipyard created around 2.800 direct workplaces. This is an important factor when explaining why 70 % of the employees were in new jobs after three years. The

spin-offs and the strong presence of related industries in the region also explains the migration manufacturing of steel and machinery (38 %) and shipbuilding (19 %).

B&W was located in the Danish capital of Copenhagen with 470.000 inhabitants. By 1996 most firms engaged in manufacturing of steel, machinery and ships had left the city (Maskell, 1986 and 1992). However the region offered plenty of job opportunities in the service sector. This explains the high reemployment rate (70 %) and the migration to the service sector (70 %). The migration to a wide range of service jobs and the fact that the 1996 closure saw no major spin-offs explains why less than 10 % of the reemployed workers were hired by top-5 firms. The high level of mobility (19 %) does not indicate that shipyard workers moved far to find new jobs. Rather it should be explained by the many small municipalities around Copenhagen.

Finally, Danyard was located in Frederikshavn with 24.000 inhabitants. The region of Northern Jutland was characterized by a strong presence of related industries. This explains the migration to manufacturing of steel and machinery (19 %) and shipbuilding (17 %). The closure was furthermore characterized by a large migration to the construction industry (15%). The high migration to top 5 firms (23 %) can be explained by the fact that many workers found new jobs at the neighboring Ørskov Christensen Shipyard.

5. Discussion and Conclusion

In the previous sections I have identified 27 spin-offs that were established from the closed shipyards. There are two factors that may explain this development. First, the Danish shipyards had very diverse product portfolios. For decades Danish shipyards had made ship engines, ship designs, ship interior, marine boilers, and steel sections to support the shipbuilding activities. Some of these activities could also be used to target non-maritime sectors such as the power plant and construction industry. By the 1970's several of these supporting business areas were turned into independent divisions that operated as small firms within the shipyard organization. When the shipyards closed these divisions did not rely on being part of a shipyard and they were easy to spin out. Second, there was a wide range of innovative entrepreneurs and investors – especially among managers, owners, and workers. The complete lack of state support during the shipyard closures may also have played a role in forcing the managers and employee to be more creative.

The fact that the shipyard employees were fairly successful in securing new jobs can be explained by three factors. First, the establishment of spin-offs from the shipyards provided jobs for many of the shipyard workers in Aalborg and at the 1980 closure of B&W. Second, the fact that the employees had very different skills made it easier to integrate them in other parts of Danish industry. 50% of the redundant shipyard workers were skilled blue collar workers including smiths, metal workers, machine operators, painters, carpenters, electricians etc. These workers could apply their skills in several sectors such as manufacturing and construction (Kamedula et al., 1987). Unskilled workers and white collar employees (engineers, sales people, accountants and managers etc.) were also able to migrate to other sectors (Olesen, 2016). Third, the regional industry infrastructure had an impact. Copenhagen offered a wide range of service jobs, and 70 % of the reemployed workers went to this sector when B&W closed in 1996. In Frederikshavn and Aalborg most workers found new jobs in SME's in the strong maritime industry cluster in Northern Jutland. In Nakskov the high mobility of the workforce explains why more than 60 % of the workers were employed after three years.

By 2013 the Danish shipbuilding industry had largely disappeared. But the spin-offs from the Danish shipyards were very visible in other industries. Innovative entrepreneurs had reshuffled the resources and capabilities at the Danish shipyards. They had developed new products, identified new markets and created new industrial organizations. By 2013 the firms had ceased, outsourced or offshored the low value added manufacturing activities and turned the focus to high value added R&D and after sales activities. Today the spin-off from the Danish shipyards are global leaders in the markets for two stroke ship engines, marine boilers, thermal fluid systems, inert-gas systems, contracting and operating diesel power plants, and software development for the shipbuilding industry. The high reemployment rate, the low level of retraining, and the migration to neighboring sector furthermore indicates that the competencies at the shipyards were sought for in other parts of Danish industry.

The closure of the Danish shipyards should thus not only be viewed as a story of decline but also as a story of transformation and Schumpeterian creative destruction.

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