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PRODUCT STRATEGIES IN MERCHANT SHIP AND AIRLINER INDUSTRIES

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ABSTRACT

Despite interesting similarities, there are major differences in the way products of airliner and merchant ship industries are developed, sold and delivered. The fact that these both industries manufacture equipment for transportation and have similar design targets brings up a question, why applied industrial paradigms are so different? Theories about evolution of industrial paradigms and product strategies linked to them suggest that over a time change is towards more sophisticated methods. The examples from merchant ship and airliner industries however show that in reality the development is anything but straightforward.

This paper will specify the factors and present reasons for differences in applied industrial paradigms and present concept map analysis about the existing causalities within merchant ship industry. Based on the differences in historical and existing factors it can be seen that the ultimate reasons for different industrial paradigms are due to the customers' behavior and industrial regulation, fostered by national and industry specific causalities that maintain the existing situation.

Keywords: platform strategies, product architecture, design to X, merchant ships, airliners

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1 INTRODUCTION

Despite major differences between merchant ship and airliner industries, there are also interesting similarities. First of all, these both industries manufacture equipment for transportation: airliners with focus on passenger and merchant ships on cargo. Furthermore, civil airliner and a merchant ship have the same main targets for design: capacity of units to be transported (e.g. persons, containers or tons), the speed of the transportation and range and/or conditions of use (e.g. regional/coastal vs. long-haul/ocean-going). (Molland, p. 641, 2008; Price, Raghunathan, Curran, p. 334, 2006). These targets are typically in contradiction to each other and therefore any airliner or merchant ship is a compromise that meets the given restrictions.

Despite similarities in design targets, it is clear that different functional premises (aerodynamics vs. hydrostatics and -dynamics) and carried units require different technical solutions. However, it's not that clear which factors have created the major differences in applied industrial paradigms. That is to say, the way these two industries develop, sell and deliver their products. When we compare evolution of airliners and ships it can be said that there's similar tendency to copy and modify successful designs. The biggest difference is that, in airliner industry this seems to be a systematic process driven by existing and expected market needs thus leading into use of assemble-to-order (ATO) and configure-to-order (CTO) manufacturing processes. On the other hand, shipyards seem to be more passive and short-sighted in their actions, copying and modifying old designs based on single customer requests thus forced to rely on engineered-to-order (ETO) type of process. In this paper we aim to specify the factors behind applied paradigms and the existing causality in shipbuilding industry.

First we have a brief look into theories of fore mentioned industrial paradigms followed by introduction to histories of merchant ship and airliner industries. Then, we identify the major differences in business environments, products strategies and industrial paradigms. Furthermore, we ponder the roles and effects of these factors and finally present our conclusions.

2 EVOLUTION OF INDUSTRIAL PARADIGMS

There are multiple theories about evolution of industrial paradigms and product strategies linked to them. Well known examples are Victor & Boynton (1998), Baldwin & Clark (1997, 2000) and Jovane et al. (2003). These theories have common view that industrial ways of manufacturing can be classified to different levels of sophistication. The starting level proposed is craft work, which according to Jovane et al. (2003) means to produce exactly the product that the customer wants, usually one at a time. Thus craft can be defined also as engineer-to-order (ETO) kind of work. Craft is not the best way to do work if the market becomes more and more interested about the result of the work and the demand increases. In mass production, products are identical and they are made in high quantities. Thus mass products can be defined to have made-to-stock (MTS) kind of order-delivery process. Victor & Boynton (1998) explain that like in transformation from craft to mass production the impulse from mass production to process enhancement is managerial issue. It is possible that customers learn to ask higher quality when they understand the important properties of the deliverables. This results in introduction of quality systems and enhancement of processes. Learning from mass production when doing same work time after time produces practical knowledge that is key enabler in process enhancement work. Process enhancement work links doing and thinking with how to do better. Capability to improve the process improves the quality of deliverable (a product). This is a main goal in process enhancement. Jovane et al. (2003) explain that flexible production was answer to a request for more diversified products compared to mass products. Flexible production includes elements from mass production. Lot sizes were reduced in flexible production because new products were introduced more often to the market than earlier. Components of products were manufactured using mass production principles but they are assembled when customer has chosen some options. Thus flexible production work type fulfils assemble-to-order (ATO) kind of order-delivery process type. Victor & Boynton (1998) and Jovane et al. (2003) have stated that at some point, the available products with better quality are not enough to satisfy customers and this leads mass customization. Quickly changing customer requirements cause the need for product variety. New products lead to introduction of new processes. In process enhancement work, workers get used to continuous changes resulting in improving of design skills of changes also. This deep understanding of the interactions and interdependencies is called architectural knowledge. Baldwin & Clark (1997, 2000) propose that mass customization based on modular product architectures and configure-to-order (CTO) delivery process will become the dominant norm in industrial operations. Victor & Boynton (1998) propose that after mass customization the next paradigm will be Co-configuring, which is an activity where integrated system is built and upheld for sensing, responding and adapting to the individual need of the customer. In this paper, the latter paradigm is omitted as neither of the studied industrial application areas is nowhere near to enter this paradigm.

Prior presented theories share understanding that industrial paradigms develop step by step and the natural direction of change is towards more sophisticated paradigms. In addition, it is claimed that the change to next paradigm is a matter of maturity of the application area. Similar application areas in similar business environment should reach same level as time elapses. And if we follow the thinking of Baldwin & Clark all should finally reach mass customization with modular product architecture. The examples from merchant ship and airliner industries however show that even if the principles in these theories are correct, they seem to not take account all factors and in reality the development is anything but straightforward.

3 BRIEF HISTORIES OF MERCHANT SHIP AND AIRLINER INDUSTRIES

When we start to check the history of these two industries we can immediately specify one major difference – the time they have existed. In commercial shipbuilding the history goes all the way back to ancient Egyptian and Chinese civilizations' whereas the history of commercial aviation has reached barely age of hundred years. In able to keep this paper in reasonable length we here start to wield both industries from early 20th century – the point in time when commercial aviation took its first steps.

3.1 European era in shipbuilding and early years of commercial aviation: 1900-1950

In turn of the century shipbuilding had already seen one of the biggest changes for centuries as the construction material had started to shift from wood first to iron and later to steel. Despite the radical change in materials, until 50's the assembly of ship's hull was based on riveting which resembled the joining techniques of wooden shipbuilding. The ship hulls were built in one spot, without a cover, near to the shore, more or less piece by piece, from start to the launch and later as the hull was in floating condition the work was finished by the pier. The world's center in shipbuilding in beginning of 20th century was in Britain and West Europe, however US and Japan were also major players (Cho & Porter, p. 551-552, 1996; Motora, p. 197-199, 1997). The biggest driver for British shipbuilding was the empire's vast need for new ships and the local resources for coal and iron ensured that shipyards had the steel they needed. Rest of the Europe had similar needs due to colonization. Within the beginning of century Japan was already in the beginning in its journey to become shipbuilding superpower but made rather slow progress. Japanese technology development and shipbuilding activities were supported by US that supplied to Japan the steel it needed and got ships for exchange (Motora, p. 198, 1997). Despite technological progress the shipbuilders had tough times between world wars due to the weak demand caused by great depression. British shipbuilders managed to keep their leading position until the WWII (Cho & Porter, p. 551, 1986). The WWII brought one interesting phenomenon to shipbuilding history that affected the business all the way to 70's. The huge need of allied forces for cargo ships gave birth to a true series manufacturing of ships. These standard ships, called "*liberty ships*", were manufactured in long series and the record construction time of one vessel is said to be four and half days. Over 3000 ships were built and what is most important, these ships were widely used also in post war merchant shipping. (Elphick, 2006)

The first serious steps of commercial aviation took place soon after WWI during which airplanes had developed from Wrights brothers' flyers to planes which have structures like in airliners of today. In US, the first commercial uses involved flying mail based on regular schedules and occasionally few passengers. The development of passenger traffic aviation in US was lacking behind of Europe as US dense railroad network gave no chance for airplanes to compete for passengers. Trains offered trouble free, safe, often faster and certainly more comfortable journey compared to risky airplanes of that time. In Europe the situation was different. WWI had led to destruction of many important railroads and the airplanes gave true advantage in this situation. The European governments soon became interested of sponsoring this new business and major subsidies were granted to newly established airlines. Europeans were also eager to connect their colonies to mainland with airlines thus pushing the technology and routes ever further. (Heppenheimer, p. 1-17, 1995) What is important to notice regarding the subject of this paper is that already in the very beginning of commercial aviation national governments took very different approach to airlines compared to shipping of that time. Especially in the US, national route system, developed first for mail and later for passenger traffic, became strictly controlled by officials and thus secured against competition. In contrast to US, in Europe the airline business was international from the very beginning. However, even this aspect didn't lead into open competition environment but to national airline companies. The quick leap that was taken in aircraft design during the WWI led to stagnation in development and it required WWII until the airplane designers took the next step and got rid of the fuselage of welded steel tubes construction, open cockpits, biplane wings and fabric coverings (Heppenheimer, p.15, 1995).

3.2 Standard ships and golden years in commercial aviation: 1950-75

After the WWII, shipbuilding started to grow steadily. Also the dominance of Asian shipbuilding – the era that still continues- emerged during this period. The Japanese were first to challenge European yards. At first the Japanese emergence was mainly due to cheap labor packet up by government subsidies and orders by national ship owners but also the quality of products soon reached European levels. However, the most important developments were seen in building methods. The latest technology in electrical welding (method that had advanced radically in US during WWII as shipyards struggled to deliver "*liberty ships*") was quickly adopted in Japan after the WWII. It's worth to mention, that further development and implementation of these innovations were supported by intensive cooperation among competing shipyards (Motora, p. 204, 1997). The development of production technology in Japanese yards speeded up radically in 1950's when US based bulk shipping company NBC leased shipyard in Kure for ten years and started to build merchant ships (mainly tankers and bulk carriers) (demand for tankers was huge in 50's due to Suez crisis) with advanced methods. As part of the agreement for the lease, these methods were efficiently disclosed and implemented to all Japanese shipyards (OECD, p. 9, 2007; Motora, p. 204, 1997). After these developments Japanese builders continued with such re-innovations as block construction (1950's) and advanced assembly system (1960's) that had been used already by German shipyards in WWII time for submarine construction but never applied in peace time construction (Williamson, 2005; Weir, 1998). It seems that the Europeans, especially British shipbuilders at that time, didn't see the need for radical development of building methods perhaps due to steady growth in overall shipbuilding volumes that ensured work for everybody. In the late 1960's emerged new phenomenon in shipbuilding history which is especially important when we consider the topic of this paper. The "*liberty ships*" that had been built during WWII for allied navies were coming into the end of their life. Major share of these ships had been sold to private ship owners and had had major role in post war shipping - It is estimated that by the mid 1960's there was some 700 liberties still trading. Major shipbuilders foresaw this need to replace old liberty ships and started the design. The British shipbuilders were led by Austin & Pickersgill from Southampton with its SD-14 design. Notable German counterparts were the "German Liberty Replacement", and 36/36L. Japanese took part into the competition with designs called "Freedom" and "Fortune". The first SD-14 and other liberty replacements saw the daylight in late 1960's. (Lingwood, p. 6-7, 2004; Detlefsen, p. 107-108, 1996).

The years from WWII to 70's can be described as the golden era in commercial aviation. WWII had remarkable effect to the development of aviation technology which was rapidly exploited in commercial aviation. One of the most important was the jet engine - at first a turbo-jet (which had origins in gas turbine technology) that was later developed into turbofans, the technology that is used in modern airliners (Heppenheimer, p. 75-107, 1995). Secondly, the stressed aluminium skin construction and improved aerodynamics that had been invented in very short period in late 1930's (Heppenheimer, p. 44, 1995) finally proved their superiority. And thirdly, the implementation of pressurized cabins allowed airliners to fly high above the changing weathers (Heppenheimer, p. 114, 1995). The period from WWII to late 1970's was clear domination of US based manufacturers – Boeing, McDonnell Douglas and Lockheed ruled the world market (Yoshino, p. 518, 1986). One of the most interesting aspects of this period was the race for supersonic passenger flights. After the advancements in supersonic flights in military side the common opinion among US and European manufactures alike was that supersonic speeds would be also the future of passenger airliners. The race for first supersonic passenger airliner was interesting in a sense that it was very strongly driven by national governments. In this race British and French governments were united to compete with Americans which had also government driven approach (Heppenheimer, p. 205-206, 1995). There was however few problems in the way in form of sonic boom, turned out to be too disturbing for people beneath the flight path, and the fuel consumption. It soon became clear that these airliners could be flown in a full speed only above oceans and the fuel hungry concepts took another radical hit as the prices soared due to oil crises. As a result only the European governments pushed their project into production, despite the cost of hundreds of millions of tax payer's money. Only 20 units were manufactured and British Airways and Air France were to be the only paying customers. The Americans in turn started to focus on new economic supersonic passenger concepts. This trend set the path for success e.g. for Boeing 747. (Heppenheimer, p. 197-226, 1995)

3.3 Asian era in shipbuilding and consolidation of airliner industry: 1975-2000

The seventies were rough times for shipbuilders as they were for airliner industry. All major shipbuilders, including the Japanese yards, were challenged by period of very low sales levels. European yards were challenged first time by the Asian builders in market situation of decreasing demand and it soon became evident that the Japanese weren't the ones to give up. However, also Japanese production was shrinking. There was however one notable exception. In 1980's the South Korea emerged as new player in the game. The most interesting fact in rise of Korean shipbuilding industry is that it happened in a market situation when all other shipbuilding nations lost production volumes (Bruno, Tenold, 2011). Despite that, most of the success factors were already familiar (cheap labor and government subsidies) the Korea introduced the "parallel shipbuilding method" into use whereas same method was banned in Japan by local government to reduce competition among Japanese yards (Cho & Porter, p. 557, 1986). The latest and long expected turn in trend has been the emergence of Chinese shipbuilding in late 1990's. (OECD, 2008)

Airliner industry was no exception what comes to the effects of oil crisis and overall downturn of economics in 1970's. In 1983 the total number of orders for new airliners had decreased to 223 units from 332 units in 1981. In 1978 the figure had been more than threefold. Furthermore, in 1983 there were about 600 secondhand airliners for sale. (Yoshino, p. 531, 1986) The challenged times affected Lockheed which decided to leave the civil airliner business in 1983 (Heppenheimer, p. 254, 1995). The hard times also pushed companies to seek for partners, synergies and strategic alliances. The US based manufacturers were finally challenged by European airliner manufacturer Airbus, which had been organized in 1970 by governments of France, Britain and Germany. In 1978 it finally made its first contracts for US based airline for twenty three A-300 airliners (Heppenheimer, p. 292-297, 1995). Boeing in turn deepened cooperation with Japanese government and local manufacturing companies which reinforced an already strong tie with the Japan Airlines, the nations publicly owned airline (Yoshino, p.530, 1986). In 1997 the number of players in wide-bodied airliner industry shrunk to two as McDonnell Douglas merged with Boeing.

4 BUSINESS ENVIRONMENTS AND PRODUCT STRATEGIESS

As stated in the first chapter, there are major differences in applied industrial paradigms among shipbuilding and airliner industries. One of the major differences occurs in design and delivery process. In general level it can be said that airliners are developed and designed based on customer requirements (needed capacity, range and speed in certain segment). As certain state of development is achieved (e.g. first concepts has been introduced) manufactures starts to take pre-orders from customers and finally when the product is ready the orders are finalized and equipments are delivered to customer. This process, from start of the development to the first deliveries takes often 10-15 years taking e.g. recent new comer Boeing 787 or historical Concorde as examples (Heppenheimer, 1995). Development of completely new airliner is not the only applied strategy to meet customer needs. Typically all successful models have triggered off entire family of different versions (capacity, engine configurations etc.). One typical example is the Boeing 747 that has, since the start of its manufacturing in 1969, lead to multiple versions. Ships in turn are designed based on customer specific requirements and manufactured as one-offs or in short series (Erikstad, p. 10, 2009). The development and design is usually based on reference ship and therefore the time for completion depends highly on the amount of required changes.

As mentioned in the previous chapter, in the history of shipbuilding, there's been at least one peace time occasion when ships have been designed and build with similar strategy to airliner industry. This was during the era of liberty replacements in 1970's. For a while it seemed that the shipbuilding would enter into an era when products are systematically designed for entire customer segments, these products (not just production slots) are actively sold by yards and the required customer variations are met through pre-designed options and add-ins, methods that had been spotted from automotive industry. (Lingwood, p. 10, 2004) However this new approach didn't develop into a common strategy. One reason might have been that in the depressed market environment this new product strategy couldn't overcome the supremacy of low cost production and national subsidies. In addition the product itself, two decked dry cargo ships, were later played out by more efficient design - the container ships. Since, there has been occasional and segment specific attempts to develop and change the course of shipbuilding. As an example European project InterSHIP between 2003 and 2007 aimed to significantly increase the competitiveness of European cruise, passenger ferry and RoPax shipbuilders. However, the specific segments have relatively small volumes compared to other merchant ships which make it even more challenging to reap the benefits of repetition. The most concrete results can be seen in the segment of offshore supply and anchor handling vessels where such companies as Ulstein Group and STX OSV have come out with clearly specified product families.

In general, ship-owner in need for a new ship may order rather customized equipment and still get it in reasonable time or seek for second hand ships on the market. In contrary, an airline company seeking for a new airliner has options either to choose among some of the models already in-production (and pre-defined options like seating arrangement), seek the market for second hand products or place a pre-order for some of the future models. Also here we have seen exceptions during the history. For example notorious intercontinental airline Pan Am, which acted as an unofficial flag carrier of US, had such a strong position in 1960's airliner development that it didn't have to settle down with the existing offering of the airline builders but was able to impact on emergence of new solutions and technologies. One example of this is the Boeing 747 that was designed based on Pan Am's requirements (Heppenheimer, p. 221-222, 1995). Those days are now over due to deregulation of the business. What is common for both industries is that they are affected by the existing market situation. When the economy is booming and demand for transports is high the customers are more compliant for any available equipment that can be delivered quickly but become more picky and selective in recession.

What comes to the benefits of series manufacturing in shipbuilding, it seems that there's very little of them or are underestimated by the industry. The savings in total costs of design and manufacturing in case of identical sister ship instead of one-off is estimated create reduction of 8 to 15 percent (Watson, p. 489, 1998; Benford, p. 6-33, 1996). It it's worth mentioning that most sources of information in this matter use examples of two, three or four units compared to one-off. Quite the contrary, it has been stated that airliner manufacturing has steep learning curve and economies of scale are significant (Yoshino, p. 517, 1986).

We can also compare the costs of developing and manufacturing of these products as well as the sales prices. Recent estimated for new wide-bodied airliner development cost have been up to 15 billion $ scale (Gates, 2011 - considering Boeing 787) which seems to be in line with earlier estimates (10-20 billion $) presented by Starkie and Ellis (1995). These figures include also the costs of new production facilities and equipment which are among the most expensive elements of a major aircraft program (Heppenheimer, p. 295, 1995). What comes to the production volumes, the longest series have consisted of nearly 7300 units (Boeing 737 series). This means that despite the enormous development cost, average narrow-body airliner can be sold with price of 80 million $ and a wide-bodied with a price of 200 million $ (Boeing and Airbus websites, 2012).

In shipbuilding the balance between costs and sales price is a question that is defined in project level. That is to say that in case of a one-off ship the project is targeted to cover its own costs and provide adequate profit. However it seems that this principle changes over market situation and is due to market cycles and high variation in demand that is typical in shipbuilding (Stopford, p. 203 2009). Following example describes the change. In latter part of 2012 an order for 13800 TEU container ship from South Korean yard was reported with a price of 115 million $ (Clarkson Shipbuilding Forecast Club - August, 2012). Earlier in 2008, almost the same sized vessel, 13100 TEU, had been ordered from Korean yard at a price of 170 million $ (Clarkson Shipbuilding Forecast Club Monthly Update – February, 2008). It seems that in airliner business such dramatic market cycle driven price variation is not conceivable. However, it's highly interesting that instead of market cycles the prices of airliners tend to reflect consistently the series' life cycle (Lee, p. 45, 2000). To make a rough estimate, price of an airliner seems to drop 15 or 20 percent on average during the series lifetime due to learning in manufacturing, cost reductions of components and materials as well as the weakened business value of the model. To conclude, prices of certain type airliner as well as ship tend to change over a time. However, an airline is more probably to have business benefits for buying expensive equipment for future operations, whereas in shipping the profitability of new equipment investment is more uncertain.

It is also interesting that the development and design of airliners is led by original equipment manufacturer (e.g. Boeing, Airbus) whereas the technological know-how in ship design and building is shared among three actors: ship yards, ship design offices and ship owners. Ship building is in many parts separated from ship design and there are ship design offices selling their design services for shipyards. Often the shipyards act solely as constructors which means that the major share of the actual product design knowledge accumulates somewhere else than to shipyard organization. In airliner business the division of knowledge has happened mainly in component level manufacturing as production of parts and assemblies have been outsourced or some external knowledge has been needed. (Yoshino, 525-530, 1986)

What comes to the number of players in these markets, only two wide-bodied airliner manufactures have survived in the business: Boeing (US) and Airbus (consortium of European manufacturers). In smaller airliner segments (below 150 seats) these two are challenged mainly by Embraer (Brazil) and Bombardier (Canada). Furthermore, there are at the moment mainly two new competitors that are expected to enter the market in near future: Chinese COMAC and Japanese Mitsubishi, both with regional airliner concepts. Shipbuilding in turn has developed into a hegemony of three nations, South Korea has currently seven major shipbuilding enterprises (KOSHIPA website, members 2012) in Japan the figure is 19 (SAJ website, members 2012) and based on OECD data there is approximately 20 major shipbuilding enterprises in China and the total number of 430 enterprises have been stated depending of the source (OECD, 2008). The facts that number of airliner manufacturing companies has steadily decreased over time and global shipbuilding capacity adjusts based on shipbuilding cycles (Stopford, p. 626, 2009) leads into conclusion that shipbuilding has very low entry barriers compared to airliner industry. And the fact that shipyards are seen as important mean to create and sustain jobs by national governments (OECD, p. 14, 1997) creates relatively higher exit barriers. What comes to the customers of these industries, the exact number of airlines is hard to define but in 2012 the International Air Transport Association had 240 members (responsible for 84 % of world’s air traffic) whereas there was estimated to be over 5500 shipping companies in the world in 2007 (IATA website, 2012; Stopford, p. 84, 2009). However, more important than the number of customer is the difference of completion in these industries. Despite decades of deregulation in US and European Union the airliner industry is still completely different case in terms of freedom of competition when compared to international shipping.

And last a short study about the regulation regarding these industries. We can see that there’s a difference especially in way the condition and design of the equipment are validated and the nature of responsible authorities. Airliners’ design and airworthiness is controlled by national authorities, e.g. United States Federal Aviation Administration (FAA). On the other hand, design and seaworthiness of a ship designs is controlled primarily by classification societies (IACS, 2012) which act more as private owned organizations in competition with each other. As a result, classification societies have to balance between demands of insurance companies (that relay their decisions on reports and structural rules placed by classification societies), ship owners (which make the decision about the applied class when ship is built and operated) and international organizations (e.g. International Maritime Organization and International Labor Organization) which observe the industry.

5 AFFECTING FACTORS, CAUSALITY

The particulars of airliner industry presented in previous chapters help us to understand why airliners are delivered with ATO or CTO processes - as standard products with varying amount of features and add-ins. Airliners have huge development cost, creating extensive entry barrier to the market. The regulation of the business is strict and development of the technologies has been fast. However, none of these issues explain why merchant ships are designed and manufactured as customer specific one-offs or short series - the standard paradigm in shipbuilding.

In the previous chapters we have identified some of the differences in business environments and product strategies. Next we analyze the effects of the differences and their role to the existing situation in the business. These factors and their presumable effects to each other are presented in form of a concept map in *Figure 1*. This concept map is not intentioned to be an all-embracing explanation of the existing situation but a proposal based on causality of identified factors and effects.

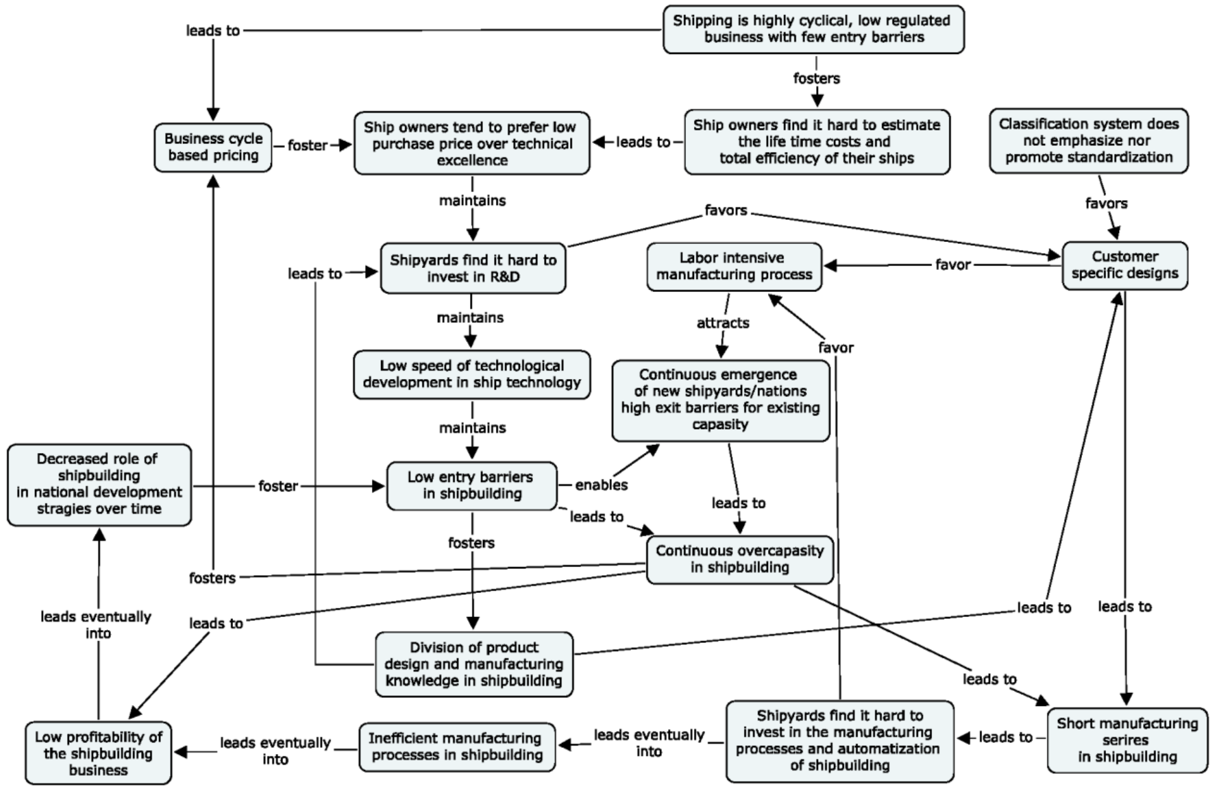

Figure 1. Concept map representing the factors with effect of engineered-to-order (ETO) industrial paradigm in shipbuilding industry.

Compared to airline business, the highly cyclical and competitive shipping is a very uncertain and risky way of making money. This has been the case especially in the history when national US and European airlines had little to worry about domestic and or international competition. In shipping, the strict and uncertain competition environment has lead into a situation where ship owners found it very hard to estimate their future costs and profits- the utility value of the ship. As a consequence, it has been wise to invest in robust, simple and cheap equipment that fits the near future business prospects. For the very same reason, shipyards, also in very competitive environment, have not seen the benefits of investing into development of product families or other means of standardized offerings without clear business case (with the few exceptions in history). These factors, nurtured by diversified design rules and practices of classification societies, have favored customer specific designs. As a natural consequence the manufacturing series have remained short. Short manufacturing series have not enabled nor motivated development of standardized and highly automated manufacturing systems (as has happened in airliner industry). Therefore shipbuilding has maintained its labor intensive manufacturing technologies. This very specific factor of shipbuilding has been one important reason why national governments of developing countries have invested in local shipbuilding capacity in forms of subsidies, tax-benefits and order of ships. It has also created the high exit barriers for existing capacity as governments have tried to restrain unemployment, thus maintaining the constant overcapacity in shipbuilding. This overcapacity has had at least one important consequence – it has fostered the business cycle based pricing of ships which takes us back to the ship owners challenge to weigh up the price of the ship and its utility value.

The above mentioned (shipyards) challenge to invest in manufacturing technology has eventually led into outworn methods and inefficient manufacturing processes. This has close connection to low profitability of shipbuilding business and finally into decreased role in national development strategies over time which opens up the doors for new entrants.

As shipyards have found it difficult to invest in development of the products they build, it has maintained the rather slow technological development in ship technology. This has furthermore maintained the low entry barriers of shipbuilding business. The low entry barriers (and continuous emergence of new shipyards) have fostered the division of ship design and manufacturing knowledge as it’s possible for developing nation to start up a shipbuilding business but harder to establish knowledge intensive ship development and design activities.

6 CONCLUSIONS

During last hundred years commercial airliners have developed from canvas covered single-seat gadgets to equipment made of advanced materials and capacity for hundreds of people. Similarly, the related industrial paradigms have developed from craft work to assembled-to-order and configured-to-order processes. Shipbuilding however still employs the craft and engineered-to-order type of processes.

In this paper we have proposed that the reason for shipbuilding’s tenacious confidence on engineered-to-order process is ultimately due to three main factors. First there’s the very nature of shipping and classification processes that drive ship owners to sub-optimization and re-design. Second, we can identify a causal loop between short manufacturing series, labor intensive manufacturing, continuous emergence of new shipbuilding entities (and slow exit of existing ones), constant over capacity and finally back to short series in manufacturing. Third, we can identify an another loop between shipyards’ challenge to invest in R&D, low speed of technological development, low entry barriers in shipbuilding, division of design and manufacturing knowledge and finally back to shipyards’ challenge to invest in R&D. And forth, we can identify a long term, national development, from short manufacturing series to, inefficient manufacturing processes, to weakening of profitability, decreased role of shipbuilding in national strategies, low entry barriers of shipbuilding and finally back to the short manufacturing series.

The methods for shipbuilding business to develop exploiting ATO or CTO paradigms are clear. The shipyards which have strong position and relatively developed manufacturing processes should take the first step and start to develop “products families” with strong customer focus – leading into substantial benefits of repetition in manufacturing. Possible consolidation of shipping business and classification societies might promote this development but from the “product knowledge ownership” point of view the customers cannot be ultimate drivers for the change.

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