Nordic Development of Shipping Systems: On Symbiosis Between System and Organization

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Abstract. The successful development and implementation of global container shipping systems is related to conditions characteristic for the shipping world. One of them concerns the need for proper communication and common understanding at sea and across the different professions and national authorities involved in shipping. This has created a framework of standard concepts and activity patterns, which are reflected in international rules and regulations as formulated at conferences among shipping people. Another concerns the early participation in Nordic IT development, where a group of shipping people became experienced in computer handling and system developments. It included the IT formalization of the above framework and the holistic view of enterprises based on a coherent complex of IT systems. This supported the decision to include terminal handling and landbased logistics into the organization to maintain control of containers all the way and to get full benefit from the technology.

1 The Origin of Shipping Systems

Hazards of the sea attracts insurance and causes classification of ships.

Shipping has since early stages been considered risky business. Already the Justinians Laws of Rome in 530 A.D. considered shipping such a "perilous" affair that marine insurance was exempted from legal restrictions on excessive interest rates. Also the Phoenicians, the Venetians and the Hanseatic merchants are said to have had their insurance systems against the hazards of the sea. That included the installation of guns to prevent attack from hostile enemies.

As ships began crossing oceans regularly and cargoes became of high value, the seaworthiness of the ships became a critical issue for discussion among the three professions involved: ship-owners, shipbuilders and shipping agents. In London in the 18th century shipping people met with marine insurance people at local coffee houses for exchange of information and discussions of the risk involved in contemplated voyages. The owner of a cosy coffee house in Tower Street, Mr. Edward Lloyd, became famous for his ability to collect and publish useful information on ships and their cargoes. They were later to be published as Lloyd's Lists. Among other entertainments he also arranged auctions on the risk insurances.

Some of the insurance people (later to be "the Insurance Corporation of Lloyd's) suggested that the shipping people organized a classification of ships by an independent institution to improve the evaluation of a ship's strength and seaworthiness. The classification was to be followed by regularly inspections of a ship's hull and equipment by an independent institution, and the results were to be published in a register book available to everyone for a fee. It was anticipated that such a book would also become popular outside the shipping environment and could finance the whole arrangement.

A commission of prominent persons was established and founded "Lloyd's Register of Shipping" in 1760 with headquarter in London. Like in other cases of standardization Lloyd's Register had a tough time in fighting and negotiating with competitors from other shipping centers specially Liverpool, and it was not until 1834 that the authority of Lloyd's Register was accepted by the Parliament and Board of Trade after endless disputes and many attempts to downgrade the importance of the matter.

It is worth noting that the final acknowledgement of Lloyd's Register was closely connected with the common appraisal of the quality of the surveyor team and the book of rules and recommendations published by Lloyd's Register as standard for classification of ships. The surveyors and the rules have since constituted a common reference on concepts and activity patterns among shipping people and marine insurance people all over the world.

The authority of Lloyd's Register spread soon to other seafaring nations, where Lloyd's got a stronghold in some countries like Holland, Sweden and Denmark, and met competitors in others like France, Germany, Norway and US. In this way Lloyd's got an international standing in classification of ships, and the rules were simply adopted as governmental standard in many seafaring countries.

Increased concern on safety of lives at sea results in establishment of IMO, an UN agency, as a permanent body for international regulation of shipping.

Poor conditions of life on merchant ships for ordinary seamen were ignored until a politician, Samuel Plimsoll, in 1876 after heated debates in Parliament got a law against overloading of ships accepted. When Titanic went down in 1912 it was realized that safety on board great passenger vessels needed international regulations on lifesaving and navigational equipment as well as on radio communication practice. They were agreed to in 1914, but did not come in force until 1929.

In the political turmoil after World War II it was difficult to arrange international conferences. But the concern on the increasing risk for collisions of ships and other concerns caused a number of countries to propose the establishment of a permanent body for international regulation of shipping. In 1948 an international conference formally established IMO, the International Maritime Organization as an agency under UN with special responsibility for the safety and security of shipping and for the prevention of marine pollution by ships.

IMO has since been a very active forum for international cooperation on rules, recommendations and conventions to be adopted by governments and shipping companies. But most important for the IT systems development is the contribution to the maintenance of the common framework of reference within shipping. Here IMO has recently developed an ambitious concept of a sustainable transportation system focus-

ing on a number of issues from "Safety Culture and Environmental Stewardship" and "Education and training in maritime professions" to "Ocean Governance".

2 Creation of the Nordic Computing Environment

The story of the successful cooperation among Nordic countries in the pioneering stages of computing has been told often. Emphasis has been placed on the realization that each of the countries was too small to make it alone, but it ought also to be mentioned that the Nordic countries in the late 1950s were well prepared for the coming of the computer technology. The close communication among universities and research institutes and the high level of education in mathematics and electronics promoted the cooperation and created a generous exchange of knowledge. Also the conference activities during 1960s and 1970s in NordDATA and the Nordic participation in IFIP contributed heavily to the creation of Nordic computing as a significant player in the international development.

Danish shipbuilders participated from the very beginning in the exploration of the new perspectives. The initial efforts went two ways, one towards improving the design and proposals for new types of ships, and the other for improving the production process in the shipyards.

In the late 1950s shipowners asked for new types of ships, often bigger and faster. The traditional design procedure in the yards was hampered by the time needed for the many manual calculations involved. That meant restrictions on optimization of the design. And the increasing number of reports on damages due to new design features like very large hatches asked for more calculations. So when the first computers showed up, the shipbuilders were eager to make experiments. In Denmark the initial experiments carried out on DASK with much support from Regnecentralen showed drastic reductions in calculation times, *e.g.* a standard stability calculation was reduced from 3-4 days to 5-10 minutes. The experiences resulted in establishment of a Danish center for ship-technical calculations based on the GIER computer, which coordinated the development of a complete and renewed design system and serviced Danish shipyards and shipowners for a long period.

Among the experiments were the attempts to define a ships hull mathematically by digitalizing and "fairing" data measured on a drawing. Apart from the advantage of having a more precise definition of the hull in the design calculations it was contemplated as a condition for the use of new technologies in the production of ships. However, the practical problem of producing a double curved hull plating showed the limitations for digitalizing. Research in the workshop showed the use of special tricks to get the plates curbed by the rolling mill. They included for instance the use of common salt, which almost exploded during high pressure of the rolls and made the plate to curb nicely. If it didn’t fit perfectly to the frames of the hull afterwards a little heating or sheer clamping could do the rest. Of course these remains of a traditional manual skill were not transferable to new technology, and this is the reason why modern ships are made out of single curbed plating, where ever possible.

The innovation of new shipbuilding technology was pioneered by Burmeister & Wain in Copenhagen and is subject to a separate paper on this conference. But it

should be noted that similar developments went on in other Nordic countries and were subject to mutual attention within the Nordic computing environment. All told, in the 1960s Nordic use of computer technology within shipping attracted much attention from abroad. So much, that Lloyd's Register of Shipping took part in the Nordic development from their office in Gothenburg.

But the real scoop to be gained from the early stages of Nordic Computing was the explorations into the concept of system as implied in terms like information system and informatics. A more scientific approach was made to the analysis of IT systems. It was much to the comfort of software engineers, but less useful to management responsible for the integration of IT systems into the organization. But here shipowners made their own way by creating entirely new organizations for their IT systems based services.

3 Development of Container Shipping Systems

Postwar pilferage as the driving force.

The idea of transporting goods in closed boxes from door to door included the avoidance of too clumsy manual handling when loading and unloading ships. After World War II the amount of pilferage in harbours like the one in Copenhagen was a severe problem for shipping people including labour unions and insurance people. Two solutions were discussed heavily. Some argued for standardization and use of cheap wooden pallets with proper wrapping, which could be handled on board by forklifts. Others argued for worldwide standardization of container boxes and tried to justify the high investments in new ships and harbour terminals. Today we know that both parties succeeded in the developments of their ideas. In Copenhagen Unicef has just built a new terminal in Copenhagen with a huge capacity for storing EU pallets, and close by is the headquarter of Mærsk Lines handling an enormous number of containers. As for the pilferage, - although the container terminals nowadays are guarded like military fortresses, it happens that whole containers disappear.

ScanDutch as the frontrunner.

Within the Nordic countries EAC, Wilhelmsen and Brostøm organized a cooperation among their Far East services in 1969 (Scanservice). That included ships as well as shipping agencies. However the ships were not well suited for handling an increasing number of containers, and management realized the need for development of a whole new organization dedicated to container shipping. Together with the Dutch shipowner Nedlloyd a new enterprise was created in 1972 named ScanDutch.

The announcement of the ScanDutch I/S enterprise focused very much on the new and advanced ships to be built special for container transportation, and next to nothing on the new and advanced IT system, which was to be the base for the whole busi-

ness.

The ScanDutch ships represented an entirely new standard for ships dedicated to container-transport. They could carry 1200 twenty feet standard containers (TEU's) and had excess of engine power to maintain regular schedules, cellular rags in all holds, plenty of remote controlled facilities for container conditioning etc. When finished, the ships were presented with much festivity for the public as the kernel of the container shipping service. As for the IT system, to most people the ships were seen as the system, and only a few imagined the size and complexity of the IT system covering computer tracking, slot allocations and container conditioning on board the ship, scheduling of terminal activities besides streamlining all the paperwork involving shipping agents, customers, harbour, authorities, banks etc. The dedication to container shipping meant revision of concepts and activity patterns in the organization as well as in the design of the ships and the terminals.

The development of the ScanDutch IT system was undertaken by EAC Data, and the project was managed by experienced ScanDutch members to ensure the coordinated development of the organization and the IT system. Irrespective of the IT system being the kernel of the services ScanDutch management should remain in control of the organizational development. The communication between head quarter in Copenhagen, the terminals and the agency offices was based on a private telex network operated by EAC Data under the name of Texcom.

The development of the ScanDutch IT system included many challenges. One of the more exciting was the establishment of a standard message format for the tracking system. It contained a secure identification of a container, its position and condition, and a code related to the operational stage of the transport. The codes were rather compressed and it was expected to take a little while to get them properly introduced to all the agencies, ships and terminals, but it was a pleasant surprise that the tracking messages quickly became of very high quality. Here again the developers benefitted from the common framework of references established within global shipping.

ScanDutch proved successful from the beginning, and two more shipowners joined the corporation, a French in 1973 and a Malaysian in 1977. At the end of the 80's some of the partners came under economical pressure from other shipping activities and the ScanDutch partnership was dissolved at the end of 1991. EAC continued the shipping activities until 1993, when the container shipping activities were sold to Mærsk Line. The ScanDutch IT system had then been in successful operation for more than 20 years.

Mærsk Line, the powerful system builder.

After some preliminary experiences on container transport with traditional ships, Mærsk announced in 1973 its decision to create a new organization, Mærsk Container Line, dedicated to container shipping and with a capacity sufficient to offer regular weekly service, not only on the date but also on the hour. The first container ship of a series of 9 departed from the Mærsk terminal in Newark, N.J., in 1975. It had a capacity of 1.400 TEU's. The ships were more modest than the EAC ships,

but the greater number made the weekly service a standard, which ScanDutch had to copy from 1977.

As in the ScanDutch case the announcement of the Mærsk container shipping system focused much on the ships and only little attention was given to the IT system development, apart from the general knowledge on the close connection between Mærsk and Mærsk Data and the early use of expensive, private data communication lines between Mærsk offices, which in the longer term proved useful for the increasing amount of data to be communicated.

During the 1980s Mærsk placed much emphasis on supplying data services to the customers at all steps of container transportation incl. preparation of transport documents, warehousing and distribution. In 1995 Mærsk Logistic Services was organized as a selfcontained unit for that purpose.

Most important for the turn-around time of the ships was the expedition in unloading and loading of containers in the harbour terminals. Mærsk had its own ideas incorporated into their IT systems, and to ensure optimal expedition they established in 2001 the APM Terminals as a central organization to handle the interests of the Mærsk Group in more than 50 terminals all over the world.

But it was the expansion through acqusitions and takeovers which proved the strength and capacity of the Mærsk organization and its IT systems. Among the most remarkable was the acquisition of Sea-Land Service Ltd. in 1999, which is said to have included 70 ships and 200.000 containers besides terminals and agents all over the world, and the takeover of P&O Nedlloyd N.V. in 2005, which included 156 ships and 13.000 employees in 146 countries. To the shipping world in general and to IT systems people in particular this was a very ambitious and courageous achievements of a management, who obviously trusted the ability of their organization and IT systems to include such "foreign" worlds.

The inclusion of Sea-Land seems to have been rather smooth, and the Mærsk organization continued under the new name of "Mærsk Line". But the P&O Nedlloyd takeover obviously resulted in problems. Customers leaving to join competitors diminished the expected increase in market share, and the new employees had difficulties in adjusting themselves to Mærsk's IT systems. The Nedlloyd people, who originally participated in the development of the ScanDutch systems, had after the merger with the British P&O Containers Ltd. in 1996 joined the development of a much heralded IT system called FOCUS integrating into a single IT system a system of globally standardized business processes.

The P&O acquisition included a freight forwarding company, Damco. It had for some time been associated with Mærsk Logistics Services, but both were in 2009 unified in a self-contained unit within the Mærsk Group under the name of Damco, which claims to have more than 11.000 employees and to have managed in 2013 a volume of 2.8 million TEU of ocean freight and supply chain management. They are not dedicated to container shipping only and have presumably a wider perspective in their system development.

The turbulence after the P&O Nedlloyd takeover lasted for some years, but Mærsk Line continued the scheduled program for newbuildings. In 2006 Lindø shipyard delivered the first of seven sisterships. "Emma" was with room for 11.000 TEU

containers once more the largest container ship ever built. In 2011 the first ship of the Triple-E serie was shown to the public as the greatest and most advanced ever with a capacity of 18.000 TEU.

4 Implementation of IT Systems into Corporate Organizations.

The "bottom-up" approach.

The inclusion of computers into our offices half a centenary ago was an exciting affair in many companies and public service organizations. Computers were expected to be fast and cost effective, but also hypersensitive to order in human thoughts and operational behaviour. So most managements decided to implement IT systems stepwise starting from the bottom with well-known office routines in regular functions like pay roll administration, stock control and general accounting. The IT system was merely seen as an automation or simulation of the manual routine with limited consequences for the overall organization. The expectations were savings in costs and time. Usually the organizational consequences of the implementation were greater than expected, and the savings less than expected, but in most cases followed an implementation of another IT system in another part of the organization, and so on until after years of hard work and much luck the entire organization and its IT systems were interwoven into a casual pattern of its own. The development was usually driven by enthusiastic and skilled local staff together with system oriented consultants, who made the basic analysis of the manual systems. They also supplied the organization with computer oriented, formal system descriptions suitable for programming and testing, but of limited value to management and ordinary staff as an overall view of the coherence between organization and systems. The descriptions were also used for the creation of a common reference frame of concepts and activity patterns to ensure communication and cooperation within the organization.

Coordination or unification of competing "bottom-up" systems within regional or global corporations represents a major challenge to further system developments. "Bottom-up" systems are usually so deeply rooted in the organization and in the perceptions of the staff that a centralized effort to develop and replace the existing system with a new system surmount the capacity and courage of most managements. It is the case specially in the public sector, where a management responsible for specific well-fare systems may be subject to stressed by frequent shifting political influence with regard to on economical and social priorities.

It is evident from the present situation that many managers and politicians still are unaware of IT systems' dependency on the stringency and stability of the specified concepts and activity patterns. They still seem to consider IT systems to be a sort of automation or simulation of manual or otherwise outdated systems where replacement with new systems could promise costs savings and improved welfare. An actual case is the present Danish system for property taxation, which has been declared faulty and possibly illegal by governmental appointed accountants. The final distribution of property tax was originally performed by local evaluations from a number of skilled and experienced surveyors. Now they have been replaced by an IT system with an

obscure distribution model, resulting in citizens revolt against casual tax distributions. But so far the system has overruled the governmental organization and the mental welfare of its citizens.

The "top-down" approach.

The idea of modelling a company or public service organization as a self-contained system in its entirety was advocated by Nordic IT pioneers more then 50 years ago. The model was to be based on the perception of the organization as a coherent set of functional subsystems. It would allow management to participate in coordination of internal IT projects concurrently with managing externally oriented business or service developments. Also it would serve as a link between the computer oriented and the people oriented system documentation and support the creation of a common and consistent reference framework for concepts and activity patterns.

Today the modelling is considered a prerequisite for a "top-down" approach, where implementation and maintenance of IT systems is scheduled according to a common activity plan, and where internal exchange of ideas and knowledge is stimulated by creation of the common reference framework on concepts and activity patterns. Managementwise this is in agreement with the present transition from traditional "command and control" hierarchy towards networked distribution of management, where top management is supposed to support efficient communication and local cooperation.

As it should appear from the container shipping cases, creation of a common reference framework plays an important role for computerization of an organization (or a community). It is in line with the extension of computing science to include Domain Engineering, besides hardware and software engineering. Otherwise as a self-contained discipline it is most often ignored or considered too cumbersome and unstable for practical use. But in reality it should be deducibel from own requirement specifications and public legal documentation. Socially a group of persons working together is expected to develop a common reference framework for mutual understanding and activity coordination. It is important for the productivity of the group as well as for the job satisfaction and system confidence of the individual group member.

In the shipping case it took more than 200 years to develop a global, public reference framework, which was updated to several fundamental changes in technology and social life. In great commercial corporations it often took a management generation or two to create a common standard for communication and behaviour, a called a company spirit. In present times such group frameworks are dissolved by fast developments in technology and frequent shifts in organizational structures. But as the container shipping systems show, if the remainder of the framework for the surrounding world (the domain) is strong enough it is still possible to create a framework suitable for development and worldwide implementation of IT systems in an international group of dedicated people.

As for the future it looks like many managers, civil servants and politicians are unaware of the waste of resources our communities suffer at present from failed or malfunctioning IT projects. The waste includes financial resources as well as human

resources, and loss of investments as well as loss in productivity. The ignorance may be due to a general underestimation of the potentials in IT systems. But the importance for our societies should justify an evaluation of IT systems in line with material assets like buildings and bridges, which are to be approved of by governmental institutions, quality certified and insured. That would make the "bottom-up" approach obsolete and support further development of the "top-down" approach.