Foreword
STANDARDS NETWORKS

STANDARDS AND INNOVATION

Standards play a crucial role in the definition of market conditions in many industrial sectors and not only in those concerned with high-technology. The use of standards is accelerating technological and organisational change and thus improving innovation performance. Standards are part of the infrastructure that supports efficient innovation processes. They play a major role in promoting innovative products and services, by providing stable references for the development of new innovative solutions and creating large scale markets.

As codified information, standards serve to spread knowledge of the requirements for market acceptability and contain explicit technical information reducing uncertainty and search costs for producers and customers. In addition, non-technological standards help shaping new organisational forms and business models and contribute to raising the quality of services and to the efficiency of business processes.

The mechanism through which standards impact the innovation process is often described as the "path dependency of the innovation process". In short, when specifications are defined, the options for future technological developments are narrowed down by definition, since alternatives are ruled out by a combination of technical and market choice. This may be considered as detrimental to innovation but at the same time innovation requires some kind of predictability and stability so that innovative solutions can more easily find their way.

The merit of developing standards lies in the possibility of reducing the transaction costs involved in the development and application of (new) technologies and of generating positive network externalities by reaching economies of scale. Standards may, under certain circumstances, also generate negative effects, such as the adoption of sub-optimal technical solutions, the freezing of potential new technological developments or the "stranding" of entire user communities in dead-end products or services. However, innovation does not necessarily favour the "best" technological solutions but those that find strongest support from the market.

There is evidence to suggest that well implemented standards may contribute to the innovation process and therefore to economic growth. The challenge lies in increasing awareness of how standards may be used by economic actors to develop innovative new products and services and more efficient business processes. Such information must be neutral and unbiased in order to be credible. This offers new business opportunities for information services that assess the costs and benefits of standards in a user-friendly manner thus helping clients to take informed decisions on how to use standards in the most innovative way.

Standards may therefore be considered as a catalyst for innovation. In Europe, large investments are made into the development of standards, offering enterprises potential competitive advantages under the right framework conditions. However, standards in many industrial areas are not sufficiently known or used by product and service developers. In many areas, more than one standard exists for the same purpose which makes it often difficult to decide which the best are.

EUROPE INNOVA AND STANDARDS

To promote the awareness of existing standards and their potential to stimulate innovation, a call for proposals for European projects was launched under the Europe INNOVA initiative in the framework of FP6 with the objective to exchange and compile good practice on how to use standards to develop innovative business solutions, focusing on three key aspects:

1. Facilitating the integration of open standards into the design of new products and services

European standards are widely acknowledged as one of the measures to enhance intra-EU trade and to foster competitiveness. In this respect, the objective was to demonstrate the possibilities to promote the use of existing standards in the design of new products and services by bringing together designers, product developers and consumer associations to identify and test practical approaches to using standards in an innovative manner.

2. Facilitating the integration of open standards into business processes

Non-technological standards play a crucial role for the development of new business practices and services. Examples include, in particular, quality standards and standards defining new business workflows, such as in the area of e-business. From a public policy perspective, a wider use of standards in these fields would help to promote the quality of new business services and to facilitate networking among enterprises, by promoting interoperable business solutions. In this area, the objective was to identify the most promising standards for the development of business practices and services and to develop practical guidance for their implementation at sectoral level.

3. Stimulating innovation through reference to standards in public procurement

Public administrations have a huge impact on the economy in their role of procurers of goods and services. Public tenders and purchases are rather formalized processes, where reference to standards is often made.

Here, the objective was twofold: on the one hand to assess how standards are currently used and referenced in public procurement processes in the EU and, on the other, to improve the way in which existing standards are referenced in European public procurement processes, with a view to helping bidding companies become more innovative in their product and service design and offer.

EUROPE INNOVA STANDARDS NETWORKS

The Europe INNOVA call for proposals resulted in six European standards networks, five addressing the use of open standards in the design of products, services and business processes from a sectoral perspective and one focusing on public procurement as a lever for stimulating innovation:

BIOHEALTH dealt with security issues related to the use of standards for eHealth interoperability and addressing all concerned parties: those working in healthcare as well as patients and citizens; healthcare insurers, governmental bodies and the healthcare industry. It developed relevant information and clear guidelines for eHealth standards users in areas such as identity management, biometrics, ethical applications, etc.

DEPUIS - **D**esign of **E**nvironmentally-friendly **P**roducts **U**sing **I**nformation **S**tandards - aimed at improving the environmentally friendly design of new products and services through the innovative use of new information standards with a view to enabling more companies to use Life Cycle Thinking when assessing the environmental impact of their design of new products.

EUROMIND, in the shipbuilding sector, looked at solutions on how to improve European shipbuilding supply chain collaboration by connecting digital systems via open standards. It identified the most promising open standards and documented their use in horizontal integration (cooperating shipyards) and vertical integration (in the supply chain) in order to address the ever increasing need for cooperation between shipyards, system integrators, equipment manufacturers, electrical engineering companies and other suppliers as well as professional service providers and ship owners.

INNOVAFUN - Applying open standards to **INNOVA**te **FU**r**N**iture business processes - aimed to build industrial consensus on the innovative funStep standard-based solution, facilitating the integration of open standards in the furniture industry. The funStep standard is acknowledged by many SMEs as a catalyst for the innovation in the sector. Although INNOVAFUN targeted the furniture industry, its results can also be used as a reference in other industrial sectors.

STAND-INN, operating in the construction sector, addressed new manufacturing processes based on the IFC standards with the aim of creating new and more efficient business processes, thus facilitating the construction sector's great potential for cost reduction and productivity increase. STAND-INN has brought together the set of open standards to improve information exchange and interoperability in the building lifecycle and it has identified new standards for sustainable development. This, in turn, should help improve the competitiveness of the building and construction industry.

STEPPIN - **ST**andards in **E**uropean **P**ublic **P**rocurement lead to **IN**novation - explored how referencing open standards in European public procurement processes could foster innovative business solutions amongst bidding companies and sought to encourage the use of new procedures and methods to stimulate innovation through the application of standards in both the public and private sectors.

KEY LESSONS FROM THE EUROPE INNOVA STANDARDS NETWORKS

The experience of the Europe INNOVA standards networks shows that it remains a key challenge to better use standards for the development and commercialisation of new products and services as well as for organisational innovation which requires strong business support. In many cases, new standards are not ready to be used directly by end-users but require further efforts to integrate them into new or better business solutions.

Evidence from the standards networks also suggests that in many sectors, a wide range of standards co-exist and that it is often hard for SMEs and procurers to decide which are the best. As a result, SMEs and public and private procurers are only exceptionally using standards with a view to bring innovative solutions into markets.

In order to address these challenges, the standards networks have developed a number of tools or materials, which are being presented in this series of handbooks, through which neutral information about the benefits and costs of using standards with a view to helping SMEs and procurers gain easier access to relevant standards in order that they may better accommodate innovative solutions into often complex environments. These services offer specialised information on which standards matter for what, whom and in which context, and they are seen as particularly strong tools to leverage innovation into new markets. It would be desirable if such new information services would be supported, as much as possible, by the national and European Standardisation Organisations with a view to promoting the wider use of standards.

The results of the Europe INNOVA standards networks are very encouraging. Further efforts will therefore be undertaken to facilitate the innovative use of standards, for example in support of the new Lead Market Initiative of the European Commission. Standards experts are invited to actively participate also in the next generation of Europe INNOVA that will follow a more thematic approach and therefore requires close cooperation with other actors that facilitate innovation processes. Standards can make an important difference.

About this handbook

This handbook focuses on the European Maritime Industry and specifically on the management of companies active in European shipbuilding, irrespective of the role of those companies in the supply-chain e.g. shipyard, system integrator, product supplier, engineering contractor, software supplier, etc.

This handbook describes the situation and provides promising solutions regarding digital information exchange among parties (e.g. departments, companies) within the shipbuilding supply chain.

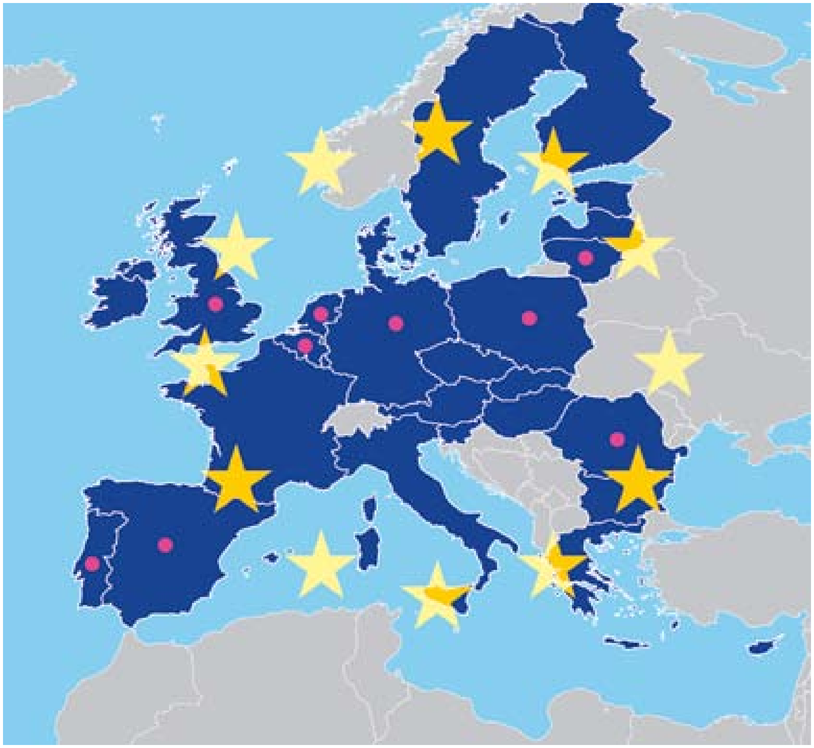
Chapter 1, Introduction provides an introduction to the EUROMIND project. **Chapter 2, Issues faced by industry** describes main problem areas experienced in the field of digital information exchange in European shipbuilding. **Chapter 3, Inventory of standards** highlights the most promising solutions available in shipbuilding industry itself as well as in other industries which have important similarities with the shipbuilding industry (e.g. electrotechnical contractors, building and construction industries and off-shore industries). In **Chapter 4, Standards related to problem areas** the most promising solutions are positioned in two basic views on the shipbuilding business i.e. the phases in shipbuilding, representing the life cycle of a ship, and the systems (installations) in a ship. **Chapter 5, Recommended good practices** proposes possible solutions to improve interoperability in the shipbuilding supply chain cooperation via the use of open standards in digital information exchange. Finally in **Chapter 6, Conclusions and recommendations** on digital information exchange are given to the European shipbuilding industry in order to improve their cooperation in the supply chain.

More information:

- a CD-ROM (included in this handbook) with a short movie titled: *EUROMIND, stay ahead of worldwide competition*
- a policy paper is available containing policy recommendations
- contact the European associations CESA or EMEC or their national associations
- visit our website at www.euromind.eu

The EUROMIND Team, November 2008

Euromind Project partners and countries



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LLSRA

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University
of Constanta

United Kingdom
SSA

CHAPTER 1: Introduction


BG FREIGHT LINE

1. Introduction

EUROMIND, which stands for "**EUR**opean **O**pen **M**aritime **IND**ustry", is a project funded by the Europe INNOVA initiative under the 6th Framework Programme of the European Commission (www.europe-innova.org).

EUROMIND is a project dedicated to the needs of the European maritime industry. The EUROMIND initiative aims to contribute to an innovative European Open Maritime Industry through facilitating the application of open standards in the area of digital product data exchange to facilitate interoperability in the shipbuilding industry in Europe.

The objective of EUROMIND is to improve European shipbuilding supply chain collaboration through interoperability by connecting digital systems via open standards. EUROMIND intends to raise awareness in the shipbuilding industry for the need of open reference standards to achieve interoperability.

In more detail, the focus of EUROMIND is on:

European shipbuilding & repair

- Irrespective of type of ship (yacht, naval, merchant, special)
- Target group: shipyards, subcontractors, suppliers, professional service providers, ship owners, classification societies and authorities

Supply chain collaboration

- The entire process of specifying, designing, selling, engineering, building, commissioning, maintaining, repairing and dismantling of a ship, carried out by a (collaborative) team of companies

Connecting digital systems

- Limited to the aspect of digital systems (e-business), excluding project management, contract management, knowledge management.
- Connecting refers to "information exchange" among different systems, preferably via the internet. It does not refer to hardware connectivity.

Open standards

- Publicly available standards, not necessarily free of charge
- Standards with the potential to become publicly available

By selecting reference standards and good practices for the shipbuilding industry, EUROMIND aims to make companies and organisations aware of performance improvement options for their businesses. EUROMIND stresses that robustness and competitive advantage can be achieved by implementing certain standards, not only at company level, but in the entire European shipbuilding supply chain. The key to improvement is **interoperability**, where shipyards, system integrators and product suppliers work together by means of clear communication channels, communication structures and communication tools. EUROMIND seeks the solution not in one standard for communication (channels, structures, tools), but in a combination of standards which can be 'linked' to each other which suits the need for flexibility in the shipbuilding industry.

European e-Business Report 2006-2007

The EUROMIND approach is fully in line with the views expressed in the European e-Business report of 2006/2007[1,2], which provides a portrait of e-business in 10 sectors of the EU economy. The shipbuilding industry is one of the sectors described in this report. It states that without **interoperability** of ICT systems, which require standards and compatibility between standards, advanced forms of e-business are hardly possible. This e-Business report confirms that the largest need for standardisation in the shipbuilding industry is in the area of design and engineering, followed by supply chain management and procurement. There are many different design applications in use in the shipbuilding sector and the exchange of drawing information and its metadata provide big challenges. Supply chain management and procurement can also benefit from the use of standards by reducing time and costs and improving quality.

These conclusions are supported by a recent report of May 2008[3] about the effectiveness of research and innovation in the Information Society "the development of cross-border infrastructure, interoperability and, in some sectors, standards, is one of the areas where true European added value can be achieved".

1. European Commission, Action Plan for European Standardisation, 2007
2. The European e-Business Report 2006/07 edition: A portrait of e-business in 10 sectors of the EU economy, 5th Synthesis Report of the e-Business W@tch
3. European Commission, DG Information Society and Media, evaluation report 6th Framework Programme for research, May 2008

CHAPTER 2: Issues faced by the European shipbuilding industry

2. Issues faced by the European shipbuilding industry

2.1 Background

As a result of structural changes and outsourcing, modern production processes of the shipbuilding industry are complex and embedded in a network of yards, subcontractors, suppliers of marine equipment, suppliers of engineering services, classification societies and other professional service providers. Seventy to eighty percent of a ship's value is added in the form of equipment and services by suppliers. Today, shipyards are the coordinating body of the shipbuilding value chain: from design to procurement, production, testing and certification to after-sales services, maintenance and repair.

Shipbuilding is an industry not suited for mass or large-series production. By virtue of its large size, its highly variable functionality and widely varying ship-to-shore infrastructure of shipbuilding will remain largely a one-of-a-kind production with very few small series-production features. In fact, the production of a ship might take up to three years.

The commercial shipbuilding market is global and depends on several other markets. The demand for ships is influenced by the development of world trade, world energy demands, demands for infrastructural development, tourism (cruise holidays), food demands, (inter)national security issues and environmental and safety standards. The shipping industry responds to this with demands for new ships to create new oppertunities and increase existing shipping volume or to replace obsolete ones. Despite fierce global competition, the European Maritime Industry has proved a strong player, largely due to intense co-operation between the members in its cluster. The total added value of the European Maritime Industry amounts to € 111 billion with over 2.5 million individuals employed directly and indirectly[1]. In such a large network, with strong interdependencies, clear communication is essential. The need for clarity and unambiguous communication is essential, especially when electronic means of communication are used. This is true for both internal processes within companies as well as external communication with clients, partners and suppliers.

In view of this need, EUROMIND identified solutions for optimising communication, thereby improving co-operation, speed, cost-effectiveness, quality and security. EUROMIND helps companies optimising their business processes in the business model of the future. Communication in the widest sense of the word is a key issue for effective global business and therefore a must for our high-tech European maritime industry.

1. Year report VNSI, 2001

2.2 Business processes in shipbuilding

As can be seen in figures 1 and 2 shipbuilding is a complex process with a lot of actors, a lot of information in different types and formats, a high competitive international arena, an extreme customer focus (one-off's or small series) with a great dynamic which requires flexibility in the structures e.g. for digital information exchange.

Shipbuilding is project driven. Parties are mostly organised around a project. In new projects mostly (partly) new parties cooperate. All processes are highly interconnected and complex, where main and sub-processes depend on each other and price calculation of the ship depends on experience gained in previous ships of similar types. Only for major installations like the propulsion system, actual prices are enquired from suppliers due to the specific one-off specification of the product.

2.3 Shipbuilding supply chain

Operational sequences and tasks in shipbuilding in the various phases of the shipbuilding supply chain starting from acquisition, via design (and engineering), via logistics (e.g. scheduling and purchasing) through production and maintenance (e.g. spare part management and after sales/guarantee) are in practice integrated to a varying degree, and manifold software tools are implemented. The shipbuilding processes are increasingly executed by working groups and in networks. From early design throughout shipbuilding projects simultaneous engineering takes place and involves shipyard service providers, system integrators, product suppliers and even other shipyards. Contrary to the many attempts in the field of process and product modelling, harmonisation (i.e. relating processes to each other whereby effective and efficient digital information exchange is made possible) of processes of the different cooperation partners up till now has not been achieved.

In the shipbuilding supply chain - from quotation to delivery - the design and engineering process are central. In the 'specify ship' phase (see chapter 3 where these standard names for phases are explained) the full functionality of the ship is defined, systems are calculated and dimensioned, major components defined and the basic topology configured. In this so-called preliminary design phase the functional and special interfaces are resolved. In this process, the system integrators are deeply involved. In the detailed design (including approval by classification societies) all reference documentation is being prepared in time with the production process.

Also, external design offices are often involved in this in cooperation with the shipyard's and suppliers' own engineering offices. This complex process of shipbuilding with a lot of actors, a lot of phases and a lot of types of information is shown in Figure 1.

Foreword
Introduction
Issues faced by the European shipbuilding industry
Inventory of standards supporting interoperability in shipbuilding
Standards related to problem areas in shipbuilding
Recommended good practices for shipbuilding
Conclusions and recommendations

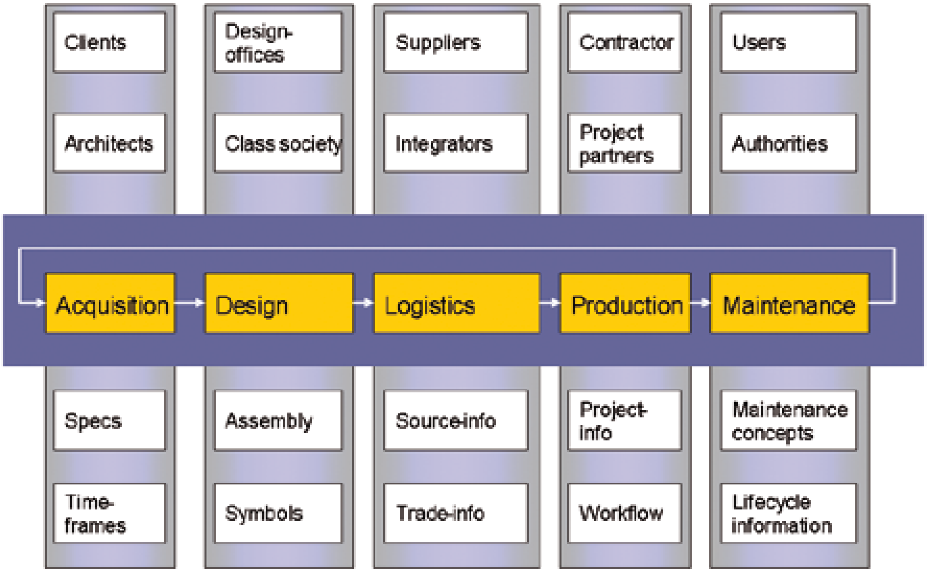


Figure 1: *Different phases, actors and types of information in the shipbuilding supply chain*

The complete design and engineering process represents some 10-20% of the total cost of a merchant ship, while 75% of the total costs are already defined and fixed in the 'specify ship' phase and the remaining 25% in detailed design. These figures show that the goal must be to display (i.e. virtual) the final product ship and its production processes within short time in sufficient quality so that the later production of the ship can be done according to the calculated conditions in order to minimise risk.

Again, in such an important and complex process, with strong interdependencies, clear communication is essential. The need for clarity and unambiguous communication in the design and engineering process is essential, especially when electronic means of communication are used. This is true for both internal processes within companies as well as external communication with clients, partners and suppliers. EUROMIND efforts are focused on solving this problem area.

2.4 Interfaces between major processes

In the 'specify ship' phase when the shipyards attempts to enter into to a contract with the ship-owner, the first major interface is production planning. Can the shipyard deliver the ship within the desired timeframe for the ship-owner?

The second major interface is between detailed design and production planning. Here purchasing and material ordering starts.

The third major interface is the beginning of the production process where modules (building blocks) are produced internally in the cooperating yards and finally mounted and also fitting equipment (e.g. ducts, pipes, foundations, cable trays) is produced and mounted in the different modules. The fourth major interface is between production and commissioning, where all the (sub)systems of the ships need to be tested as part of the overall ship approval.

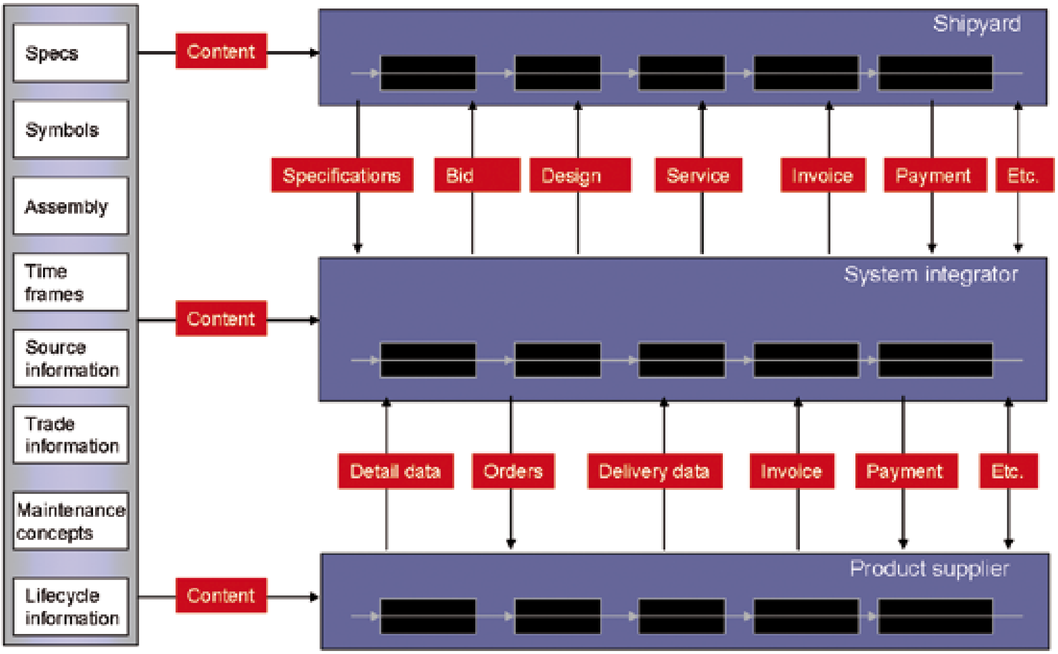


Figure 2: *Complexity of interfacing and information exchange in the shipbuilding supply chain*

As can be seen in Figure 2 the three main actors in shipbuilding, i.e. the shipyard, the system integrator and the product supplier execute the same processes and deal with the same types of information as shown in Figure 1. It would be effective and efficient to the total supply chain if all parties use the same source of information about the ship and its production, i.e. the 'content' in Figure 2.

www.europe-innova.org

2.5 Communication: verbal and digital

In order to illustrate the problem area of digital information exchange and to highlight the solution areas for effective and efficient digital communication, a comparison can be made with verbal information exchange which we as human beings practice.

Verbal communication consists of ‘characters’ (letters), and together they make ‘words’ by the use of spelling; and with the use of the grammar those words make ‘sentences’. In our mind these sentences have a certain meaning which we ‘communicate’ (exchange) with another person. That other person translates the exchanged sentences to his/her own meaning. Communication is effective when the meaning as received and understood by the receiver, is equal to the meaning that was intended by the sender. Communication is efficient when the process of information exchange (e.g. from letters of the sending person to translation into meaning by the receiving person) takes little effort or resources.

This analogy with verbal human communication also provides clues to problem areas. For example:

- People may be communicating in different systems (languages), thus precluding mutual understanding.
- People may use the wrong grammar to provide sources for misunderstanding.
- People may use the wrong words thereby conveying an erroneous message.
- People may use a synonym not known to the listener.
- People may use a homonym i.e. a word spelled the same, but meaning something different, thereby, mostly unknown conveying an erroneous message.
- People may spell words wrong, creating confusion (e.g. ship and shop).

Clearly, human beings are adept at sorting out mistakes. Computers will just go along with mistakes and end up the wrong alley. So, if human beings work with computers (i.e. digital information) they must be very exact and explicit in their communication.

Digital information exchange is based on more or less the same principles as verbal human communication:

- **Characters** are formulated in a **syntax**. An example is XML.
- **Words** are defined in a **dictionary** (terms or objects with their definitions and attributes). To make dictionaries more effective (short store and retrieval times) and more efficient (less bytes), words can be related to each other in specific dictionaries like in classifications or in taxonomies.

- **Sentences** provide a **context** for the words and structures according to the grammar rules. In this way the meaning can be derived. This is called ontology;
- Digital information has to be exchanged without the loss of meaning from one computer system to another.

For each of these most promising solutions this handbook proposes four principles for successful digital information exchange in European shipbuilding.

2.6 Different views on the ship and its installations

In shipbuilding, the ship and its installations, units and components are the central subject of information. This information "grows" during the life cycle of the ship, e.g. it starts with some functional specifications in the conceptual design, via detailed product specifications in the detailed design to a spatial view during production to build the ship in building blocks together. During the life cycle of the ship different actors like designers, engineers, purchasers, producers and maintainers have a different view on the same object i.e. the ship (see Figure 3).

These views deal partly with the same information (it is still the same ship) and partly add new information to it, specific for their view, e.g. a diesel engine as a main component in a ship:

- A designer is interested in the performances of that diesel engine.
- An engineer is interested in the weight, the specific dimensions and the input and output connections of that diesel engine.
- A purchaser is interested in the delivery conditions, the price and suppliers' address of that diesel engine.
- A planner is interested in the delivery dates of the diesel engine and associated components and the availability of people, facilities and equipment needed to install it on board.
- A producer is interested in the components that have to be installed in the engine room along with this diesel engine.

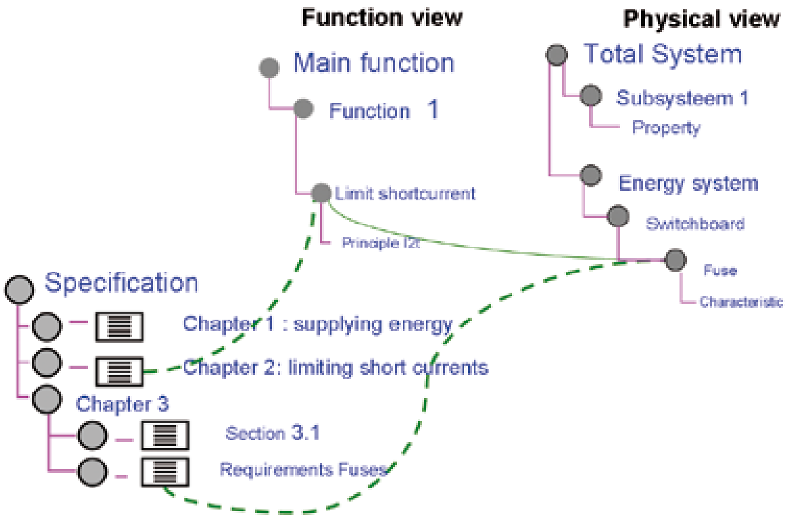


Figure 3: *During the life cycle of a ship, different actors have different views and different information needs: these must fit into each other*

For effective and efficient digital information exchange it is important that these different views of the different actors spread along the supply chain. They must fit into each other so that they all deal with the same information. As can be seen in Figure 3 in the shipbuilding supply chain, different actors have different views on the same ship/ product (e.g. sales, design, project management, purchasing, planning, producing, etc.), but the product data itself MUST be the same, only with other or additional attributes.

2.7 Types of standardisation

EUROMIND deals with the type of standards as visualised in Figure 5 in the next chapter. A central theme is that a so-called open standard is required. This paragraph highlights the terms "open" and "standard". An open standard is a standard which is publicly available and has various rights of use associated with it. The terms "open" and "stan-dard" have a wide range of meanings associated with their usage. The term "open" is usually restricted to royalty-free technologies while the term "standard" is sometimes restricted to technologies approved by formalised committees that are open to participation by all interested parties and which operate on a consensus basis.

The definitions of the term "open standard" used by academics, the European Union and some of its member governments or parliaments such as Denmark, France, and Spain preclude open standards, requiring fees for use, as does the Venezuelan Government. As to standardisation organisations, the W3C ensures that its specifications can be implemented on a Royalty-Free (RF) basis.

Many definitions of the term "standard" permit patent holders to impose "reasonable and non-discriminatory" royalty fees and other licensing terms on implementers and/or users of the standard. For example, the rules for standards published by the major internationally recognised standardisation bodies such as the ISO, and IEC permit their standards to contain specifications whose implementation will require payment of patent licensing fees (none of these organisations state that they grant "open standards", but only "standards"). The International Telecommunication Union has a definition of "open standard" that allows "reasonable and non-discriminatory" licensing.

The term "open standard" is sometimes coupled with "open source", i.e. the idea that a standard is not truly open if it does not have a complete free/open source reference implementation available.

Open standards which specify formats are sometimes referred to as open formats.

Many specifications that are sometimes referred to as standards are proprietary and only available under restrictive contract terms (if they can be obtained at all) from the organisation that owns the copyright on the specification. As such these specifications are not considered to be fully open.

2.8 ICT in shipbuilding supply chain collaboration

Application of ICT solutions in the shipbuilding supply chain reflects an understanding of e-business that encompasses more than just e-commerce transactions. The broad concept of e-business also includes the digitisation of internal business processes, as well as cooperative or collaborative processes between companies which are not necessarily transaction-focused. Collaborative design and engineering processes between business partners are a typical example from industrial engineering which is also already practiced in the European shipbuilding of today. This broad approach of e-business implicitly indicates that the focus and main objective of e-business is to be found in business process automation and integration, and the impacts thereof. To bridge the gap between 'e-commerce' and 'e-business' the role of ICT for cooperation among enterprises is stressed.

If transactions are conducted electronically ('e-transactions'), this constitutes e-commerce. Multiple systems and tools are in use in European shipbuilding for the exchange of product data within and across enterprises in the fields of CAD, CAM, PDM, FEM etc. All export their own formats and import of other systems is often not possible without loss of information. For CAD data exchange, ISO 10303 STEP protocol and confirmation classes are established, but currently are not supported by most of the IT systems used in shipbuilding in practice. The introduction of a single and monolithic CAD system would not solve the problem, as this is in conflict with the international competitive market in which the European shipbuilding industry is operating.

In Figure 4 the basic picture as presented in Figure 2 is now filled with elements needed for effective and efficient digital information exchange in shipbuilding.

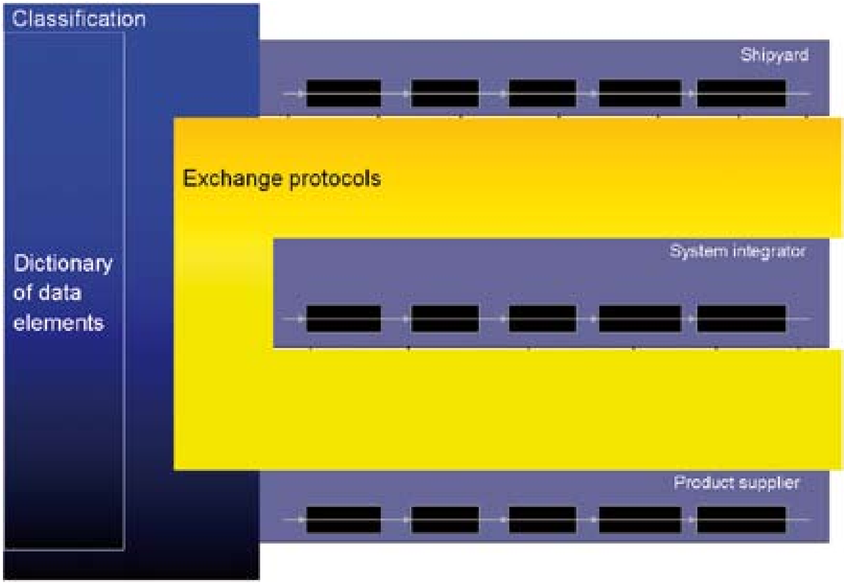


Figure 4: *Basic fields of solutions to solve the problems in digital information exchanges in the shipbuilding supply chain*

2.9 Problem areas

As stated on the first page of this chapter communication, in the widest sense of the word, is a key issue for effective global business and therefore a must for our high-tech European maritime industry. However, some essential requirements must be fulfilled.

The first requirement is the need for standardisation on a European level in order to communicate efficiently. Reference can be made to several national initiatives like Net-S in Germany, Open Mind in The Netherlands and European/International initiatives like the European Maritime STEP Association and the Marine Trading Markup Language (MTML). However, a lot of coordination still has to be done in the field of standardisation of technical, financial and logistical data. Secondly, a European standardisation of data elements is required. This comprises a uniform "European maritime dictionary" including synonyms and the "grammar" which is being referred to as classification. Communication standards have to be identified in good practice studies of shipbuilding supply chain collaboration using XML and standardised drawing formats.

The main problem is that initiatives on standards were mostly too small in scale and were not coordinated at EU level. This resulted in "standards" of too little scope being known to too few people leading to too little adoption by a sufficiently large body of players. This in turn leads to hindrance and thresholds for the application at European level of innovative e-business solutions.

The current situation in the European shipbuilding industry in applying standards in the digital exchange of product data is characterised as follows:

- **Several national developments** led to various member states applying isolated parts of standards with resulting shortcomings in the national adoption of those standards in view of the international playing field of this industrial sector.
- **Different disciplines** in the maritime sector (e.g. construction, electrical and mechanical) are applying their own specific standards.
- In the **different phases** of the product life cycle, (partly) different specific standards are applied.

All this leads to a lack of generally accepted standards which in turn leads to a fragmented development of software solutions by software providers which in turn leads to inefficient and ineffective digital information exchange in the shipbuilding processes.

2.10 Policy Issues

Based on research into e-Business by the EC[1] and moreover supported and emphasised by the outcome of workshops with European shipbuilding industry the basic problem areas for digital information exchange are:

Design and Engineering:

- 3D drawings
- exchange data.

Procurement:

- supplier component data
- technical specifications.

With this focus in EUROMIND an inventory was made on the most promising solutions (see chapter 3) on the basis of which good practices can be advised (see chapter 5) for practical use in the European shipbuilding industry.

Besides these more technical oriented, basic problem areas some underlying problems in the European shipbuilding industry have to be tackled in order to become applicable, acceptable and workable solutions. The underlying problem areas identified by EUROMIND are lack of awareness, lack of knowledge, lack of concerted, pan-European action, lack of funding for standard development and introduction, lack of transition mechanisms from in-house "standards" to real open standards (in view of the risk of losing valuable experience/historical data).

1 The European e-Business Report 2006/07 edition: A portrait of e-business in 10 sectors of the EU economy, 5th Synthesis Report of the e-Business W@tch

CHAPTER 3: Inventory of standards supporting interoperability in shipbuilding

EUROPE INNOVA
Innovation and Standards
EUROMIND

3. Inventory of standards supporting interoperability in shipbuilding

3.1 Introduction to standards in digital information exchange

Due to increasing international competition, structural changes in the shipbuilding industry have resulted in co-operation in engineering and production along the value chain among shipyards, system integrators and product suppliers. Companies co-operate and collaborate online within their value system, notably with regard to the sharing of documents and in the design processes. During the life cycle of ships, from the 'specify ship' phase to the 'decommission and disassemble ship' phase, information technology is widely applied.

From a report on e-business in Germany, 2005[1], Figure 5 is used to show the building blocks in the area of digital information. This reference model is used to highlight the focus of EUROMIND, i.e. to focus on the business of shipbuilding:

- documents like drawings, parts lists, specifications and purchase orders
- processes like design, engineering and purchasing
- classification and attribute systems which contain the meaning of the world of European shipbuilding like bilge pump, ballast system, container ship etc.

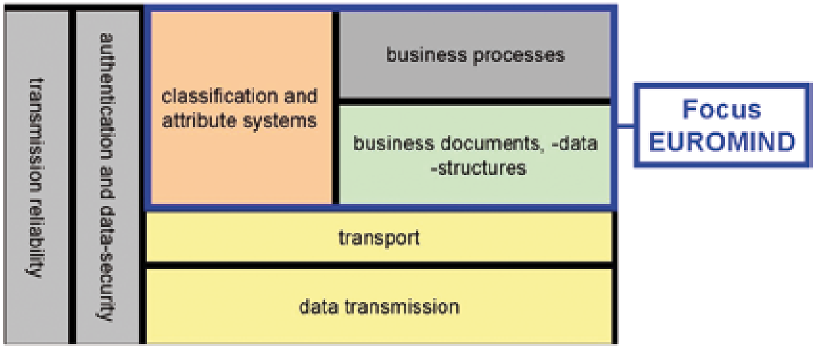


Figure 5: *Reference model for digital information exchange and the focus of EUROMIND[1].*

1 eBusiness Jahrbuch der Deutschen Wirtschaft 2004/2005 (Wegweiser Berlin, ISBN 3-932661-43-5)

In the last decade of research and development in digital information exchange experience has shown that the idea of arriving at one solution as one standard for all players is Utopian and has turned out to be a non-feasible solution for the European shipbuilding due to is diversity and its highly international competitive playing field.

A feasible solution, as proposed in EUROMIND, focuses on diversity as strength in European shipbuilding which enables its flexibility. EUROMIND focuses on a so-called reference standard, i.e. not one standard, but a set of standards which are linked to each other.

Everyone can use all or just parts of this reference standard, depending on the situation. This solution allows the European shipbuilding industry to grow step-by-step to a way of working which enables interoperability based on the increased use of standards out of this EUROMIND reference standard.

This EUROMIND reference standard functions as a neutral intermediate format/language between all the other standards. This type of solution is more feasible for the companies in the industry. The industry can generally keep the software systems they use and the data already stored in them. All can communicate with this neutral intermediate language and as a consequence everyone can communicate electronically with each other (e.g. like people mostly use the English language as intermediate language between their own languages).

This principle of the EUROMIND solution is shown in Figure 6. The left side of this figure symbolises the insurmountable challenge of installing and maintaining communication standards in a one-on-one situation in the ever changing shipbuilding supply chain (e.g. in almost every project different companies are involved).

The right side of Figure 6 visualises, through the EUROMIND solution, that every company only has to install and maintain the relation with the neutral reference standard (i.e. a set of standards to ease electronic communication), which enables every company in the European shipbuilding industry to communicate electronically with each other.

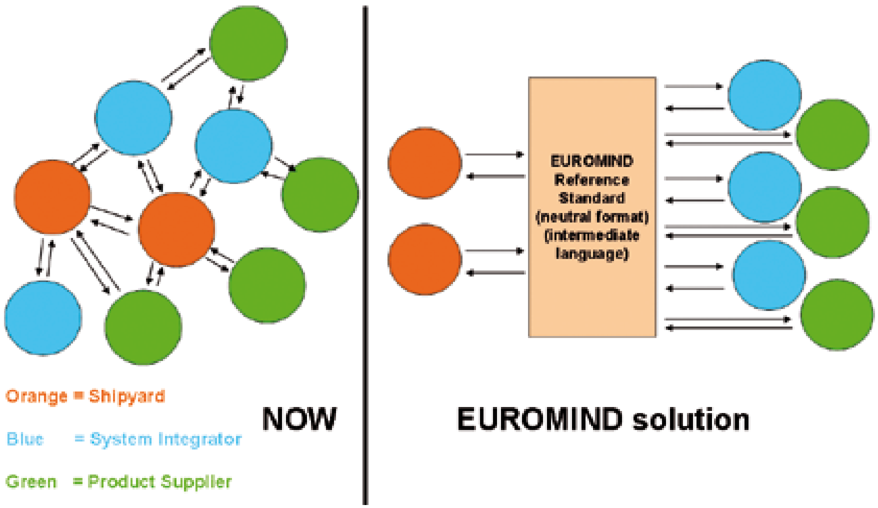


Figure 6: *Principle of the EUROMIND solution: reduce complexity in digital information exchange and enhance interoperability by an intermediate neutral language for the shipbuilding industry*

Incidentally, it should be noted that the invention of human language is a similar solution to a similar problem where human beings, rather than applications or data structures, are trying to connect in an effective way. The English language is now fulfilling the role of the central language. Using English allows people of different linguistic backgrounds to communicate more or less effectively - just as a reference standard will function in digital information exchange.

3.2 Promising standards for the shipbuilding industry

To decide in EUROMIND about the most promising standards for the shipbuilding industry in the area of digital information exchange to be part of the neutral reference standard, promising standards were evaluated against the following requirements:

- Is the standard open?
- Is the standard universal? Is it independent, unambiguous and of high technical quality?
- Has the standard a high degree of publicity, on either a national, European or global scale?
- Is the standard compatible, platform independent?
- Is the standard in use in shipbuilding or shipbuilding-like industries: on either a national, European or global basis?
- What are the costs of the standard: license cost, installation cost, operation & maintenance cost?
- Is the standard supported by (inter)national organisations and/or associations: size and number of the associations, political support?

The results of this evaluation, with the elements of successful communication in mind as described in chapter 1, are as follows:

- Use standardised descriptions of components and attributes (maritime dictionary) based on classification. Most promising are the eCl@ss and ETIM standards from the electrotechnical contractor industry.
- Use a standardised way to specify the structure of information (the type of data elements and their relations) i.e. the grammar. Most promising is the ISO15926 standard as used in the off-shore industry.
- Use standardised file descriptions to exchange digital information between computer systems with different CAD software. Most promising is the IFC standard from the building and construction industry.

- Use standardised ways to specify the meaning of the information to be exchanged in an open and neutral product data model as a basis for product data management. Most promising are the results of the projects Net-S, Open Mind and Unitbase from the shipbuilding industry.

The proposed EUROMIND solution can be characterised as a collection of existing standards and shipbuilding project results - all necessary to achieve good digital information exchange.

To be flexible in its solutions to the great variety of specific situations in the European and international shipbuilding industry EUROMIND proposes to make use of the semantic web technology with the use of standards like OWL (Web Ontology Language), RDF (Resource Description Format) and XML (eXtensible Markup Language).

3.3 Conclusion

The following standards can be a solution in the neutral EUROMIND reference standard:

- ETIM
- eCl@ss
- ISO15926
- IFC

The results of the following projects from the European shipbuilding industry can be used to specify shipbuilding content in the standards mentioned:

- Net-S
- Open Mind
- Unitbase

Semantic web technology using standards like OWL, RDF and XML can be used to interrelate all (parts) of the standards in order to obtain the flexibility needed in European shipbuilding.

CHAPTER 4: Standards related to problem areas in shipbuilding

4. Standards related to problem areas in shipbuilding

The previous chapters described the context of shipbuilding and the main problem areas in the digital exchange of information. Possible solutions to main problems in these areas were identified. In this chapter the most promising standards and project results identified in the previous chapters are positioned in the shipbuilding business.

Two basic views on the shipbuilding business, which are familiar in the industry, are as follows:

- the phases in shipbuilding, presenting the life cycle of a ship
- the systems (installations) in a ship

This chapter gives an insight into which standards and project results are relevant for which phase in the life cycle of a ship and for which systems on board of the ship. This chapter is not intended to be exact, but to give an overview.

4.1 The phases in a ship's life cycle

Every company in the maritime sector will have its own look at the shipbuilding process and will define the various steps accordingly. The representation below (see fig. 8) divides the complete shipbuilding process into five main processes as defined in the Open Mind project based on the international ISO-STEP standard[1]. Definitions of these main processes can be found in "definitions of terms" at the end of this handbook. Public literature about Open Mind can be found in[2]. The grey colour in Figure 7 shows the most promising standards as described in chapter 2. The purple colour shows the usable project results.

Specify ship

In this phase an offer for a ship is created. First calculations and a first rough general arrangement are already available (although part of the design phase). The information detail is that of an indicator. The data is mostly based on rules of thumb and experience. Important are required materials, man-hours, building time and prices. Only limited data is exchanged.

1 Open Mind, project results: process, product and information models, VNSI, 2004

2 "Enabling integrated (concurrent) design – Exploring ICT architectural issues and realization scenarios", A. Guyt, U. Nienhuis, J.C. van der Wagt, COMPIT, Hamburg, 2005 International Conference on Computer and IT Applications in the Maritime Industries

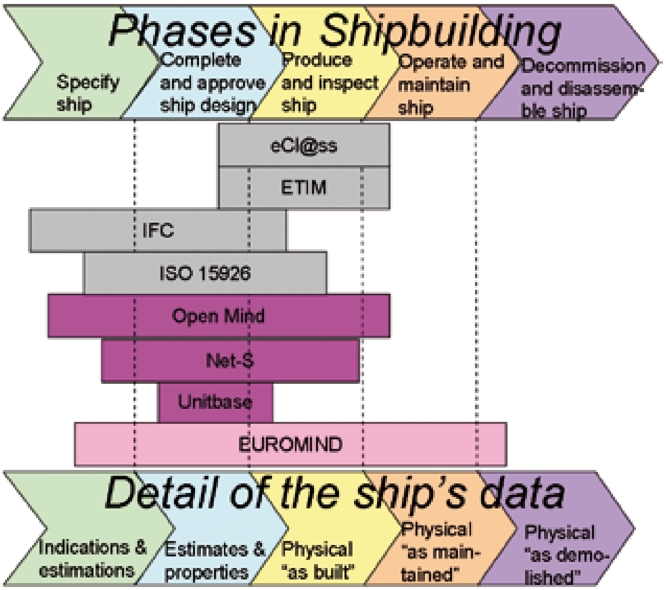


Figure 7: *Proposed standards and project results related to their relevance for the phases in shipbuilding as well as to the level of detail of the product data of the ship covered by these standards/ project results*

Complete and approve ship design

This phase will run for a longer time than the 'specify ship' phase and starts after a contract is signed with the ship-owner. In this phase a more detailed look at the ship is taken and it includes approval of proposed design and engineering solutions by the authorities, the classification societies and the ship-owner. During the first steps in this phase in mostly a general arrangement is a major result and a lot of data are estimated values, some from catalogues or first principle calculations. The margin of errors is typically some 10%. Part of the data is 'stored' in the drawings and needs to be exchanged with the drawing as well, although as a general rule drawings and diagrams only are exchanged. In the last steps of this phase, detailed drawings of all systems, areas and production blocks are created. Next to that, purchase of materials can be seen as part of this phase as well. The data quality is of catalogue value; all properties of the units become available in this phase. More and more data is attached to drawings and would need to be exchanged with the drawings as well, or on its own (e.g. to purchase).

Produce and inspect ship

This is probably the most visible of all phases. It includes the testing of equipment and systems for their compliance with the earlier specifications and for their functioning. An important issue in this phase is also the information exchange with shipowner, flag-state authorities and classification societies for compliance with rules and regulations. Still, proper data exchange is needed, not least for performance checks. Logistic processes and logistic data related to product data of the ship play an important role in this phase.

Operate and maintain ship

Depending on the type of ship, the contracts and contact between shipowner and shipyard there is a lot or no after-sales available for the ship. Long term contracts for maintenance and repair as well as leasing contracts are more and more used. Still, an improvement in data availability and possibilities for exchange in this phase could facilitate the work of the shipbuilding industry for the shipowners. Good use of standards in digital information exchange enhances the possibilities for effective and efficient support throughout the vessels life by shipyards, system integrators and product suppliers to their customers.

Decommission and disassemble ship

In this phase the ship's end of life has arrived. To allow for a safe, healthy and environmentally friendly scrapping process actual information about the ship's status is important. This requires data exchange with actors involved in the previous life of the ship. The data requirements and instances of exchange in this phase are much less than during production and operation of the ship.

4.2 Systems in shipbuilding

Another view on shipbuilding considers the different systems and specialties within shipbuilding. Where in the past a yard would do everything itself, the increased complexity of the various systems has driven and been driven by specialisation in a certain system. In Figure 8, some important systems in a ship (relevant for almost every ship) are mentioned. These systems have relations with the standards and project results as described in the previous chapters. Again, the grey colour shows the most promising standards and the purple colour shows the usable project results.

HVAC

Heating Ventilation and Air Conditioning - this system will secure a pleasant and workable environment on the ship, both for the people and the cargo. As ships sail around the entire globe, living quarters need to be heated in the arctic and cooled and dehumidified in the tropics.

Electrical systems

The electrical system is one of the most important systems on the ship, without it nothing would work. This group contains not only the supply of electricity, but also the monitoring, the electrical equipment and so on.

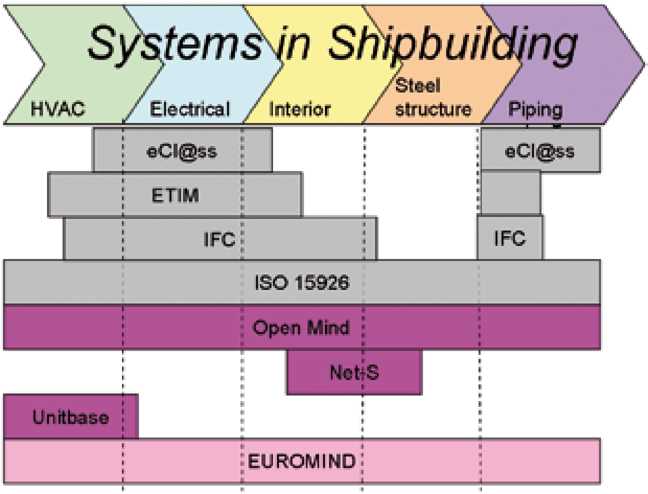


Figure 8: *Proposed standards and project results relevant for various systems in shipbuilding*

Interior

Cabins, inclusive their furniture, insulation and carpeting are the main items of the Interior system.

Steel structure

All major constructional work is summed under this system. Although it is called steel, it might as well be wood, aluminium, or plastic, even though steel is the most recognisable.

Piping

All the piping systems in the ship. Pipes run throughout the entire ship, for ballast water transfer, sanitary disposal, fuel transfer, and sometimes even to load and unload cargo or between onboard chemical processes.

Besides these 'general' systems there are also primary systems in a ship which give the ship its added value to the shipowner. These systems are very diverse and cover installations for dredging, loading and unloading, pipe-laying, LNG, etc. For this diversity in systems it is expected that for components (like valves, pumps, pipes, electric motors, etc.) standards are available (besides other parts of IFC, eCl@ss, ETIM, ISO15926) and can be used.

4.3 Conclusion

From the two main views on shipbuilding, as shown in figures 7 and 8, it can be seen that no available standard or project result covers all in both views although some elements are already there. However, these elements (i.e. existing most promising solutions) are not or only on a very restricted basis related to each other.

The intention of EUROMIND is to cover all the phases and all the systems and that it offers the relation between these partial solutions.

CHAPTER 5: Recommended good practices for shipbuilding

EUROPE INNOVA
Innovation and Standards
EUROMIND

5. Recommended good practices for shipbuilding

European shipbuilding supply chain collaboration can be improved by connecting digital systems via open standards. These recommended good practices are the result of studies and discussions performed in EUROMIND. Besides improving supply chain collaboration these recommended good practices are intended to raise awareness of the need for integration of open standards into new business practices and services in the maritime industry.

The goal of new business practices and services is to improve interoperability across all phases of shipbuilding projects and between all parties involved throughout the value chain. EUROMIND stresses that robustness and competitive advantage can be achieved by implementing standards at company level and at the level of the entire European shipbuilding supply chain.

A key to improvement is **interoperability**, where shipyards, system integrators and product suppliers work together via clear communication channels, structures and tools.

The good practices address electronic exchange of information and how to implement open standards, but do not cover other aspects of supply chain collaboration like project management, contract management and knowledge management, which were not subject of EUROMIND.

The European e-Business report confirms that the largest need for standardisation in the shipbuilding industry is in the area of design and planning, followed by supply chain management and procurement. Many different design applications are used in the shipbuilding sector and the exchange of drawing information provides big challenges. Supply chain management and procurement can also benefit from the use of standards by reducing time and costs and improving quality.

Only an integrated approach – focusing on the use of standards and compatibility between standards - will lead to advanced e-business systems and a competitive advantage for the entire European shipbuilding industry.

5.1 Steps for achieving interoperability

In order to facilitate interoperability in the shipbuilding industry several standards have to be implemented, at different levels in the organisation and among organisations. Implementing these standards requires the following three steps:

Step 1: A dictionary of data elements

Firstly, data elements – or technical content – have to be translated and related so that every stakeholder is able to speak and understand the same digital language. In parallel with a grammar in natural language this requires a digital electronic dictionary, called a taxonomy. This taxonomy should be used at least in every company's supply chain and preferably in the entire European maritime industry.

Step 2: Classification system

Secondly, a classification system is required to structure all data elements. In parallel with the grammar of a natural language, this structure is required for putting the data elements in their proper context. This type of classification structure is also referred to as ontology.

Step 3: Exchange protocols

Thirdly exchange protocols are required to communicate information in its context to all parties involved. Several exchange protocols are in place for establishing network connections. However, protocols for information exchange of drawing information, EDI and XML are not widely used yet in the maritime sector.

5.2 Available ingredients for interoperability

After a thorough investigation of all standards at different levels, the EUROMIND consortium has concluded that some standards have a high potential in the maritime industries. Concerted action is required to implement and further develop these standards.

On the product supplier level the Electro Technical Information Model (ETIM) in combination with the DIN attribute lists (DINsml) offer a good starting point for a classification and taxonomy for the European shipbuilding industry. The ETIM model is already in use in the electrotechnical industries in several European countries and can be extended to the shipbuilding industry. Concerted action is required to develop a complete shipbuilding digital electronic dictionary and to implement this dictionary starting with adding electrotechnical products relevant for use in the shipbuilding industry.

Secondly, the ISO 15926 standard for digital data integration as used in the offshore industry should be implemented in the European shipbuilding industry. The functional approach of ISO 15926 and the well developed classification structure offer good possibilities – especially for system integrators - for system engineering in different shipbuilding domains, like electrical and mechanical engineering.

Thirdly, a standard for the exchange of drawing data (i.e. geometrical, graphical and parametrical data) and its meta-data (i.e. the 'intelligence' incorporated into a drawing). E.g. a line means: a pipe of 5″ diameter, length of 10m, to transport ballast water, located in double bottom of engine room) should be implemented in the European shipbuilding industry. This does not only include shipyards and their suppliers, but software suppliers as well, since some of them do not envision open standards, but use proprietary standards to gain competitive advantage over other software suppliers. One of the most promising exchange standards is the Industry Foundation Classes (IFC).

Finally, a semantic web information standard (like OWL) should be applied and/or extended. This standard provides the ability to make a framework for all standards in use within the European shipbuilding industry. This 'semantic web'-like information standard combines classifications, taxonomies (or digital dictionaries), ontologies (also called digital grammar) and data exchange standards into one integrated approach.

Only an integrated approach – focusing on the use of (already existing) standards and compatibility between standards - will lead to advanced e-business systems which will enhance the interoperability and offer a competitive advantage for the entire European shipbuilding industry.

To fill the above-mentioned existing standards with content from the shipbuilding industry EUROMIND recommends the use of the results of the following projects from the European shipbuilding industry:

- Net-S, a project from the German shipbuilding industry[1] focused at digital product data exchange in a shipbuilding project e.g. between shipyard and some main system integrators.
- Open Mind, a project from the Dutch shipbuilding industry[2], focused at digital information exchange during design and engineering of ships inclusive definitions of processes, products and attributes.
- Unitbase out of the CE3P project[3] in the Dutch shipbuilding industry, focused at the digital information exchange in a shipbuilding project during the design and engineering phases between a shipyard and some main system integrators.

These project results give input for parts of the shipbuilding electronic dictionary and the classification structure.

1 Netzwerk Schiffstechnik 2010 NET-S, 2006

2 Open Mind, project results: process, product and information models, VNSI, 2004

3 CE3P Endreport, A.A. van der Bles, U. Nienhuis September 2008, Limited Access only.

5.3 Recommended good practices

5.3.1 Prepare a strategy and roadmap for each organisation

Without the interoperability of ICT systems, which require standards and compatibility between standards and in-house solutions, advanced forms of e-business are hardly possible. Real progress towards reducing production cost and lead time depends highly on a deep understanding of the interrelations between (internal/external) processes and role and application of e-business.

The impossibility to properly communicate digitally between the systems of the different shipyards, even inside the same shipyard between different departments, presents an alarming obstacle to enhanced competitiveness. Different in-house solutions for steel specifications, coding rules, normalisation, attributes describing parts of the ship or the process, software tools with their own formats, etc, are a continuous source of errors, misunderstandings, additional search and query time, sending and receiving (modified) documents, etc. They definitely constitute a waste of time and efforts that add up to more than 10 % of the time devoted to coordination. This increases cost and lead time (time-to-market) in an important way.

The implementation of new business practices and services that aim at increased interoperability has an enormous revenue potential which is more than 10 times as high as the cost (investment). However, it is not a quick win. Investment (i.e. the development of the initial reference standards) will take some years.

Successful implementation of services, tools and standards require a concerted action that involves an important part of a shipbuilding cluster i.e. a group of companies regularly doing business together. The entire European shipbuilding supply chain where shipyards, system integrators and product suppliers work together should eventually be involved in these developments.

Moreover, tools and standards to facilitate interoperability have to be implemented at different levels within companies and coordinated in the entire European shipbuilding supply chain.

Although the development requires the participation of many companies, each company will have to form a strategy in this area and decide on priorities. In this connection it is recommended that companies put this matter on the board's agenda and do not relegate it to IT specialists hidden somewhere deep inside the company.

While it is certainly natural and acceptable that a number of companies move faster in this area, it should be safeguarded that the developments are not exclusive for these early developers and adopters.

In fact, it is of paramount importance that the results in terms of the reference standard are made available to other players as well (open standards!). The competitive advantage for these leading companies does not and should not derive from their possession of a (proprietary) standard, but from their advantage of shaping the standards of the future and their first-mover's advantages.

The implementation needs a strategy and a roadmap for each organisation and a clear commitment of the management level.

The strategy should:

- support concurrent work processes
- facilitate openness and interoperability
- integrate information across disciplines, applications and companies
- develop reference data which are expandable
- adopt product lifecycle management system
- adopt tools based on open standards, not proprietary standards.

For too long this subject has been relegated to second-tier responsibility within the companies. For the advocated developments to take off and be successful, strong management commitment is necessary. The management is required to develop and implement a proper strategy.

Standards are an important source for innovation, flexibility and competitiveness.

Companies are advised to be committed to engage in standardisation activities following EUROMIND's conclusion that standards are a basic factor of success and innovation. Only those who participate in standardisation will be able to adapt their structures and systems in time.

5.3.2 Harmonisation of classification and attributes results in synergies

Both internally and externally product data are often presented inconsistently and in a fragmented way. During product development, in system specifications and in the final product data sheet attributes, definitions and values are described differently due to their different origin in different departments and for different purposes.

Different names sometimes mean the same or worse, the same names sometimes mean something different. In addition, often different classification systems are in use. Each transfer of classification data from one system to the other requires mapping, often great efforts, loss of information and a risk of errors or even failures. This is due between internal processes, systems and tools in the company, as well is in cooperation with customers and suppliers.

To overcome this situation companies (e.g. in the German and Dutch industry) initiated projects aiming at reaching consistent harmonisation of classification, attributes and values. Due to their membership in standardisation activities, synergies could be created and consistent classification could be built up which at least to a large extent complies with external classification e.g. in e-marketplaces. Examples from the German industry[1] show that an initial "jungle of standardised parts and components" can be reduced significantly by a very significant 30 % by means of consistent harmonisation.

Consistent harmonisation of classification attributes and values of products, parts and assemblies and continuous maintenance of product master data are pre-requisites of unambiguous internal and external data exchange.

An example in this field is the development and application of web portals for the exchange of product data with standardised attributes and drawing files. The development of a portal for the exchange of product data in a standardised format complying with the reference standard with proper attributes and drawing files (for 2D and 3D representation) should be considered seriously in national and European research programmes.

Within the European electrotechnical industry a web portal is implemented and further developed to supply data in a standardised format for several sectors (electrical, ICT, climate and mechanical systems) based on the ETIM classification and communication standard. A near-future development, which should be given serious attention, is the use of the IFC standard to exchange not only CAD pictures, but also meta-data and database information connected to the pictures. In the far future it is conceivable that the actual drawings become secondary to the data, metadata and topological information represented by that very drawing. With the advocated development of such portals, ambiguity of internal and external data exchange will be much reduced.

5.3.3 Implement a neutral exchange standard for CAD interoperability

Many different design and engineering applications are in use in the shipbuilding sector and the exchange of product information presents big challenges. More and more information is communicated in digital drawings.

1 DIN-Mitteilungen 11, DIN-Merkmallexikon: Genormte Produktmerkmale und Merkmalleisten reduzieren Komplexität, 2004M, Universität des Saarlandes, 2003

Supply chain management and procurement can also benefit from the use of standards by reducing time, costs together with improving quality.

The one-off ships or small series, together with the large amount of subcontracting tasks typical for the European shipbuilding industry, imply an enormous exchange of technical, logistical, commercial and organisational content among the parties involved in the shipbuilding process. All the information generated in the different places has to be exchanged, approved, returned (with indications of corrections to be made), re-approved, etc.

To overcome problems in exchange of data between different CAD systems, bigger players (shipyards, system integrators) in the European shipbuilding industry move towards the use of one CAD system for the entire enterprise. They also try to urge their main suppliers to use the same CAD system. They hope this will solve many problems. However, it is not a stable solution in the long run. Some players already acknowledge that most of their suppliers will not work with their shipyards' CAD system and will continue to work with their own CAD system. Various reasons are the cause of this: they have to deal with different shipyards that use different CAD systems and their in-house experience and knowledge base is built on their existing CAD systems.

The same is acknowledged for the cooperation among shipyards: not all shipyards that cooperate in projects will use the same CAD system.

There is a need to exchange graphical (geometrical, topological, parametrical) product information with meta-data ("intelligence") often the meta-data, but the parameters underlying a geometrical description are lost by exchange of CAx data. In addition, there is a requirement to receive graphical product information from suppliers attached to product attributes which is ready and suitable to use and implement in the product model during design.

Extension of the Industry Foundation Classes (IFC) provides a promising opportunity to establish a neutral format for exchange of graphical and related alpha-numerical information, the so called meta-data, between CAx systems in shipbuilding industry.

Semantic web offers interesting opportunities:

New semantic web-like information standards provide a promising opportunity to make product information from different sources available to a variety of users and for different purposes.

These semantic web-like information standards should be developed specifically for the European shipbuilding industry. A semantic web offers the ability to provide a framework for the set of standards in use within the European shipbuilding industry. This semantic web-like information standard combines classification, taxonomy - or digital dictionary, ontology (also called digital grammar) and data exchange standards into one integrated approach.

5.3.4 Implement a data integration standard for Systems Engineering & Information Management

The European e-Business report[1] confirms that the largest need for standardisation in the shipbuilding industry is in the area of design and planning, followed by supply chain management and procurement. The integration of information across disciplines, applications and companies requires the systems engineering approach and the development of an open and neutral product data model as the basis for product data management. Comprehensive development in this area of systems engineering and data integration is currently undertaken, see for example[2] and[3].

Management of a cascade of product information with an increasing level of detail from project planning, early and detailed design to production and after-sales services until scrapping is the big challenge of **interoperability**.

Projects like Net-S, Open Mind and Unitbase have analysed, defined and established a solid ground specific for the shipbuilding industry to build on.

The Offshore industry, the building and construction industry, as well as the electrotechnical contractor industry show similarities to the shipbuilding industry:

- mMany players in a project-based organisation
- information exchange across engineering disciplines, applications and companies
- concurrent work processes.

Good practice observations from the offshore industry are characterised by common standards and technologies:

- ISO 15926: Integration of life-cycle data which allow for expandable representation of reference data
- semantic web (OWL, RDF, XML) to enhance information integration.

Validation of equipment supplier data:

- reference data library (over 50,000 terms and definitions): Browse, edit, add, retrieve, manage versions of information
- develop small object information models / data sets: Set of attributes with a limited set of relationships
- validation of data sets: Exchange files, software mappings.

1 The European e-Business Report 2006/07 edition: A portrait of e-business in 10 sectors of the EU economy, 5th Synthesis Report of the e-Business W@tch

2 "A Data Driven Integrated Knowledge Framework for the Total Ship Life Cycle", L.C. van Ruijven, U. Nienhuis, COMPIT, Hamburg, 2005.

2 "Requirement management, traditional and a second generation scenario", U. Nienhuis and L.C. van Ruijven, COMPIT 06.

5.4 Conclusion

Only an integrated approach – focusing on the use of standards and compatibility between standards - will lead to advanced e-business systems and a competitive advantage for the entire European shipbuilding industry. Moreover, tools and standards to facilitate interoperability have to be implemented at different levels within companies and coordinated in the entire European shipbuilding supply chain.

Therefore, the implementation needs a strategy and a roadmap for each organisation and a clear commitment of the management.

The consequent harmonisation of classification, attributes and values of products, parts and assemblies and continuous maintenance of product master data are prerequisites of unambiguous internal and external data exchange.

The extension of the existing Industry Foundation Classes (IFC) provide a promising opportunity to establish a neutral format for exchange of graphical and related alpha-numerical information between CAx systems in the shipbuilding industry.

The new semantic web-like information standard provides a promising opportunity to make product information from different sources available to a variety of users and purposes.

The integration of information across disciplines, applications and companies requires the use of a systems engineering approach and the development of an open and neutral product data model as the basis for product data management. Management of a cascade of product information with increasing levels of detail from project planning, early and detailed design to production and after-sales services until scrapping is the big challenge of interoperability.

Projects like Net-S and Open Mind have analysed, defined and established solid ground to build on. In addition, other industries like the off-shore industry, the building and construction industry, as well as the electrotechnical contractor industry offer good practice examples to learn from and to make use of.

Successful implementation of services, tools and standards require a concerted action that involves the entire European shipbuilding supply chain where shipyards, system integrators and product suppliers work together.

CHAPTER 6: Conclusions and recommendations


NORWEGIAN PEARL

6. Conclusions and recommendations

A good standard is a standard that is in use by many organisations. Relevant standards for digital information exchange are available in industry sectors similar to the shipbuilding industry. Instead of developing new standards for the shipbuilding industry, EUROMIND recommends the implementation of standards available in electrotechnical contractor industry, in building and construction, and in offshore industries.

Together with these standards, results from recent shipbuilding research and development projects in the area of digital information exchange can be used to tailor standards to the shipbuilding industry. The standards themselves offer the shipbuilding industry the structure (proven designs) and the projects offer parts of the content to fill these structures.

EUROMIND proposes to use existing standards used in shipbuilding-like industries and add shipbuilding content to them as follows:

- use **ETIM / eCl@ss** originating from the electrotechnical contractor industry
- use **IFC** originating from the building and construction industry
- use **ISO15926** as used in the offshore industry.

EUROMIND proposes to use the results of the following shipbuilding projects aimed at solving problems in the area of digital information exchange:

- project **Open Mind** from the Netherlands
- project **Net-S** from Germany
- project **Unitbase** from the Netherlands.

Results of these projects offer valuable information to fill the structure of the proposed standards with the needed shipbuilding content.

The solution proposed by EUROMIND is a reference standard. It is an ensemble of standards which functions as an intermediary language between all software applications and data structures in the shipbuilding industry. Through this intermediary language based on the standards and projects mentioned earlier, digital information can be exchanged without loss of information.

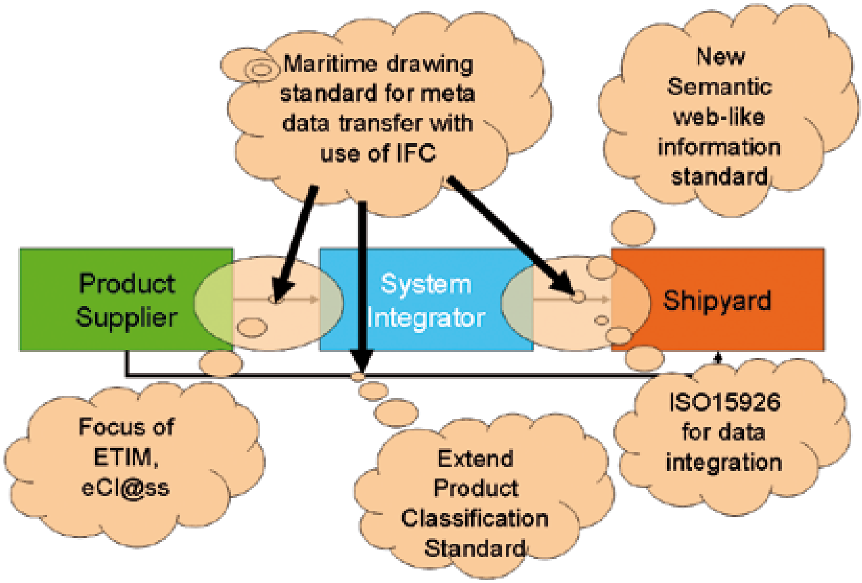
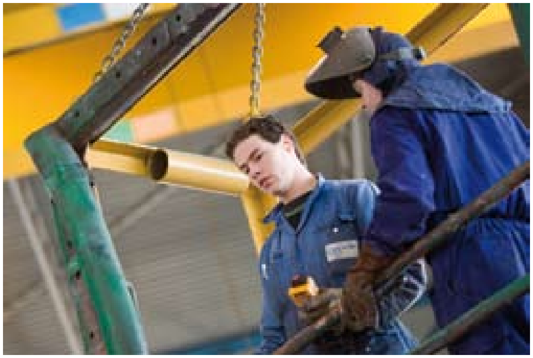


Figure 9: *Proposed solutions for enhanced interoperability in the shipbuilding supply chain*

EUROMIND proposes to make use of the latest technology, including opportunities offered by the semantic web, as a flexible coordinating mechanism between the different standards in the neutral reference standard.

Implementing this EUROMIND proposed solution requires a European effort: a joint effort of shipyards, suppliers, software suppliers, universities and technical colleges, standardisation organisations, consultants and authorities. Advantages can be very significant for the European shipbuilding industry. After 2 to 4 years of investment the cash flow is expected to be positive.



The EUROMIND consortium has made a rough estimate of the benefits of the use of open standards. For the entire European Shipbuilding Industry this amounts to a saving of € 65 million per year at the expense of up to € 25 million per year.

To end this handbook some general concluding remarks regarding the adoption and implementation of standards in the area of digital information exchange must be made. Some of them seem obvious, but nevertheless they are important aspects in creating benefits out of investments in enhancing interoperability, as can be learned from these developments in other, amongst others shipbuilding-like, industries:

- awareness raising
- pilot implementations to learn from
- demonstrations
- introduction workshops & training
- a body to maintain the standards and safeguard their public use.

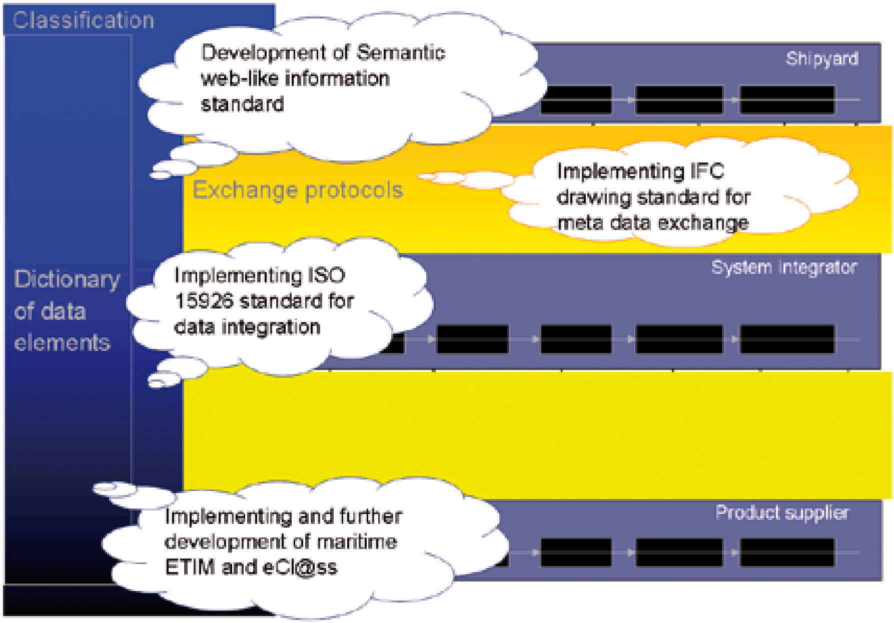


Figure 10: *Positioning proposed solutions for interoperability on the shipbuilding information exchange map*

Glossary

This glossary contains some of the terms used in this handbook.

Definitions are grouped together in three meaningful sections, followed by an abbreviations section:

1. Shipbuilding - the primary process of industry

2. Communication - general logic and principles for communication

3. Digital Information Exchange - technology to communicate electronically

4. Abbreviations

Shipbuilding definitions

Complete and approve ship design: The production of ship design and product support documents, including classification drawings, using the preliminary design from the bid preparation as well as the required rules and regulations. The result of this activity is the approved design and the production and delivery schedule.

Decommission and disassemble ship: All activities related to the last stage of the ship's life cycle. It consists of the decommissioning and dismantling of the ship.

Maritime: The complete area of maritime business i.e. shipping companies, shipyards, system integrators, product suppliers and authorities.

Operate and maintain ship: The activity that describes the running and maintenance of the ship during its service lifetime.

Produce and inspect ship: The activity that describes how the design is transformed into a real product. This activity includes high-level activities such as production, monitoring and inspection of ship production. Inspection means controlling all activities throughout the whole production life cycle of a ship.

Product supplier: A type of company from the shipbuilding supply chain. This type of company delivers ready products (e.g. valves, pumps, anchors, winches) to system integrators or shipyards. Synonym is supplier. Note: a product can also be a service like a vibration calculation. In that case an engineering office can be a product supplier.

Shipbuilding: The part of the maritime supply chain that deals with the building of ships. The type of companies included in shipbuilding is shipyards, system integrators and product suppliers.

Shipyard: A type of company from the shipbuilding supply chain. This type of company delivers ready-made ships to shipping companies.

Specify ship: All activities associated with the production of a detailed specification of the ship and its product support prior to a contract being placed.

System Integrator: A type of company from the shipbuilding supply chain. This type of company delivers ready-made systems (e.g. electrical installations, HVAC, propulsion installations) to shipyards. Synonyms are subcontractor, co-maker or service provider. Note: a system can also be a service like the basic design of a ship, or the detailed design of an engine room. In that case an engineering office can be a system integrator.

Communication definitions

Communication: The process of transferring information from a sender to a receiver with the use of a medium in which the communicated information is understood by both sender and receiver.

Dictionary: An explanation of the meaning of words and how they have to be written. Specific for shipbuilding, describing the elements (i.e. parts, components, units, systems) of a ship and of shipbuilding, including their meaning.

Grammar: The rules through which words may be connected to each other e.g. to form sentences.

Semantics: The meaning of sentences e.g. words with a meaning as defined in the dictionary and connected to each other according the rules of the grammar.

Syntax: The rules governing the logical order of words in a sentence.

Digital Information Exchange definitions

Classification: The systematic arrangement in groups or categories according to established criteria.

Ontology: An explicit formal specification of how to represent objects, concepts and other entities that are assumed to exist in an area of interest e.g. in shipbuilding.

Open standard: Publicly available and implementable standards. By allowing anyone to obtain and implement the standard, they can increase compatibility between various (e.g. hardware and software) components, since anyone with the necessary technical know-how and resources can build products that work together.

Standard: An established norm or requirement. It is usually a formal document that establishes uniform engineering or technical criteria, methods, processes and practices. A standard can be accepted as informal, a so called de-facto standard, because it is used a lot. A standard can be 'declared' to be a norm for different scopes, e.g. a standard can be a company standard, a national standard, a European standard, an international standard, a standard for a specific application (e.g. in the electrotechnical industry), etc.

Taxonomy: A set of controlled vocabulary terms, usually hierarchical. Once created, it can help inform navigation and search systems.

Abbreviations

CAD	Computer Aided Design
CAM	Computer Aided Manufacturing
CESA	Community of European Shipyards' Association
DIN	Deutsches Institut für Normung
EC	European Commission
EDI	Electronic Data Interchange
EMEC	European Maritime Equipment Council
ETIM	Electro Technical Information Model (standard in electro technical industry)

EU	European Union
EUROMIND	EURopean Open Maritime INDustry
FEM	Finite Element Modelling
HVAC	Heating Ventilation and Air Conditioning
IAI	International Alliance for Interoperability
ICT	Information and Communication Technologies
IEC	International Electro technical Commission
IFC	Industry Foundation Classes, standard of the building and construction industry
ISO	International Standardisation Organization
IT	Information Technology
MTML	Marine Trading Markup Language
MRO	Maintenance, Repair and Overhaul
Net-S	German project in shipbuilding industry
Open Mind	Open Maritime Industry, Dutch project in shipbuilding industry
OWL	Web Ontology Language
PDM	Product Data Management
RDF	Resource Description Format
RF	Royalty Free
STEP	Standard for the Exchange of Product model data
VNSI	Vereniging Nederlandse Scheepsbouw Industry (Dutch shipbuilding association)
VSM	Verband für Schiffbau und Meerestechnik (German shipbuilding association)
XML	Extensible Markup Language

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