PRODUCT DATA MANAGEMENT IN CONCURRENT ENTERPRISES

D.H. Müller, H. Gsell, N. Homburg

Bremen Institute of Industrial Technology and Applied Work Science
Division of Product Development, Process Planning and Computer Aided Design
e-mail: {ml, gll, hom}@biba.uni-bremen.de

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Abstract: *To cope with the strong world-wide economic competition a seamless product data management has to be established between concurrent enterprises which are defined as long-term partnerships carrying out product development task efficiently concerning time and costs. The paper at hand describes the product data management done by concurrent enterprises throughout the example of co-operating shipyards. In shipbuilding industry there is a need for intensive co-operation of different actors (ship builders as well as suppliers) working in highly flexible networks. To establish a network co-operation of concurrent shipbuilding enterprises a practical product data model is needed that allows a speedy and easy data exchange between the product development units. This paper shows the key attributes representing a ship's component part, a product data model which integrates different views on a shipbuilding project and a platform for product data exchange.*

1. INITIAL SITUATION

An intensive cooperation of concurrent shipbuilding enterprises is true for all phases of a shipbuilding project – from conception through design to production of a ship. Normally, project constellations are subjected to change during ongoing projects where in different phases new partners have to be integrated. Even greater changes occur if a completely new project for engineering and producing of a new ship is set up. To get a dynamic network co-operation concurrent enterprises there is a need for an easy to handle information and communication structure through which work packages containing construction and design tasks can be exchanged. From a PDM point of view a main challenge during designing and producing a ship which usually is a one-off-a-kind product is building up a manageable structure of the ship's product data. The built up product data model must support a speedy and easy data exchange between concurrent enterprises and, in particular, it must support a traceable revisionary management which in shipbuilding projects in difference to most other engineering tasks is very hard to manage. The data exchanged between the concurrent enterprises describe work packages containing design tasks. For the data exchange a suitable communication structure hosted by a communication platform is needed. Consequently, there is a need for defining the technical requirements concerning the identification of a ship's component parts when product data between the concurrent enterprises are exchanged as well as for an ideal product data model for shipbuilding industry which supports the data exchange.

2. PRELIMINARY WORK

In order to cope with the rising complexity in product development especially in shipbuilding industry there have been finished some Germany research projects in 2005 which analysed the organisation structures and worked out solutions for improving the quality of data exchange by defining practicable product data models as well as by installing capable information and communication structures. So far, the research project called NET-S defined suitable attributes for identifying a ship's component parts and built up a product data model for shipbuilding industry [1]. Further more, an information and communication platform for product data exchange between concurrent shipbuilding enterprises working together on an equal level (such as shipyards) as well as between different levelled partners (e.g. shipyards and suppliers) was built up. Similarly to the NET-S research project, the focus of the research project called ShinCoS laid in building up a comprehensive structure for storing and exchanging product data and engineering drawings for the shipbuilding industry as well [2]. The European and German research projects dealing with product data models carried out in the 1990ies did not result in solutions suitable for solving today's tasks done in concurrent shipbuilding enterprises. Nevertheless they give some hints and ideas for a new product data model meeting the demands of the shipbuilding industry. Using some of these established solutions as well as newly developed ones and combining these to new concepts for data exchange and communication anticipates an improvement to the efficiency and velocity of concurrent enterprises carrying out shipbuilding projects. The paper at hand describes an approach for a product data model representing different views on a shipbuilding project. The different views represented by the product data model support the exchange of product data exactly from that view a single partner of a shipbuilding project prefers for its own work.

3. RESEARCH APPROACH

To find out the attributes suitable for identifying a ship's component parts, in a first step, the existing identification systems of two concurrent working shipyards have been analysed. Starting from this, in a second step, a classification of these attributes was carried out that allowed an estimation which of the attributes can be used for an explicit identification of a ship's component part. The attributes were continued to be differentiated so that only a few attributes remain to be useful for identifying a ship's component parts (see figure 1).

For the development of the product data model the interrelations of these ship's component parts were analysed and represented in entity relationship models [3]. These models support the derivation of exactly these views on a product that are necessary for solving a specific problem or for performing a specific task. The conceptual advisements in combination with the needs and requirements of the industrial partners finally lead to a few attributes that would be used for identifying the component parts when product data are exchanged between the partners of a shipbuilding project. The defined core attributes for identifying a ship's component parts in combination with the needs and requirements of the concurrent shipbuilding enterprises lead to that attributes which can be used for the exchange of product data. Some key attributes for identifying ship component parts are (a) the name/notation of the part, (b) the cross-company ID-number which gets assigned through the communication platform and (c) the basic metrics like dimensions, volume and weight. Further more, there should be a reference connecting these attributes to documents giving some additional information about the part.

Taking into account the identified needs and experiences of shipyards and supplying partners working together as concurrent shipbuilding enterprises, in a further step, a general cooperation model for shipbuilding with different views to the product data has been developed. Further more, the design results have to be made available in a structured and clearly defined model and must enable views to the data that supports the design methods of all participating enterprises. To meet these requirements, the developed cooperation model represents a ship in its state of delivery in different views. For the model there have been chosen two prime views on the ship's design data which are on the one hand the so called "room view" and on the other hand the view on the ship's systems. These views on the ship give the opportunity to establish a task orientated design environment which is needed to solve a specific problem or to carry out a specific task.

4. RESEARCH RESULTS

Concerning the product data model the partners of the NET-S project detected the necessity of two different views on the ship's product data which are on the one hand a so called "room view" and on the

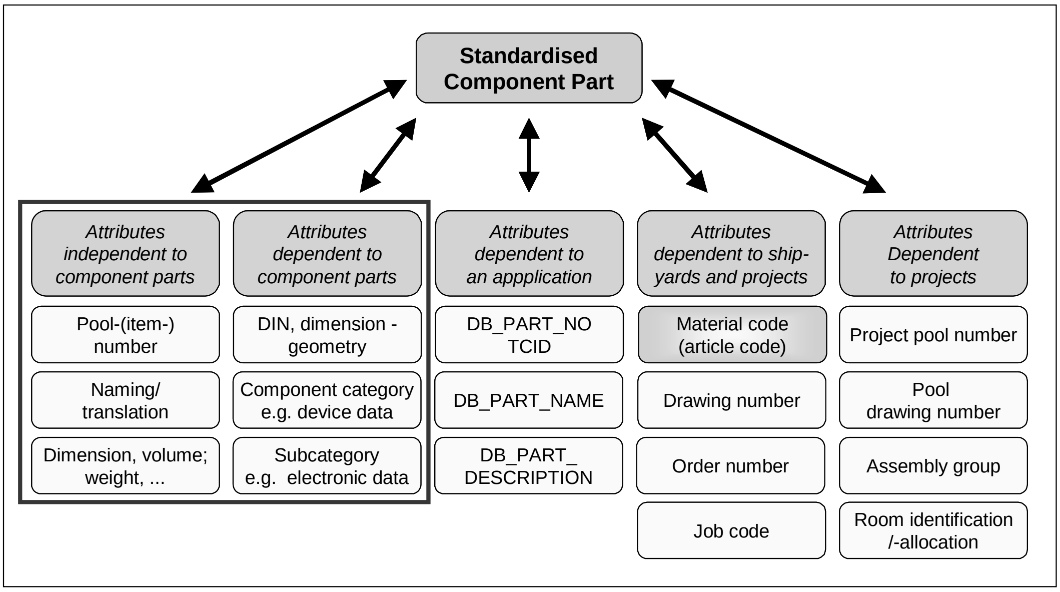

Fig.1. *Attributes for identifying a ship's component parts*

other hand a view on the ship's systems. The room view structures the ship by dividing it into physical rooms as well as into technical rooms, which may completely differ from the physical rooms of the ship. It derives from the following two design elements: (a) the hull of the ship and (b) the main dimensions which are decks and important vertical zonings. The hull of the ship is represented by the ship's body which is created by a planar model. The definition of the planar model is realised by the NAPA system usually used by shipyards for 2-D construction. The generation of the body is realised by a CAD system to which the planar model has been transferred before. The main dimensions are defined by a grid which is valid for all persons involved in the construction process. Higher-ranking rooms, e.g. coordination areas, zones or panels are derived from this grid. By combining the hull and the main dimensions the concept model is created as a basis for the following segmentation of the rooms. By "cutting" the body along the main dimensions and the room zoning working areas could be created which are necessary for construction.

The room view of the ship's cooperation model is mainly needed by concurrent working shipyards to create complete ship units and to define work packages which can be given to engineering companies or suppliers for further elaboration. It presents a basic model for structuring a ship. To exchange data concerning this view the component parts or artefacts to be exchanged are described as data objects. Further more, the built work packages could include structures and arrangements. How a particular work package is integrated into the design environment of the engineering companies and suppliers is decided by themselves. Only the constraints of the work package must be checked to ensure a defined exchanged of the product model data. The results of the elaboration are returned to the principal in a similar work package only containing the results of the elaboration but none of the unchanged data from the original work package. The content covers all of the design results.

Besides the room view a system view for the ship was developed which is especially relevant for the definition of systems by the systems suppliers. It allows a representation of the ship's systems independently from the ship itself. Within this view the ship's component parts can be classified along the systems of a ship like fuels, ventilation, power supply, equipment, etc. The system view allocates a defined structure for data exchange but does not define a generalised system view for all partners of a cooperative shipbuilding project. To create the view on the ship's systems an assembly unit directory is used which gives a unique filing structure for all parties involved in a shipbuilding project. This structure supports the exchange of product data and reduces the time of searching specific parts of a ship's systems. It has to built up individually by every partner of a shipbuilding project who needs a system view for his own work.

The implementation of the structure described needs a hierarchical organisation: Directly beneath the root directory of the ship are the directories of the room view and the system view. The directories within the

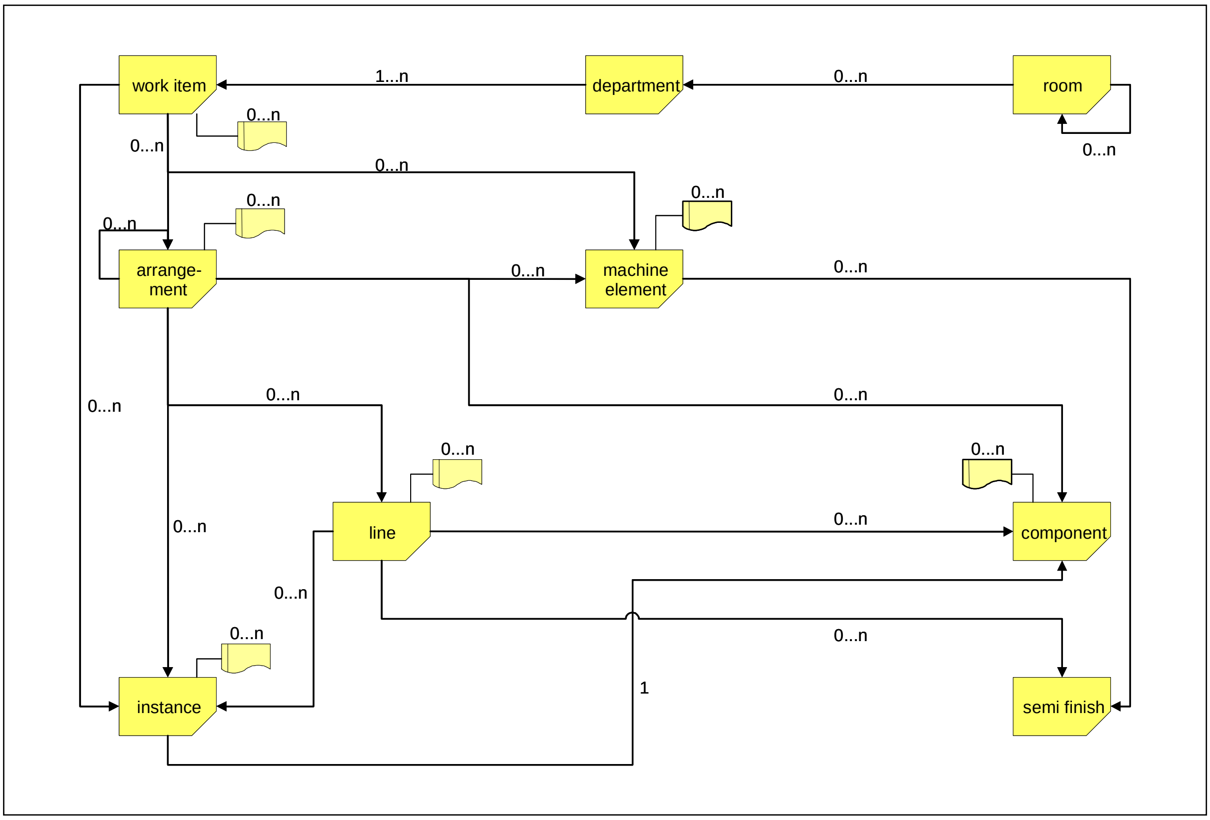

Fig.2. *Assignment of the objects for the room view*

room view directory show the underlying segmentation of the ship (prow, stern, deck, etc.). Lower in this structure there are the directories of the single rooms (e.g. engine room) which are structured along the categories engineering, facilities, coordination and equipment. Within the system view there are directories for the single technical systems (fuels, ventilation, power supply, etc.). Beyond this information concerning devices, configurations and foundations is filed. The connection between the room view and the system view can be realised by allocating a system to a room.

The combination of the key attributes for identifying a ship's component part with the conceived general cooperation model for shipbuilding and its different views lead to a total of 13 data objects that are necessary for defining the work packages exchanged between the concurrent shipbuilding enterprises. The basic attributes valid for every of the defined objects are a identification number, the name of the object, the object description and a values list. The 13 defined objects form a hierarchical structure to organise the product data of the work packages to be exchanged between the enterprises in a well manageable manner. Figure 2 shows the correlations between the specific data objects relevant to establish the room view.

The arrangement of the objects allows a delimited view of the cooperation model that exactly provides the room in which a task has to be fulfilled. To assign a task within a specific room to another enterprise, e.g. a design office or a system supplier, a work package has to be created that is being exchanged between these enterprises through an information and communication platform. On basis of the defined data objects that are necessary for defining the work packages exchanged between concurrent shipbuilding enterprises and on basis of the conceived general cooperation model for shipbuilding with its different views a number of exchange scenarios were set up to test the product data model. Basis for the exchange of defined product data is a XML scheme shown in figure 3 which checks for the correct layout structure of the exchanged product data arranged in the respective work package.

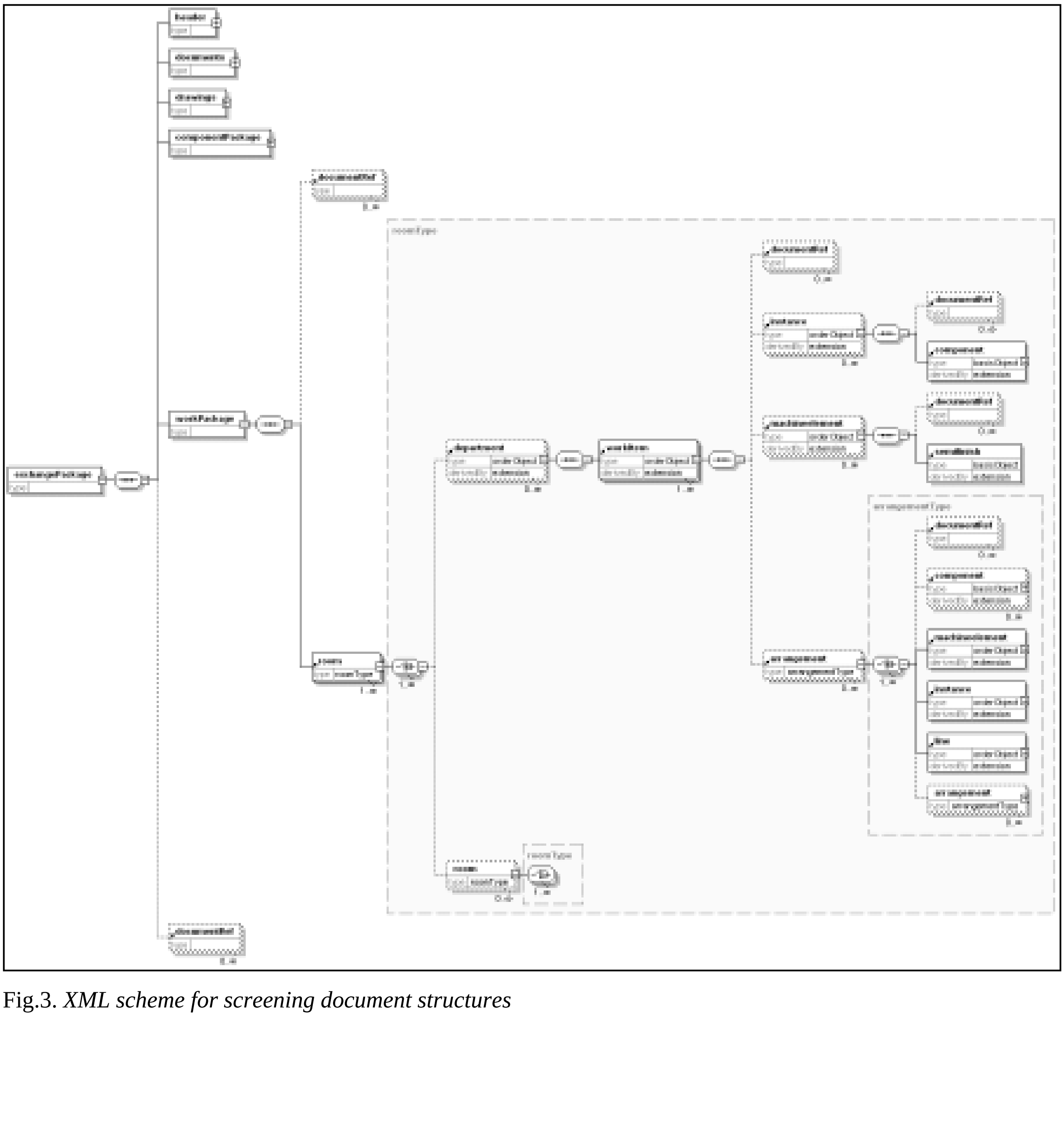

Fig.3. *XML scheme for screening document structures*

5. PRODUCT DATA EXCHANGE

If the work packages exchanged between concurrent shipbuilding enterprises do not follow the structure demanded by the room view of the cooperation model the correct transmission of the product data can not be made sure. To guarantee that no incorrect structured product data achieves the information and communication platform an XML scheme has been developed that screens the layout structure of the XML documents being exchanged (see figure 3). This XML scheme serves as a supervision system preventing the information and communication platform from accepting documents with product data structures that diverge from the defined work package structure. The XML scheme scans the composition of the objects of the exchanged product data to validate the work package. It represents the reference model for the organisation of the exchanged product data. Its structure is linked to the defined structure of the work packages exchanged between the partners of a cooperative shipbuilding project. On its highest level the exchange package is subdivided into a header with the basic information about the exchange package itself, a documents part to refer to all files connected to the exchange package, a drawings part for the organisation of drawing data, a component package used to generate the system view and the work package presenting the room view.

The XML scheme described above represents a product data model for the exchange of a ship's product data defining an exchange package for design and construction. It supports the exchange of product data independent of a specific shipbuilding project as well as the exchange of project specific data. The data exchange will be realised via a information and communication platform accessible through the internet which comprises three main functions to optimise the communication as well as the exchange of product data between the concurrent shipbuilding enterprises. One function already mentioned before is the screening of the layout structure of the exchange packages via the XML scheme presented above. The second function is the structured storage of the work packages and their retrieval through the respective enterprise. Thirdly, there must be a secure correlation of communication via the platform with the exchange package, e.g. if there are modifications or revisions in the work package or in the product data itself [4], or if there is additional need for information.

The output of a product data management (PDM) system, which e.g. could be Teamcenter Engineering (TCE), towards the information and communication platform as well as the export of the product data out of the platform to another PDM system or a computer aided design (CAD) system, which is e.g. AutoCAD (ACAD), is schematically illustrated in figure 4. As shown in this figure, in the first step an export of the product data from the PDM system to a TCE specific XML document is realised. In the second step, this XML document is transformed to a neutral XML document. The layout structure of this document finally is scanned by the XML scheme and uploaded to the information and communication platform, if it is valid. The export proceeding of the product data out of the platform can be described vice versa: In the first step, the product data of a specific exchange package is rescanned by the XML scheme. The created neutral XML document then can be transformed into e.g. a TCE specific document followed by its import into the TCE PDM system or be transformed into the structure of the CAD data system which is directly imported into the e.g. AutoCAD system.

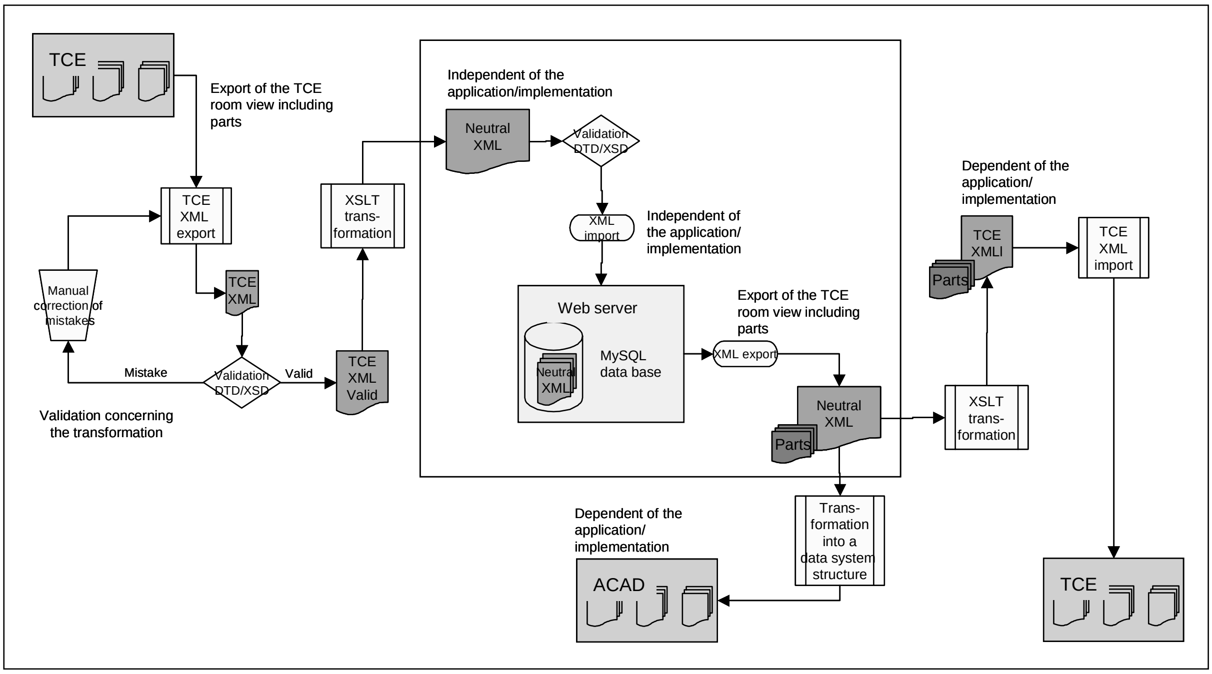

Fig.4. *Product data exchange via the internet platform*

6. CONCLUSION

Especially, the developed product data model helps concurrent shipbuilding enterprises to systematically categorise the complex structures of the product data handled during the life cycle of a ship. The model is of high relevance for realising information technological solutions as well as improving the information and communication structures of cooperative shipbuilding projects. With the suitable communication structure hosted by a communication platform, clearly distinguished construction and design tasks can be transferred to the respective companies fulfilling these tasks, e.g. design offices or system suppliers. The results of the work of these enterprises concerning their work packages have to be retransferred to the coordinating shipbuilding enterprise which integrates these results into the overall context. This integration automatically can be carried out through the communication structure as well. The data exchange will be realised via a neutral XML document with a well defined layout structure. This way, the aimed information and communication platform can be utilised by numerous software applications without losing information.

The relevance of the solution presented in this paper is founded by the fact that more and more shipbuilding projects are carried out through concurrent shipbuilding enterprises to cope with the strong international competition. To make the cooperation of these enterprises work there is a need for exchanging data between them. As a basis for the data exchange, suitable attributes for identifying the ship's component parts and a common structure for handling the exchanged product data was found developed. Further more, a practical product data model has been developed. The approach presented in this paper was very much driven by a German corporate group which actually integrates three shipyards under its roof what indicates the high relevance for industrial practice.

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