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# EXCHANGE OF PRODUCT DATA IN COOPERATIVE SHIPBUILDING PROJECTS

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## 1 Introduction

To cope with the strong world-wide economic competition in shipbuilding industry there is a need for intensive cooperation of different actors (ship builders as well as suppliers) working in highly flexible networks for realising often changing project constellations. To establish a network cooperation between partners working together in a shipbuilding project a practical product data model is needed that allows a speedy and easy data exchange between these partners. The data exchanged describe work packages containing design tasks for specific partners within the network. For the data exchange a suitable communication structure hosted by a communication platform is needed. This paper describes the key attributes representing a ship's component part, a product data model which integrates a so called "room view" and a structure view to a shipbuilding project and a product data exchange structure developed within the NET-S research project.

## 2 Initial Situation

An intensive cooperation of all partners involved in a shipbuilding project is true for all phases of such a project – from conception through design to production of the 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 cooperation between these partners working 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 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 the network partners 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. Consequently, there is a need for defining the technical requirements concerning the identification of a ship's component parts when product data between different partners are exchanged as well as for an ideal product data model for shipbuilding industry which supports the data exchange.

In order to cope with the rising complexity in product development especially in cooperative shipbuilding projects there are some research projects in Germany analysing the current environment and structures of such cooperative shipbuilding projects and finding solutions for improving the quality of data exchange by defining practicable product data models as well as by installing capable information and communication structures. The most important projects researching these topics are called NET-S (www.net-s.org) and ShinCoS (www.shincos.de). So far, the NET-S project in which research institutes as well as shipyards and a supplier for shipbuilding industry participate 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 partners working together in cooperative shipbuilding projects on an equal level (core partners which today mainly are shipyards) as well as between different levelled partners (e.g. shipyards and suppliers) is built up. Similarly to the NET-S project, the focus of the ShinCoS project lies 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 within cooperative shipbuilding projects. 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 cooperation with numerous divers partners in shipbuilding projects. The paper at hand describes the attributes suitable for identifying a ship's component parts as well as 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 shipyards were analysed. Starting from this, in a second step a classification of the 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. These attributes were continued to be differentiated so that only a few attributes remain to be useful for identifying a ship's component parts (cf. figure 1).

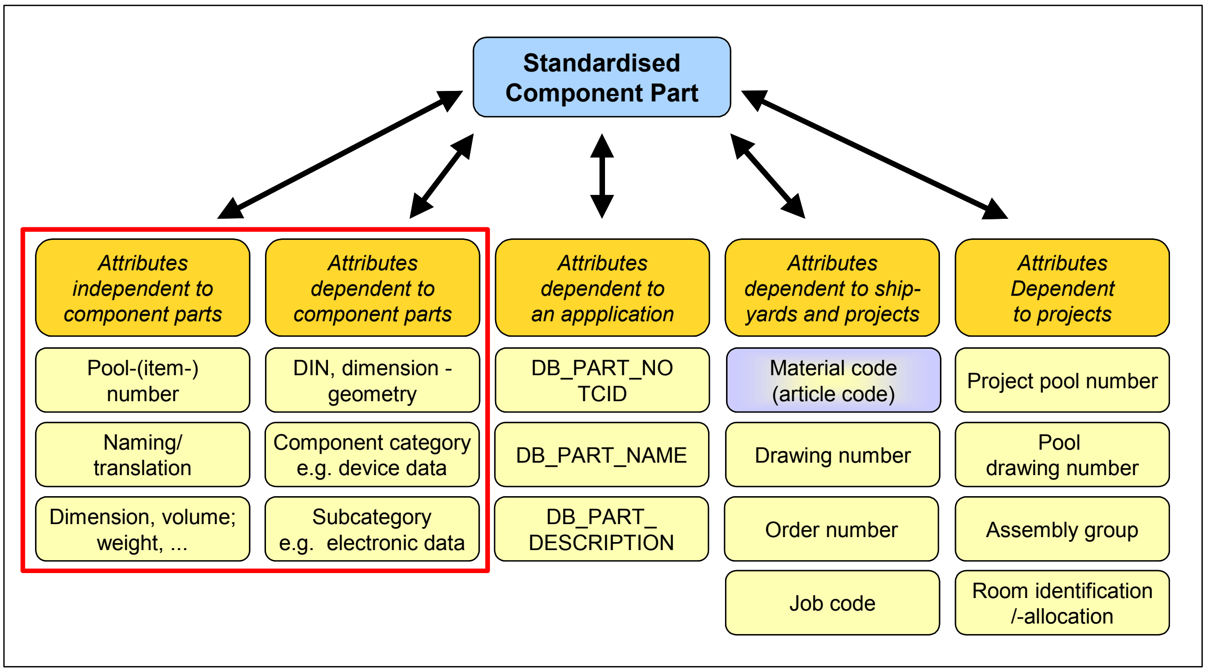


Figure 1. Attributes for identifying a ship's component part

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, 4]. 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. These defined core attributes for identifying ship component parts in combination with the needs and requirements of the industrial companies participating in shipbuilding projects lead to these attributes which are now being used for the exchange of product data within the NET-S consortium. 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 in a shipbuilding project 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 relevant within a shipbuilding project have to be available in a structured and clearly defined model and enable views to the data that supports the design methods of all participating parties. To meet these requirements, the developed cooperation model represents a ship in its state of delivery in different views. For the model the NET-S project [1] has 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 Findings

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 partners of a cooperative shipbuilding project. 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 shipbuilding partners 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 a design office or a system supplier a work package has to be created that is being exchanged between the partners involved through an information and communication platform. On the basis of the 13 defined data objects that are necessary for defining the work packages exchanged between the partners of a cooperative shipbuilding project and 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. The exchange of the product data through the information and communication platform is described in the following paragraph. Basis for an exchange of defined product data is a XML scheme also shown in the following paragraph which checks for the correct layout structure of the exchanged product data arranged in the respective work package.

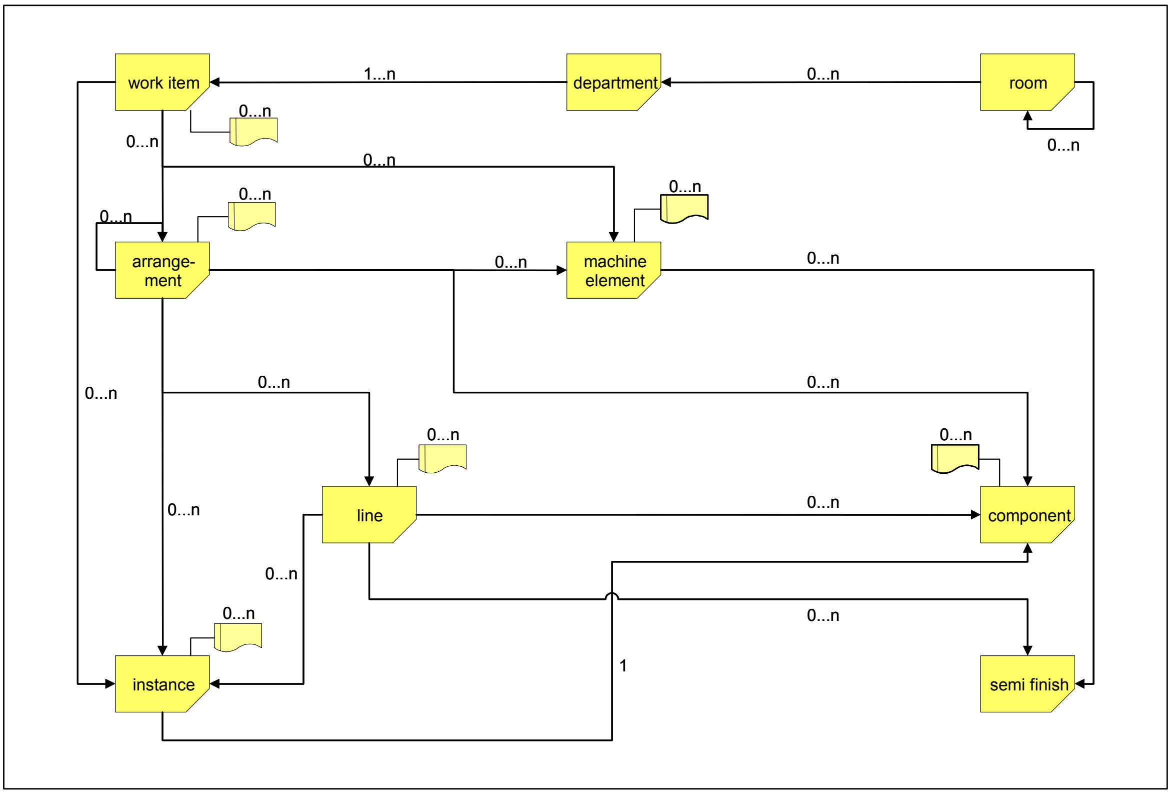


Figure 2. Assignment of the objects

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 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 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.

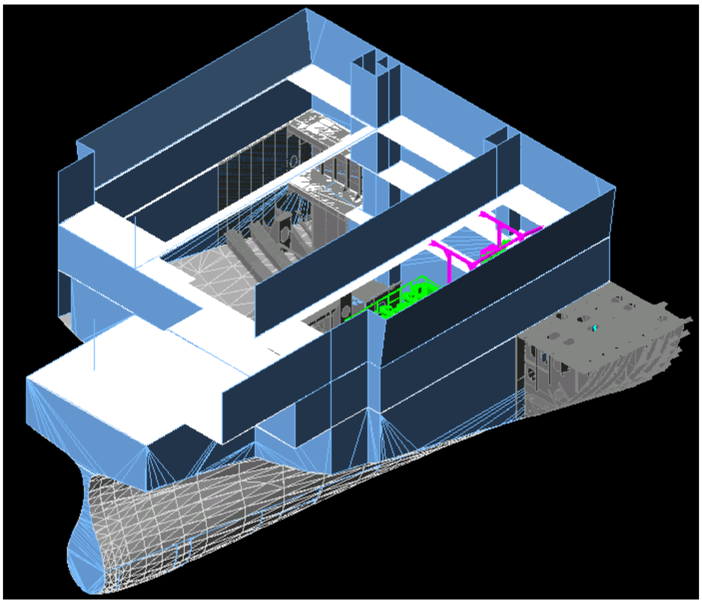

Figure 3. Room view on a Ship's basic model

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 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 system view and room view can be realised by allocating a system to a room.

# 5 Product Data Exchange

If the work packages exchanged between the partners of a shipbuilding project do not follow the structure demanded by the room view of the cooperation model a correct transmission of the product data can not be secured. To make sure that no incorrect structured product data gets into the information and communication platform an XML scheme was developed that screens the layout structure of the XML documents being exchanged. 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". (cf. figure 4).

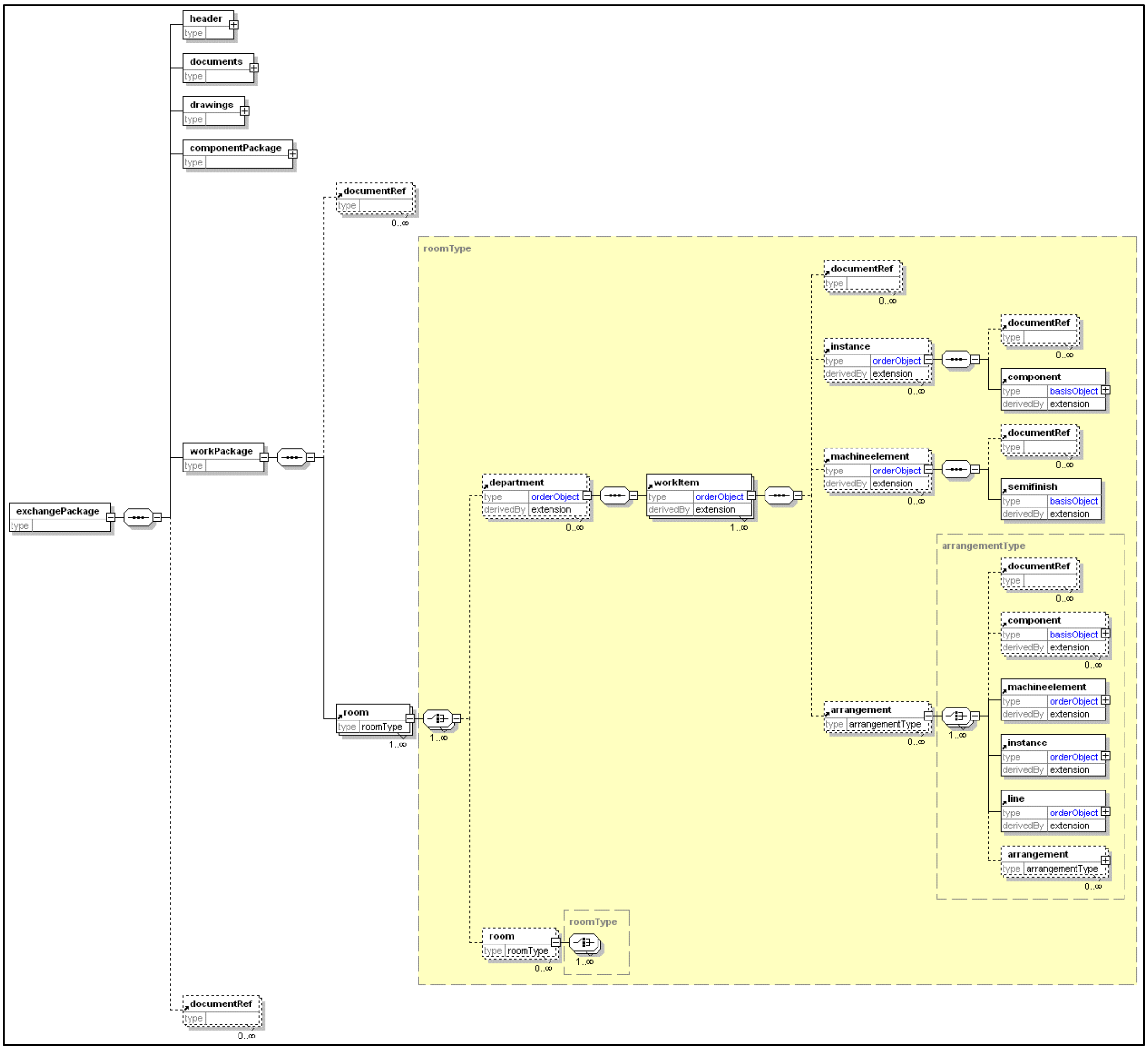


Figure 4. XML scheme of the ship's product data to be exchanged

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. This platform comprises three main functions to optimise the communication as well as the exchange of product data between the partners of a shipbuilding project. 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 partner. 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 [5], 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 5. 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 the neutral XML document which layout structure finally is scanned by the XML scheme and uploaded to the information and communication platform, if valid. The export proceeding of the product data out of the platform can be described as follows: In the first step, the product data of a specific exchange package is rescanned by the XML scheme. This 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.

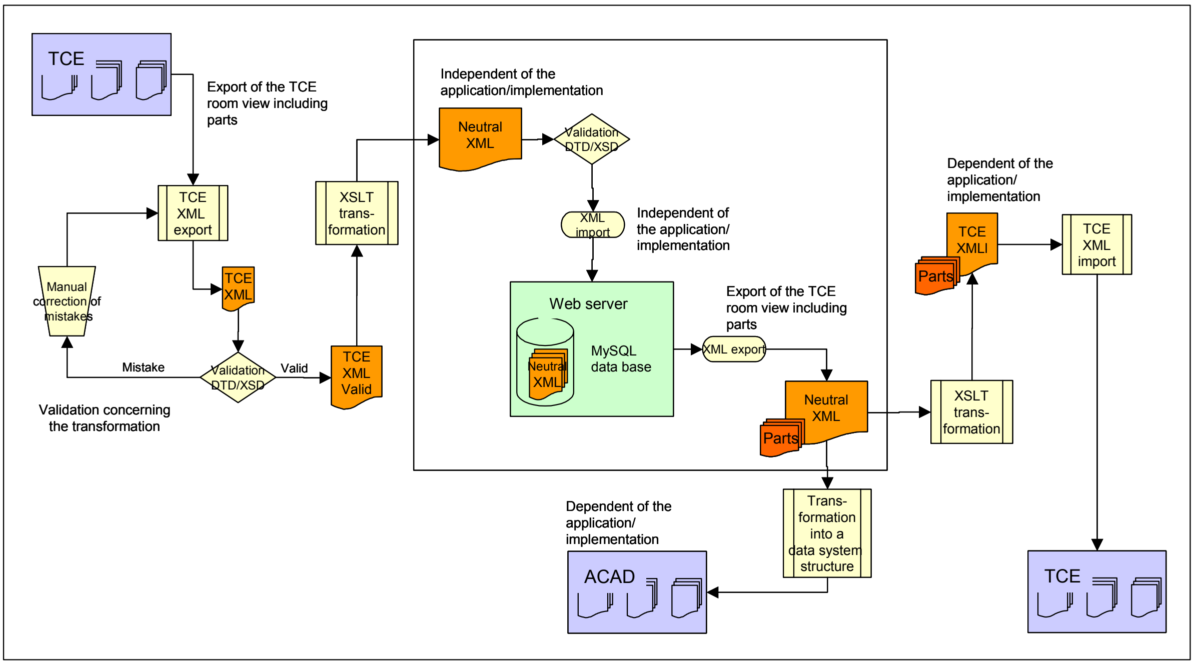


Figure 5. Transfer of product data onto and out of the information and communication platform

# 6 Conclusion

Especially, the developed product data model helps shipbuilding industry 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 engineering companies or system suppliers fulfilling these tasks. The results of the work of these network partners concerning their work packages have to be re-transferred to the coordinating partner of the shipbuilding project who integrates these results into the overall context. It is imaginable that this integration is automatically done 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 solutions presented in the paper at hand for engineering design is founded by the fact that more and more shipbuilders have to cooperate in developing and producing ships to cope with the strong international competition. To make such a cooperation work there is a need for exchanging data between the partners of a shipbuilding project which efforts usable attributes for identifying the ship's component parts and a common structure for handling the product data exchanged. Therefore, a practical product data model is developed. The approach presented in this paper is very much driven by the industrial partners participating in the NET-S project what indicates the high relevance for industrial practice.

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