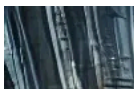
PLM — Main Information Objects for Shipbuilding



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Shipbuilding & PLM | AI-generated by Dall-E

Complex information situation in shipbuilding

It’s tricky to combine the product lifecycle management (PLM) domain with the shipbuilding industry. PLM operates on a limited set of information objects, including products, projects, and documents, and offers a multitude of sophisticated functionalities. In contrast, shipbuilders work with a vast array of complex information objects, such as work process-related structures and document structures and use a relatively limited set of functionalities.

I am engaged in a research project, SEUS, which is funded by the European Ur

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through digitalisation. A consortium of nine partners from Spain, Germany, the Netherlands, Norway and Finland will proceed to implement a comprehensive CAD-PLM software solution, specifically designed to address the unique requirements of the shipbuilding industry. Further information on this innovation action can be found here .

The development and construction of a ship requires the collaboration and digital consistency of complex information throughout its entire ship life cycle. This information is frequently highly interrelated and must be considered from a variety of perspectives and viewpoints in order to meet the necessary requirements (Bronson et al., 2024). The process begins with the initial conceptualisation and design phase and extends through the procurement of materials, construction and integration of systems, and finally to the outfitting of the ship.

What we have and what shipbuilding want

CADMATIC offers CAD design applications for shipbuilding that has been established over years. It covers mainly design phases of detailed planning and outfitting, is customizable and has integrations to other design and production applications. Additionally, CONTACT Software offers a flexible and comprehensive PLM system that is not exclusively tailored to shipbuilding. It is capable of handling large data products and provides comprehensive functionality across the entire product lifecycle.

· PLM for shipbuilding needs to be adapted to ship specific information objects

· PLM must offer processes or best practices for ship design

· PLM must be integrated into ship design tools to collaborate designs and construction

By combining a PLM system with a CAD system and then specialising it for shipbuilding, it presents a significant opportunity to enhance the productivity of every shipyard.

SEUS partners and their data

CADMATIC and CONTACT are decribed before. As shown in the figure, for the initial design of ships, SARC offers as a CAx application for 2D Hull designs, CAE/simulation and analyses. SARC supports engineers and designers to meet customer requirements in the early design phase and can be used by following basic designs in 3D with CADMATIC design applications.

The PLM system following the single source of truth paradigm stores and maintains the master data of theses design applications in a generic product data model. Partners from universities in Finland, Norway and Netherlands research approaches for analysis and data manipulations of shipbuilding data. The goal is to handle complexity in in shipbuilding projects and support the user with valuable insights of high amounts of data. In summary, we have the following main systems for generating, processing and managing information.

1. Primary Data Generation Authoring System

2. Primary Data Management System

3. And Experimental Data Manipulation research

In the SEUS project, additionally to software vendors the shipyards Ulstein and Gondan apply developed shipbuilding integrations, evaluate their functionalities and contribute with best practices in shipbuilding processes. These two users are engaged to provide use cases, thereby facilitating continuous feedback on concepts and the testing of solutions within their daily work routines. The objective of this project is to ensure customer satisfaction. Furthermore, the combination of customisation and research will result in the development of optimal solutions. It is anticipated that these best practices for shipbuilding in the deep will facilitate the transition to the PLM domain for the European shipbuilding market.

First impressions of integrating PLM and shipbuilding

It is evident that the design of a ship requires a significant amount of data beyond that which can be created using CAD tools. In the initial

conceptualisation phase, the predominantly two-dimensional computer-

quantity of models. The creation of an intended geometry design and the subsequent calculation of associated parameters is essential for providing the customer with a comprehensive understanding of the proposed design, including its visual appeal, financial implications and potential avenues for optimisation.

In the initial analysis, the primary PLM data objects are contrasted with the actual information generation within a ship design department. The discussion commences with an examination of the conventional PLM objects and subsequently transitions to an investigation of their parallels in the shipbuilding domain.

PLM standard information objects to work on products

In essence of working with PLM, the creation of a project is triggered by the order, which in turn contains the tasks that will deliver the product. The completion of tasks within the project is indicative of an increase in the maturity level of the product.

A **project** is defined as a discrete entity created for the purpose of managing a specific product. It is not necessary for the product in question to be a unique entity; indeed, different variants of a product may also be created within the context of a single project. In the context of product lifecycle management (PLM), project work entails the delineation of sub-projects, tasks, sub-tasks, or work packages. Such elements are characterised by a temporal sequence and interdependencies, as well as the identification of responsible personnel and the delineation of delivery units. The aggregation of these planning elements typically yields a hierarchical structure, which is known as the work breakdown structure.

Products are composed of individual parts that are related to each other and can therefore be mapped in a hierarchical structure, creating the product structure. Each of these individual parts (BOM items) has its own properties.

The term **document** is employed to designate a container that may contain any type of file. This may include, for example, files created in Microsoft Office, computer-aided design (CAD) documents, or other file formats.

Each of these entities can be hierarchically ordered to form a distinct structure. Furthermore, each structure element can be linked to an object in another structure.

PLM main information object relations

Structures for designing and building ships

In the context of discussing the product and its associated structure within the realm of product lifecycle management (PLM), and in the specific context of seeking a solution within the domain of shipbuilding, it is not feasible to identify a product structure that aligns with the aforementioned definition (Pal, 2015). However, it does offer insights into the various operational structures that are employed in shipbuilding. One notable example is the Ulstein Company, a member of SEUS, which is engaged in the definition of 45 WBS (work breakdown structure) perspectives pertaining to its shipbuilding process. These 45 perspectives provide a personalised view of the 30,000+ design activities. Each activity is specified in more detail by the following properties: Firstly, each activity is assigned to a type: *Task, Drawing, CompletionCriteria* or *TechDoc.* Depending on the type, mandatory properties are specified: It is essential that each of these activity types is assigned a unique identifier and a brief description, or title. Furthermore, activities, tasks, drawings and TechDocs are consistently allocated to a WBS perspective.

It is evident that a methodology for the decomposition of a product of such complexity as a ship does indeed exist. These decompositions are employed in a manner analogous to that of product structures; however, they serve as placeholders for subsequent, tangible physical components. This product decompositions can be understood as PBS (product breakdown structures). (*ISO 10303–215, Industrial automation systems and integration — Product data representation and exchange Part 215: Application protocol: Ship arrangement*, o. J.)

The commonality among these PBS is that the attribute pertains to spatial considerations. The requisite functions for these spaces are defined and fulfilled by a multitude of systems. Consequently, the system structure is also a crucial PBS.

Solutions for main information object in shipbuilding

The principal information objects of Product Lifecycle Management (PLM), namely project tasks, document types and product structures, have also been identified in the context of shipbuilding. The following challenges and solutions have been identified:

1. **Project** tasks: In the context of PLM CONTACT Project Management, the term “project” encompasses not only the primary project itself, but also any sub-projects, tasks, and sub-tasks that may be associated with it. Furthermore, the utilisation of checklists and open points facilitates the planning, management and control of a project. Therefore, it was necessary to transform the task list into a more complex, hierarchical structure. The challenge was that not every project task was associated with a group, phase, or sub-project. The aforementioned entity had reference up to 19 WBS perspectives. To address this issue, the Universal Classification was employed, for instance, in the context of the SFI perspective.

2. **Documents**: The CONTACT document management functionality is based on three fundamental principles: the categorisation of documents, their assignment to a specific task within a project, and the utilisation of search functionality with document metadata. Similarly, the documents, in this case drawings, are originally grouped to 19 WBS perspectives. However, a new structure of customer-specific document types will facilitate greater organisation and clarity.

3. the **Product** structure: In order to be able to use the entire Contact Virtual

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C e have found a large number of product breakdowns into different process phases or work areas. We will solve this by using attributing classes that can be developed individually according to the customer's needs.

These attributing classes can extend the product structure (which in this case will only consist of the system structure, as this contains real physical components and thus corresponds to a BOM item) and thus generate the required perspectives as required. Overall ship design is an interdisciplinary development with complex products. Product structure must be multi-dimensional and integrated in work break down structures.

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