An Enterprise Modeling Approach for the Early Ship Design

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Summary

The global maritime market is characterized by an increased competition between shipyards. This imposes shipyards to permanently develop their design methodologies in order to efficiently achieve the design studies especially those related to the early design phase. This can be attributed to two reasons, the first is related to the great influences of these studies on the entire design process, and the latter is connected to the fact that the results of these studies are the basis on which the offer in the tendering process will be built. Therefore, the efforts of this research are subjected to the development of an approach to enhance the early design phase. In order to efficiently achieve this target, an analysis of the early design phase regarding its importance, complexity and its research-needs comparing to the remained design stages, are discussed in detail. Thereby, the aspects, which can be considered the key development aspects within the early phase such as the decision making, the data-reuse, data exchange and design constraints, are introduced regarding their needs and drawbacks with respect to the current state of the ship early design process. In order to enhance the analysis and complete the picture of the current state of the ship design, the international standards, which are concerned with the structuring of the data related to the ship, are reviewed. With the review of many published approaches, the objective of this research is further refined in so far as to concentrate on the enhancement of the following interactions with respect to the early design phase: data-data, data-process and process-process.

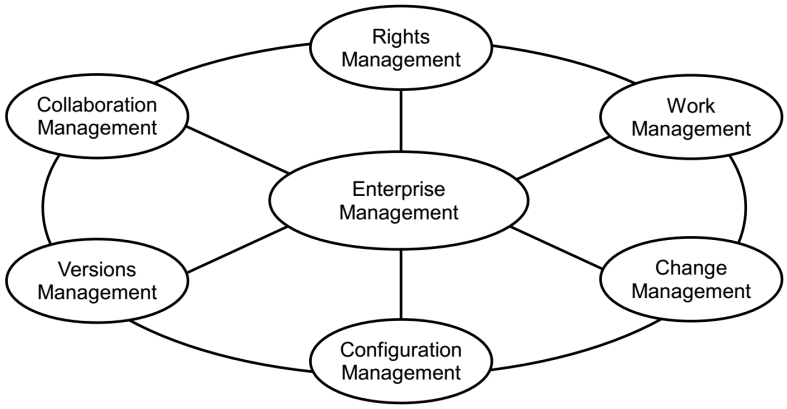

Figure 1: Enterprise Management functions

Based on the definition of the enterprise, which is compatible with the domain of system design engineering, several concepts regarding the modeling as well as the management of an enterprise are introduced and discussed. Here, methods of modeling data and process perspectives of an enterprise are introduced. Thereby, a special attention is paid to integration concepts within an enterprise. The core enterprise management concepts, which are Configuration Management, Change Management, Version Management, Work Management, Rights Management and Collaboration Management, are introduced with regard to their main characteristics.

Depending on these theoretical basics, an Information Model for the ship in the early design phase is developed and introduced. It represents the data perspective of the adopted enterprise modeling approach.

Thereby, the information, which are modeled, reflect three areas: Ship Product-information, Support-information and management-information. These three types of information are organized in many packages according to the function or concept which they serve. Each of these packages includes one or more information objects. These objects are interrelated to each other. The associations are modeled with two main objectives in mind, to insure the data-consistency concept and to guarantee and support the data-data interaction concept.

With the development of the activity management package, the notion Predefined Activity is introduced. It represents the major concept used throughout to model the tasks related to the early ship design phase. Each of the predefined activities is further subdivided in *ActivityPartition(s)*. *ActivityPartitions* are interacting with the information objects by means of *ActivityPartitionItem(s)*. In this context, the activity management package represents the foundation, which guarantees the reflection of the data-process as well as process-process interaction concepts within the ship information model.

The process perspective of the enterprise modeling approach represented by the ship's early design process is. The tasks related to the early design phase are analyzed and formulated according to the ICOM-concept regardless of the tools used to perform these tasks. This analysis is used to represent the early design tasks as *PredefinedActivities*. Each of these *PredefinedActivities* is analyzed by the definition of a *ConfigurationItem*, which reflects the Configuration Management-concept and represents a combination of all *ActivityPartitionItems* interacting with the *ActivityPartition(s)* related to a specific early design task represented as a *PredefinedActivity*. Thereby, the Status-concept is integrated supporting the combined items (represented by the *ConfigurationItem*) with the decision dimension. Moreover, *PredefinedActivities*, which reflect the process perspective of the developed management models, are introduced. For example, three *PredefinedActivities*, which are Check Change Influences, Request Change and Approve/Reject Requested Change, are showcased to discuss the Change Management capabilities.

In order to illustrate the benefits of the developed models, they are translated in the information processing system level by means of the following techniques: Python as Object Oriented Programming (OOP), SQLite as Relational Database Management System (RDBMS) and SQLAlchemy as Object Relational Mapping (ORM). Thereby, the developed Ship Information Model is set up in a database and the Predefined Activities are implemented in UseCases. These implementations are integrated in a Ship Early Design System. During the implementations the fact of the variety of scenarios, which can be used to perform an early design task, is taken into consideration. While realizing this fact, three types of the interactions with external tools, such as AVEVA ID-system, ν-Shallo tool, etc. are introduced. Moreover, tools for the 3D-Compartmentation and the creation of hull-forms based on available ones are implemented. The developed system endorse the dynamical and the collaborative nature of the ship's early design phase by accounting for the numerous interactions between early design tasks and by ensuring of the key aspect, which can be summarized as follows: Providing the key persons with the key data at the right time. Fur-

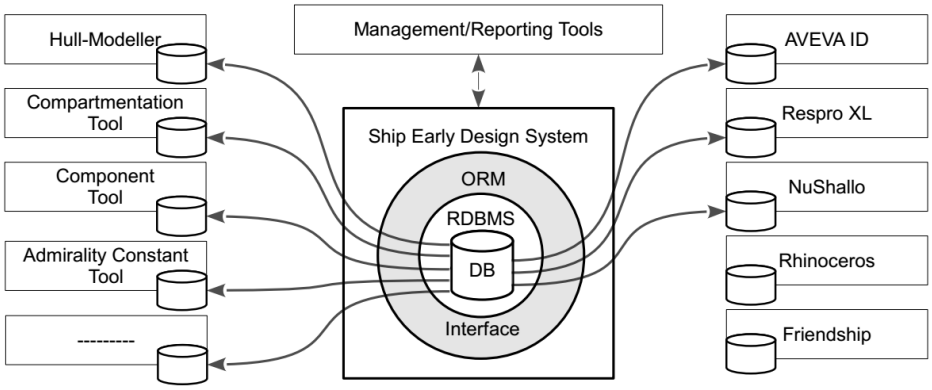

Figure 2: Ship Early Design System integrated with Shipyard's Workbench

thermore, the consistency of the multiple representations of a design object is thereby insured. In order to evaluate the efficiency of the developed Ship Early Design System, it is integrated in a shipyard design workbench. The developed system is used to perform studies related to the early design of a RoRo-ship and the results are represented. Thereby, examples of the system-advantages; such as Create Design Solution, Versioning, etc. are introduced.

The Ship Early Design System offers a means to increase the efficiency of performing the early design studies by making use of the functionalities provided by different tools. Thereby the developed system plays a central role in management of the data-transfer between applied tools by providing a central database. The interactions between the system and the applied tools can be implemented in different ways depending on the tool-characteristics. It should be noted that the applied tools within this thesis are just example tools of an assumed shipyard to reflect the applicable nature of the developed approach, they can be replaced by any other tools in order to take the diverse software infrastructures of shipyards into consideration.

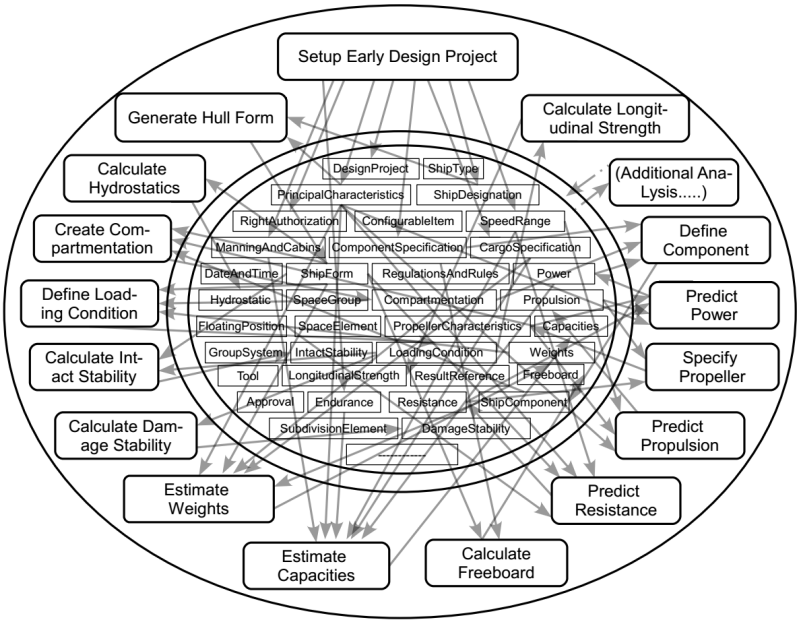

Figure 3: Ship Design Predefined Activities

Moreover, the developed system accounts for the collaborative nature of the early design phase by the efficient control of the interactions between different design tasks and accordingly between the responsible design team members. The performing of any design task represented as a *PredefinedActivity* is started by an automatic procedure to detect the available data within the central database, which are required to perform the task. This is followed by automatically informing the responsible user about the achievable task-scenarios at that point of time. In this context, a periodical checking of the available data in the central database (such as each one hour) and accordingly informing the responsible users about the achievable tasks can be developed. Furthermore, performing a design task is always finished by the definition of a *ConfigurationItem* and by informing the concerned users about the new data available.

Finally, the introduced Enterprise Approach offers a means to enhance the integration dimension of the early design phase with the following phases. Here, a development of the Ship Information Model to consider more and more details is possible. This can be used, for example, to account for a shipyard perspective regarding the design requirements. Expanding the information model and accordingly the set-up database to play a central role through the entire design life-cycle could be a solution for many drawbacks regarding the design process as of today. Thereby, adding new design tasks with respect to the adopted *PredefinedActivity* concept and accordingly implementations of new UseCases to cover the new tasks (*PredefinedActivities*) can be achieved.