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# A study for production simulation model generation system based on data model at a shipyard

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**Abstract**

*Simulation technology is a type of shipbuilding product lifecycle management solution used to support production planning or decision-making*. *Normally*, *most shipbuilding processes are consisted* of job shop production, and the modeling and simulation require professional skills and experience on shipbuilding. For these reasons, many shipbuilding companies have difficulties *adapting simulation systems*, *regardless of the necessity for the technology.* In this paper, the data model for shipyard production simulation model generation was defined by analyzing the iterative simulation modeling procedure. The shipyard production simulation data model defined in this study contains the information necessary for the conventional simulation modeling procedure and can serve as a basis for simulation model generation. The efficacy of the developed system was validated by applying it to the simulation model generation of the panel block production line. By implementing the initial simulation model generation process, which was performed in the past with a simulation modeler, the proposed system substantially reduced the modeling time. In addition, by reducing the difficulties posed by different modeler-dependent generation methods, the proposed system makes the standardization of the simulation model quality possible.


*Keywords:* Modeling and simulation; Digital shipbuilding system; Simulation model generation; Shipyard data model; Panel block assembly shop; Shipbuilding

## 1. Introduction

Today's shipbuilding industry is facing a serious depreciation as a result of being severely affected by the current global economic recession. Because of low ship prices, small-and-medium shipbuilding companies are experiencing liquidity crises, and even large shipbuilding companies are threatened by the competition from emerging shipbuilding countries. To counteract these situations, many shipbuilders are turning their attention to high value-added lines, such as offshore plants or drill ships. They are increasingly upgrading their operation capacities from the traditional management system with commercial vessel-centered structures and databases to a system that prioritizes the development of new high value-added vessel types. In particular, shipbuilders are placing their effort into establishing a strategically efficient production system that integrates new production technology with the Advanced Planning System (APS) and the Manufacturing Execution System (MES) (Song et al., 2011).

This paper presents a method for the simple and systematic application of modeling and simulation that has been attracting attention as a new production support system. Extensive research has been conducted on manufacturing simulation designed to set up plans with high accurate capable of predicting imminent production-related problems (Woo et al., 2009; Wang et al., 2009). Considering the simulation of the

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evaluation of the shipyard panel line capacity as an example, shipbuilding expert analysis of the target factory or line is required, followed by long-term modeling by a specialized simulation modeler. Sophisticated modeling should be performed by a modeler with corresponding background and experience. Because most shipbuilding companies do not have adequate human resources, modeling projects are usually implemented by modeling specialists based on commission. Against this background, this study is intended to develop and present an automated simulation model by redefining the shipbuilding-related data from the simulation perspective, and developing a system based on the data obtained thus far.

For the development of an automated simulation modeling technology, three structural components should be established: a data model with definitions based on the shipbuilding data, simulation control scripts for simulation modeling, and an interface system for simulation software monitoring. Research into simulation automation techniques began in the 2000s with the National Institute of Standards and Technology (NIST) as the leading institute. A variety of practical studies have been reported ever since. Lu et al. (2003) proposed a simulation interface specification for automatic factory modeling for the aircraft manufacturer Boeing. Harward and Harrell (2006) created a neutral file for simulation based on the NIST shop data model and validated its efficacy. More recently, with the development of the neutral simulation schema (NESIS), which integrates related systems by analyzing a range of simulation software architectures and previous studies on simulation data models for the assembly line production industry, a web-based model exchange service was presented (Lee et al., 2011a). A practical interoperability technology that offers integration of heterogeneous software components was implemented using a simulation data model, thus verifying the efficacy of the simulation data model.

Fig. 1 presents the NESIS simulation data model where the data required for simulation are structured in an integrated system that consists of three model elements, namely: a) product, process, and resource, b) configuration for simulation model environment setting, and c) Sim_List structured based on the routing data of the model elements. In this model architecture, the structure for the product, process, and resource is the part that can express the simulation software data in sharable formats, thus posing no difficulties for general factory simulation. The specialized routing expression part is addressed by the Sim_List structure. However, in the shipbuilding industry that constitutes the research object of this study, job shop type processes typically occupy the bulk of the entire operation, and schedule-related data occupy a large proportion of the system. This particularity and the high number of resources that influence the process steps act as limitations for expressing the shipbuilding process simulation with the NESIS architecture. To overcome this difficulty, this paper explores a NESIS-based improved simulation data model that considers the product, process, layout, facility, labor, and scheduled data, specific to the shipbuilding production system. Subsequently, a case study is conducted in a field situation to validate the data model and test the application method.

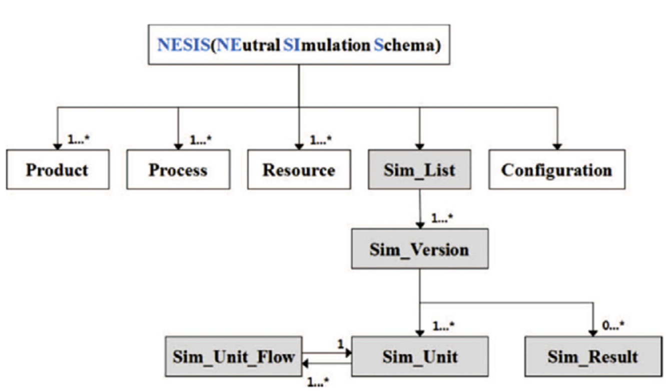


Fig. 1. Simulation data model schema for NESIS (Lee et al., 2011b).

## 2. Background of automation technology for shipbuilding simulation modeling

In most cases, the simulation for product development or design is embedded in the corresponding Computer Aided Design (CAD) tool as a module. Correspondingly, the simulation does not require an additional module for data conversion, mapping, or system control, unless a separate simulation tool is employed. However, in the case of production simulation, such simulation should run based on data other than product information, such as information on equipment, resources, and production and project schedule (Watson et al., 1997). To address this limitation through the application of the simulation technology to a shipyard field situation, Song et al. (2009) established a simulation model that supports detection in advance and solution of the problems likely to occur in a block assembly factory. However, problems arose in the process of field application of the relevant technology by the field manager after learning the necessary technique, merely because the application of such technique greatly depends on the skills of the simulation modeling engineer. This experience made it clear that a simple “foolproof” application method should be developed so that even a manager without sufficient knowledge of simulation technology can create and manage simulation models.

Woo (2005) defined the simulation model generation procedure in three major steps, as shown in Fig. 2, while conducting a study on the simulation methodology for the prediction of shipyard productivity. In step 1, the problem to be identified or solved is formulated, the system generation project plan is set up, and the system goal is defined. In step 2, input data necessary for the simulation model generation is collected, the collected input data are analyzed to allow the definition of the data for the simulation, and the simulation model is specified based on the analyzed data. In step 3, the simulation model is implemented for productivity prediction, followed by validation and verification. Information pertaining to the simulation goal defined in step 1 is extracted by applying the simulation model constructed. A simulation model is generated by following this series of processes and sub processes. In consideration of the time requirements, although the time required in step 1 for formulating the problem and defining the goal of the simulation model generation is inevitable, the time