Design of an Integrated Production Planning System Framework Based on Simulation Using a Production Information Model

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ABSTRACT

Due to intrinsic variability and uncertainty of the Engineer-To-Order (ETO) industry, it is difficult to establish accurate plans. As for the shipbuilding industry, a representative ETO industry, enormous size of finished product and different required information by product make it even harder to establish an accurate production plan. To conduct accurate production planning, simulation is adopted to production planning. However, it is impossible to apply this simulation directly. Therefore, this paper defines an integrated production planning information model for production planning and simulation. Finally, an integrated shipyard production planning system framework was developed and applied to real production planning.

KEY WORDS: Engineer-to-order industry; shipbuilding production planning; simulation; information model.

INTRODUCTION

Research Background

The intrinsic variability and uncertainty of the project-based Engineering-To-Order (ETO) industry makes customized design and production planning very difficult, even though they are required in the ETO process. In an ETO manufacturing environment, various products are simultaneously manufactured at different stages in order to satisfy different customers' demands. Thus, production planning is a very difficult task in the ETO industry (Rahim and Baksh, 2003). In the shipbuilding industry, which is a representative ETO-type industry, it is very important to fulfill customized orders and to accommodate dates of delivery. The importance of production planning is highly emphasized because it is the first step of the Plan-Do-Check-Act (PDCA) (Deming, 1986) cycle for process or quality improvement. Shipbuilding production planning plays a crucial role in connecting design and production, and includes not only a planning stage where the long-term vision and strategies of a company are established but also a scheduling stage where manpower and facilities needed for real production are allocated. The objective of production planning is to determine an optimal plan that can reduce the duration of production, save money, and improve productivity by realizing load leveling, an optimized capacity utilization rate and turnover ratio, and by minimizing stock and work-in-process(WIPs). Unfortunately, the end products of the shipbuilding industry have a much larger scale than those of other industries, and necessary information for production planning varies by product. Accordingly, establishing an accurate shipbuilding production plan is a challenging task. Various research studies have been carried out to overcome the difficulty of shipbuilding production planning. After the concept of Work Breakdown Structure (WBS), which covered the entire range of a project as well as planning and management, was introduced into the Japanese shipbuilding industry, Ishikawajima-Harima Heavy Industries (IHI) regarded a ship as a project and developed Product WBS (PWBS). This was a classification system for shipbuilding works (Okayama and Chirillo, 1980). Another research study utilized the PWBS system to develop the Generic Product-oriented Work Breakdown Structure (GPWBS), which was an improved version of WBS that used a product-oriented combination of stage and work type (Koenig et al., 1997). Since the 1990s, South Korea became one of the leading countries in the research of production planning as its competitiveness in the global market was increased due to cost advantages and facility expansion. One study attempted to apply the expert system to production scheduling (Lee et al., 1995). Integrated process planning and scheduling system was also developed, which was able to consider loads in block assembly process (Cho et al., 1998). An optimization study considered the determination of an erection network as a Traveling Salesman Problem (TSP) and adopted a genetic algorithm (Varghese and Yoon, 2006). In addition, as simulation have been implemented in the shipbuilding industry, the pre-verification of production plans has become more emphasized. With regard to simulations for verifying production plans, one study established a general-purpose shipyard computer model for supporting production planning (Chung et al., 2000). Another study performed the modeling and simulation of a subassembly line of a shipyard (Shin et al., 2004). Additional research established a