Study on Scheduling of the Planning Method Using the Web-based Visualization System in a Shipbuilding Block Assembly Shop

A. Eui Koog Ahn, B. Gi-Nam Wang, C. Sang C. Park

***Abstract*—**Higher productivity and less cost in the ship manufacturing process are required to maintain the international competitiveness of morden manufacturing industries. In shipbuilding, however, the Engineering To Order (ETO) production method and production process is very difficult. Thus, designs change frequently. In accordance with production, planning should be set up according to scene changes. Therefore, fixed production planning is very difficult. Thus, a scheduler must first make sketchy plans, then change the plans based on the work progress and modifications. Thus, data sharing in a shipbuilding block assembly shop is very important. In this paper, we proposed to scheduling method applicable to the shipbuilding industry and decision making support system through web based visualization system.

***Keywords*—**Shipbuilding, Monitoring, Block assembly shop, Visualization

I. INTRODUCTION

DURING this time of global recession, the shipbuilding industry is exerting much effort to make profit, thus gradually intensifying industry competition.

As ships are built based on the Engineering to Order (ETO) system, the shipbuilding industry must accommodate more customer requirements and higher product complexity than other industries [1]. Thus, design changes by customers are frequent.

Furthermore, the shipbuilding industry is labor-intensive, and the skill level of its workers has a great impact on their productivity [2]. Consequently, it is more difficult to calculate the processing time for production in such industry than in other manufacturing industries.

Moreover, as it takes long to produce a ship [2], unitary and consistent management throughout the process of design and production is required for the successful production of ships [3].

A. Department of Industrial Engineering, Ajou University, San 5, Woncheon-Dong, Yeongtong-Gu, Suwon 443-749, Korea (corresponding author; tel: 82-031-219-2429; fax: 82-031-219-2983; e-mail: euikoog@gmail.com)

B. Department of Industrial Engineering, Ajou University, San 5, Woncheon-Dong, Yeongtong-Gu, Suwon 443-749, Korea (e-mail: gnwang@ajou.ac.kr)

C. Department of Industrial Engineering, Ajou University, San 5, Woncheon-Dong, Yeongtong-Gu, Suwon 443-749, Korea (e-mail: scpark@ajou.ac.kr)

It is difficult, however, to identify field performance data such as the work progress and the loading rate because such data are not properly entered into the Computer-integrated manufacturing (CIM) system. Therefore, the establishment of schedule plans in the shipbuilding industry depends mostly on the experience of the scheduler.

As a result, if the scheduler unexpectedly changes the schedule, the delivery deadline will not be met due to missing parts or work overload, and the ship production cost will rise due to overtime work.

Many attempts have been made to develop a system for shipbuilding schedule planning. Kwang-Kook Lee [4] and Sang-Dong Han et al. [5] studied the development of a simulation-based scheduling system for the panel line. Yong-Seob Kim et al. [6] studied the development of a detailed scheduling system for the dock process [6]. Hun-Hee Yoon et al. [7] developed a shipbuilding process monitoring system by applying the theory of constraints, and proposed a method of intuitively showing the progress of the shipbuilding process. These studies, however, proposed scheduling and monitoring methods based on accurate acquisition of performance data from the field. Therefore, the accuracy of the systems will be low if inaccurate data are received from the field.

Chapter 2 of this paper introduces the assembly shop and the current method of scheduling planning.

Chapter 3 proposes a scheduling method for the shipbuilding industry and suggests a decision-making support system through a Web-based visualization system. Furthermore, this paper developed a web-based visualization system.

Chapter 4 summarizes the conclusions and future tasks.

II. SCHEDULING IN A BLOCK ASSEMBLY SHOP

A. Assembly Shop Introduction

Typically, 300-500 large assembly blocks are required to build one ship. These large assembly blocks are produced through the small and medium assembly processes, as shown in Fig. 1.

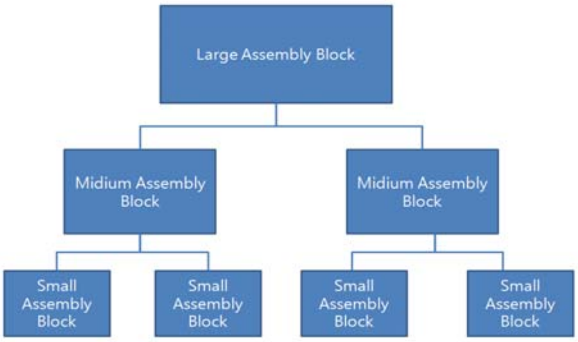

Fig. 1. Method of block assembly

The assembly shop featured in this study produces 70-80 large-assembly blocks, more than 260 medium-assembly blocks, and approximately 700 small-assembly blocks per month, on the average. The processes are divided into small, medium, and large assemblies. Each process consists of detailed tasks, such as main-plate arrangement, longitudinal and erection. Each detailed task in turn consists of fitting, welding, and gauging, which the workers carry out as shown in Fig. 2.

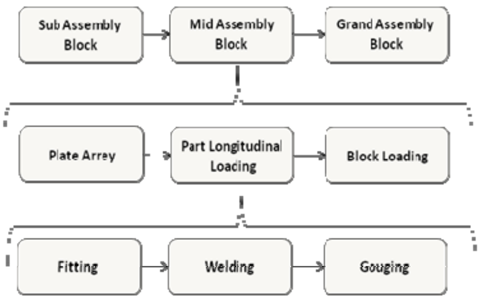

Fig. 2. Process of block assembly

B. *Current Method of Scheduling Planning*

The current scheduling planning method in assembly shops follows the process shown in Fig. 3. On the other hand, the master scheduler makes decisions based on large assembly blocks. The production scheduler makes monthly schedules based on the master schedule.

At this time, the production scheduler gets the master schedule from the CIM system of the database. Then the production planner uploads the monthly schedule to the CIM system of the database. Thereafter, the staff of each shop makes the weekly plan. Then the field workers execute the weekly schedule.

At this point, the master schedule and the monthly schedule are saved in the CIM system of the database, but thereafter, they are no longer saved in the CIM system because the weekly schedule changes due to the field data.

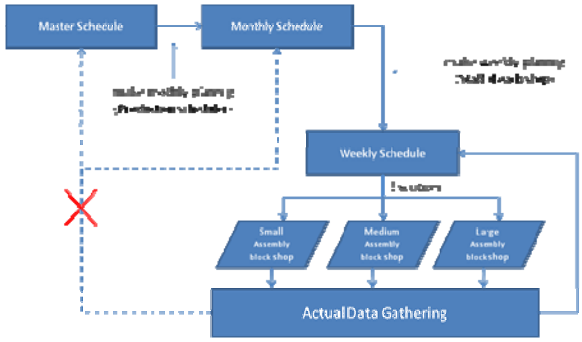

Fig. 3. Process of scheduling planning in an assembly block shop

At present, the field workers are required to enter the performance data into the CIM system, but they do not do so because they are required to do it after their regular working hours and because entering such data is cumbersome.

Even if the field workers enter their performance data, they distort these and enter average values because they are worried that the data will be reflected in their performance evaluation. Thus, the entered data differ greatly from the actual data.

To address this problem, the staff members in charge of the production process investigate the work progress each morning. The investigation results are maintained with the MS Excel application, a legacy system, and are shared in process meetings held at least twice a week.

As a result, data sharing meetings need to be frequently held. Also, the field performance data must not be shared with the production scheduler. As a result, the production schedule differs much from the actual data.

III. Suggested Scheduling Planning Method

A. *Scheduling method applicable to the shipbuilding industry*

Due to the characteristics of the shipbuilding industry, such as frequent design changes, high product complexity, and the high influence of the skill level of the workers, it is impossible to establish schedules through computer-centered methods, which automatically generate schedules. Thus, the shipbuilding industry must adopt the human-centered virtual manufacturing approach [8], which supports the decision-making by the schedulers based on their experience and knowhow.

Moreover, it is difficult to establish accurate schedules and to abide by them because frequent changes occur during the production of ships. Therefore, as shown in Fig. 4, the schedulers must quickly establish a schedule using their experience and simple reference data, and the changes in the field must be shared to facilitate the modification of the schedule.

Furthermore, the system must be established in such a way that when the work is performed in accordance with the modified schedule, the performance data are collected by the performance data sharing system so that the data can be used when the next schedule is established.

Therefore, to establish a schedule plan in a manner applicable to the shipbuilding industry, sharing accurate performance data from the field is most important.

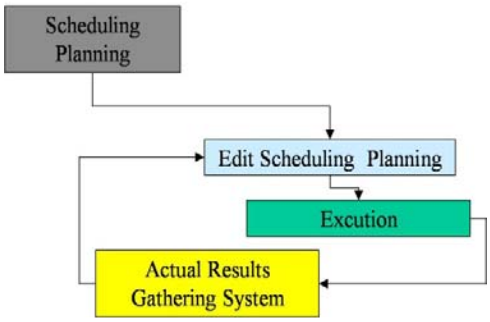

Fig. 4. Scheduling method for shipbuilding

B. Method of a Web-based Visualization System

In this paper, a decision-making support system through a web-based visualization system is proposed and developed.

This system includes the database (DB) for the connection system. The data acquired from the field are sent to the DB using the Object Linking and Embedding (OLE) DB.

The DB data are also sent to an MS Excel application using the OLE DB. Then the DB is shared through the Web, which makes the field data easy to identify.

In addition, the DB data and the CIM system are connected by the OLE DB.

This system is shown in Fig. 5.

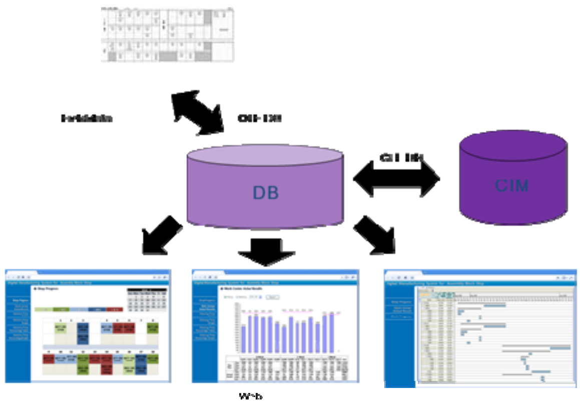

Fig. 5. Web-based visualization system

The user interface (UI) of the developed web-based visualization system is shown in Figs. 6-8.

Fig. 6 shows the progress of the blocks by shop in different colors, and the shop share rate by day.

Fig. 7 shows the loading rate by work center. The quantity of the weekly schedule and the quantity of the actual results are compared.

Fig. 8 shows a Gantt chart of the progress by block and the delay time of the blocks.

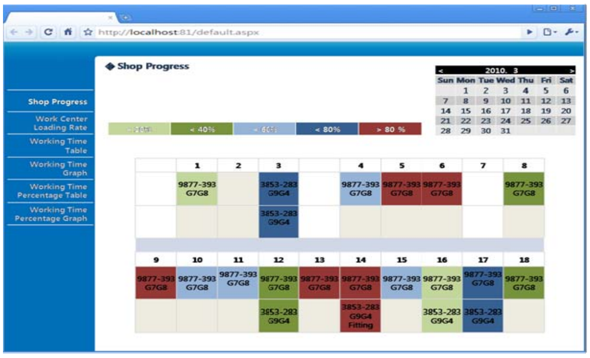

Fig. 6. Progress of blocks by shop in different colors

Fig. 7. Loading rate by work center

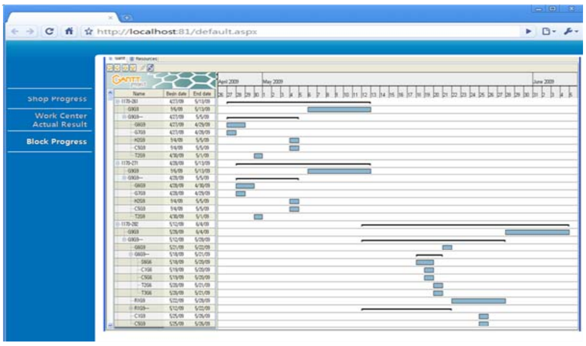

Fig. 8. Gantt chart of progress by block

IV. Conclusions and Future Studies

The shipbuilding process faces frequent changes, and the changes in the field must be actively reflected on the schedule plan rather than setting up a fixed plan once and sticking to it. For this purpose, a monitoring system must be developed, which obtains field performance data as accurately and quickly as possible. Although performance data sharing is difficult, a performance data sharing and monitoring system is very important.

In this paper, a scheduling method that is applicable to the shipbuilding industry was proposed.

Furthermore, this paper proposed a method of saving the acquired data into a DB and sharing them through the Web-based visualization system.

In the future, the Web-based visualization system should expand the entire shipbuilding industry. Moreover, the view of the Web page will be supplemented for the staff of each shop and the production scheduler.

REFERENCES

[1] SAP. "Manufacturing Strategy: An Adaptive Perspective". White paper, 2003.
[2] Brodda, Joachim. NSRP Report 0320, Shipyard Modeling: Approach to Obtaining a Comprehensive Understanding of Functions and Activities. 1990.
[3] Sun Mo Yang, Soon Yo Lee, and Lee Seouk Joo. "A Study on the Information System for CIM in the Ship Production Industry". KACC, 1992. 10.19-21.
[4] Kwang Kook Lee, Dong Hwan Choi, Sang Dong Han, Ju Young Park, and Jong Gye Shin. "Construction of a Scheduling Support System for Panel Lines by Digital Manufacturing Simulation." Journal of the Society of Naval Architects of Korea. Vol..43, No. 2, pp. 228-235, April 2006.
[5] Sang Dong Han, Cheol Ho Ryu, Jong Gye Shin, and Jong Kun Lee. "Modeling and Simulation of a Ship Panel-block Assembly Line Using Petri Nets." Journal of the Society of CAD/CAM Engineers. Vol. 13, No. 1, 2008. 2, pp. 36-44.
[6] Yong-Seop Kim and Dae-Hying Lee. "A Study on the Construction of a Detailed Integrated Scheduling System for the Shipbuilding Process." Journal of the Society of Naval Architects of Korea. Vol. 44, No. 1, pp. 48-54, February 2007.
[7] Hoon Hee Yun and Dongmok Sheen. "Development of a Monitoring System for Hull Construction Processses Using TOC Analysis." Journal of the Society of Naval Architects of Korea. Vol. 45, No. 3, pp. 315-321, June 2008.
[8] Byung K. Choi and Byoung H. Kim. "A Human-centered Virtual Manufacturing System for Next-generation Manufacturing." Technical Report VMS-99-01.