Simulation and optimization analysis of ship production logistics

Guoqing Zhang, Xincheng Ma, Xiaofeng Meng

***Abstract*— With the overall improvement of production technology level, China has occupied a place in the world shipbuilding market. The material management system of Chinese shipbuilding enterprises must be comprehensively improved to meet the development needs of assembly and shipbuilding. Chinese shipbuilding enterprises have delayed delivery and consume a lot of materials and Such problems make the material management system particularly important. To this end, this paper has conducted in-depth research on the material management of the assembly shipbuilding model. In order to better study the production logistics management of shipbuilding, this chapter takes the ship segmentation as the research object, uses eM-Plant to simulate the ship segment production line, and proposes the corresponding optimization plan.**

***Index Terms*— Final assembly shipbuilding mode; Material management; plane segmentation; eM-Plant.**

I. INTRODUCTION

Since the 21st century, with the country's policy support, talent cultivation, financial input and many other factors, China's shipbuilding industry has developed rapidly, and China has become one of the world's shipbuilding powers. However, the rapid development of the shipbuilding industry has not brought very large profits to the Chinese shipbuilding industry. Compared with other shipbuilding powers in the world, China's shipbuilding industry still has a relatively large gap in management mode[1-2]. It understands and analyzes the optimization of material management in shipbuilding enterprises, and deepens the distribution of materials in the segmental production process of a shipbuilding enterprise. The discussion, taking the production line of the plane segmentation as an example, uses the eM-Plant simulation tool to simulate the plane segmentation production process of the shipbuilding enterprise and propose an optimized scheme.

II. CO OPTIMIZATION ANALYSIS OF SHIP PRODUCTION LOGISTICS SIMULATION

A. Analysis of production logistics problems

In general shipbuilding mode, production logistics should maintain smooth production, supply materials on time and reduce unnecessary waste of materials. The technological level of Chinese shipbuilding enterprises is relatively backward, which can not meet the requirements of material management in general shipbuilding mode[3]. There are still many problems in production logistics, mainly in the following aspects: The following aspects:

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(1) The unscientific allocation of personnel and equipment, the process of ship construction requires a large number of personnel and equipment to participate in it. To ensure that the production of shipbuilding enterprises can proceed smoothly, the cumbersome and complex construction process will inevitably lead to a variety of problems, such as the workshop in-process products need to be processed immediately, but workshop workers have emerged. In the case of insufficient staff, sometimes there will be a phenomenon of overcrowding. General shipbuilding production logistics should solve the unscientific problem of personnel and equipment allocation. Using advanced technology, arranging personnel and equipment scientifically and rationally, while ensuring the minimization of material consumption, the production logistics of shipbuilding enterprises can proceed smoothly.

(2) The inventory of WIP is large and the material occupancy is serious. The control ability of shipbuilding enterprises in China is relatively weak. In order to ensure the smooth operation of production, it is usually necessary to set an advance period. In the process of building the ship in sections. Weekly production cycle, large-scale production of various types of segments to meet the production needs of the following processes, production needs of the segments directly receive the use of such a way to ensure the normal production of shipbuilding enterprises, but it will cause a large number of in-process inventory accumulation, occupy the capital of shipbuilding enterprises, the profits of enterprises are very high. In addition, the shipbuilding cycle is relatively long, and the accumulation of materials has brought pressure to the operation of shipbuilding enterprises. At present, Chinese shipbuilding enterprises have many orders, but they have not brought greater profits. Therefore, it is necessary to change the material management mode and improve the management efficiency of shipbuilding enterprises.

(3) There are unscientific links in the production process. In the production of general shipbuilding logistics, the timeliness of production should be emphasized, the inventory of manufactured goods should be reduced to the greatest extent, and the waste of materials should be minimized. Therefore, the production process of shipbuilding enterprises should be refined, and the production process should be kept smooth. There are still many problems. In the process of sectional production, a lot of materials are occupied and not put into the assembly process in time. Occupying the site also affects the normal production operations. Some production links can only be carried out manually, not mechanized production, and the arrangement of work stations is not reasonable enough. The matching process is relatively long, so the whole assembly process will also be affected. There are also some links with inadequate equipment capacity, resulting in congestion, but there are also some links with too strong capacity, resulting in idle equipment. The above problems all

reflect the unreasonable distribution of materials and the unscientific production process settings. The material management under the general shipbuilding mode emphasizes on maintaining the production fluency and avoiding material waste.

B. Research object

Ship segmentation is representative in the shipbuilding process and is of great significance for the study of production logistics optimization. Plane segmentation and surface segmentation do not affect each other[4]. From the perspective of contemporary shipbuilding companies, the plane segmentation basically implements a specialized production line, but the level of material management is far from the requirements of modern shipbuilding. In this paper, the plane segmentation in the ship segment is taken as the research object to optimize the production logistics simulation. Planar segmentation is an important part of ship construction. Simulation optimization is conducive to the smooth flow of ship production and effectively shortens the ship construction period.

III. Planar Segmented Production Line

The hull is divided into planar and curved segments. The surface subsection structure is complex, the curvature of the outer plate is relatively large, the plane subsection structure is relatively simple, and the outer plate is straight, as shown in the ship subsection diagram shown in Fig.1 and Fig.2.

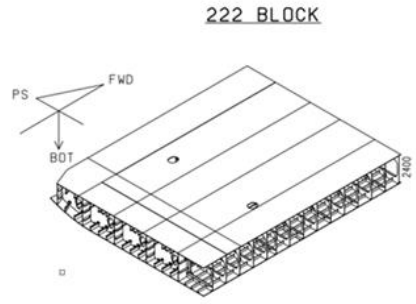

Fig.1 Plane segmentation diagram

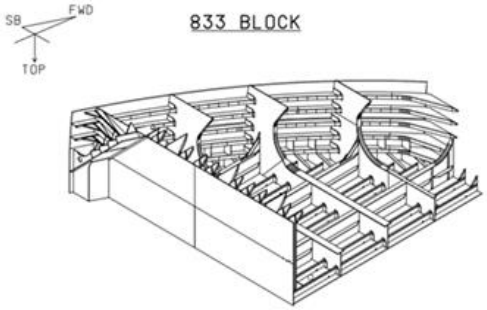

Fig.2 Surface segmentation diagram

The structure of planar segmentation is relatively simple and easy to realize automated production. The following are the main features of planar segmentation:

(1) Most of the plane segments are double-deck segments. As shown in Fig. 2, they mainly consist of inner bottom plate, rib plate, truss and outer deck.

(2) Welds are generally parallel distribution, basically no linear, using continuous welding mode.

(3) Segmentation of ships is similar, and the workload is similar. The process of construction is a multi-variety assembly line.

In order to improve the efficiency of production and shorten the time of ship construction, shipbuilding enterprises have implemented the production of planar segmented pipeline and planar segmented production in a closed area. As shown in Fig.3, it is a planar piecewise pipeline diagram.

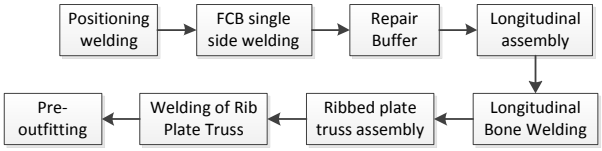

Fig. 3 Schematic diagram of the plane segmentation pipeline

Location welding is a manual operation, in the bottom plate assembly work, to meet the accuracy requirements, positioning welding, and then enter the next position.

FCB single-sided welding is the most important link in the whole planar sectional pipeline, which saves the site and cost. The main work is to weld the bottom plate. The welding process is basically automated, and the preparation is sufficient, which makes the preparation time more than the operation time.

Repair inspection is mainly to check the front and back of the weld, to ensure the quality of welding, the number of personnel changes to ensure the rhythm of the pipeline.

Longitudinal assembly is mainly carried out on the top of the floor longitudinal. Automatic assembly and manual work complement each other. Before assembly, we must do a good job of inspection to ensure the accuracy of assembly.

Longitudinal welding is mainly to complete the welding work on the bottom plate longitudinal bone, while completing the remaining work of the previous several processes to ensure the quality of the segment.

Rib-plate truss assembly station mainly assembles the neutral components. Rib-plate truss assembly adopts pull-in method. In order to ensure the balance of production, personnel are adjusted appropriately by manual way.

The main work of rib plate truss welding is to weld the neutral components. This process is operated manually. In order to ensure the progress of welding, reasonable and scientific arrangement of personnel and equipment should be made.

Pre-outfitting mainly outfitting part of the segment, to achieve the integrity of the segment, to share the tasks for the following process, not all of the segment production needs pre-outfitting station, the content is also slightly different.

Planar segmented production is an important link in the process of ship construction. It is of great significance for the simulation of production line of planar segmented production. Proposing relevant optimization schemes is conducive to material management of shipbuilding enterprises, improving production efficiency, and laying a good foundation for material management under general shipbuilding.

IV. Optimal Analysis of Planar Segmented Pipeline

As a part of the ship, segment is mainly composed of parts and components. In this chapter, the production line of plane subsection is taken as the research object, and the double bottom subsection is taken as an example to study. In the process of double bottom subsection production, most of them are produced in plane subsection production line. Large plane subsection, outer bottom plate and longitudinal bone

are the most basic components of double bottom subsection, such as. Fig.4 shows a sectional anatomical sketch of the double bottom plane.

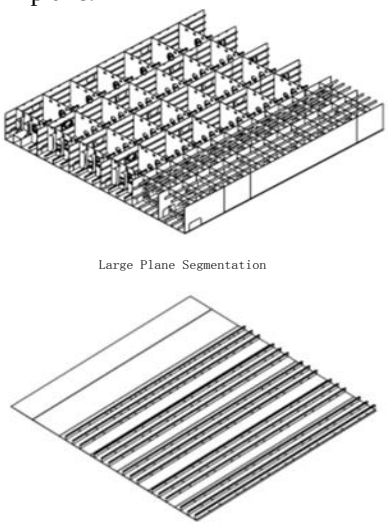

Fig.4 Sectional anatomical diagram of double bottom plane

There are some differences in the production process of large-scale plane subsection and outer floor and longitudinal bone. To complete the production of outer floor and longitudinal bone, only a few processes are needed in front of the production line of plane subsection. However, to complete the production of large-scale plane subsection, the whole production line of plane subsection is needed, but the first few of large-scale plane subsection are needed. The production process is the same as that of the outer bottom plate and the longitudinal bone. The specific production process is shown in Fig.3.

In this paper, the production pipeline of two-layer bottom plane is taken as the research object, and the eM-Plant is used to simulate it. The production pipeline of two-layer bottom plane is deeply analyzed. According to the simulation results of the production pipeline, the relevant optimization scheme is put forward, and then the feasibility of the optimization scheme is compared and analyzed.

V. Planar Piecewise Pipeline Modeling Based on eM-Plant

Using eM-Plant to model the production line of double-layer bottom-plane section. The main process of plane section is shown in Fig. 3. Steel preparation, positioning welding, FCB single-side welding (welding of single-side welding and double-side forming), repair buffer, longitudinal assembly, longitudinal welding, rib-plate truss assembly and rib-plate truss welding, outer bottom welding[5]. The completion of plates and longitudinal bones only needs to go through positioning welding, FCB one-sided welding, repairing buffer and longitudinal bones welding, and then transfer the outer floor and part of the longitudinal bones out of the workshop, while the large-scale plane segment needs to go through all the processes in the production line of plane segment, because there are many differences in the contents of pre-outfitting. So I don't think about it here.Combining with the schematic diagram of the planar production line in Fig. 3, the eM-Plant simulation model is established as shown in Fig. 5.

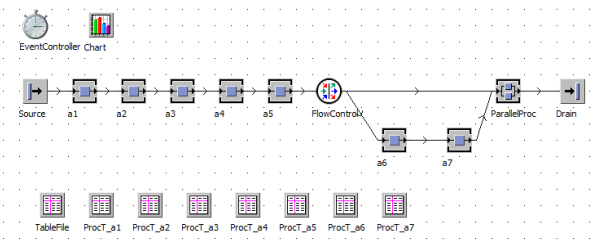

Fig.5 Modeling based on eM-Plant plane segmentation production pipeline

A. *Analysis of simulation results*

The simulation results obtained by eM-Plant are shown in Fig.6 as the simulation results of the planar sectional production line.

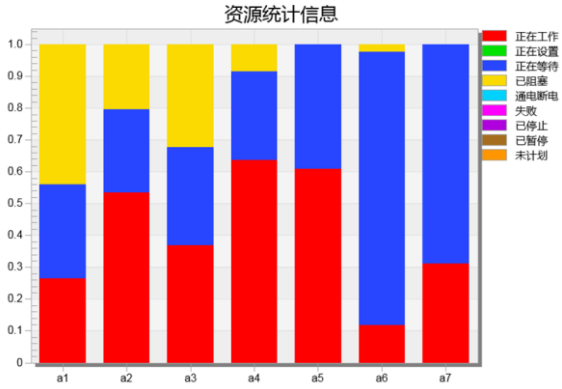

Fig. 6 Plane segmentation pipeline simulation results

From the simulation results of this planar sectional production line, we can clearly see the utilization efficiency of each process on the pipeline. We find that the utilization ratio of each process on the sectional production line is unbalanced. In Figure 6, we can clearly see that the A6 process, namely the ribbed truss assembly process, is at a lower level. At the same time, rib-plate truss welding is the most time-consuming process in all processes.

Aiming at these problems, this paper puts forward the corresponding optimization scheme, which keeps the assembly process of ribbed truss unchanged, adds a set of other processes, jointly uses the welding process of ribbed truss, and balances them by two parallel lines. Next, this paper uses eM-Plant to simulate the proposed optimization scheme again.

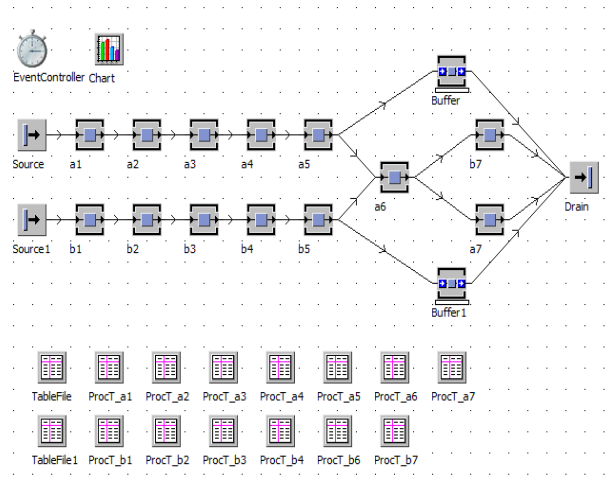

Fig. 7 Optimization Simulation Pipeline Modeling

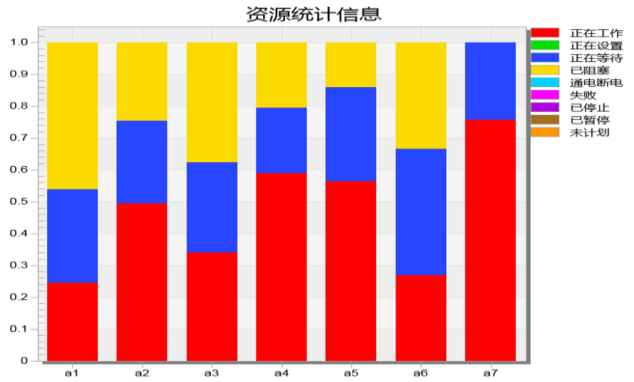

Fig. 8 Optimize the simulation pipeline results

The simulation results show that the welding speed and equipment productivity are greatly improved by using this two-line parallel production line method. Optimizing planar production line is a very important step in material management under general shipbuilding mode. Using eM-Plant to model and simulate, an optimization method is found to improve productivity, save materials and reduce the cost of shipbuilding enterprises.

VI. Conclusion

Introducing the advanced material management mode into the material management of shipbuilding enterprises can realize the rational distribution of materials, save materials and optimize the material distribution process, which is of great significance to the material management of shipbuilding enterprises and has practical value.

Planar sectional production line is an important step to realize material management under general shipbuilding mode. This chapter mainly uses eM-Plant to simulate the planar sectional production line. Aiming at the problems of low utilization rate of ribbed plate truss assembly station and time-consuming and labor-consuming of ribbed plate truss welding, the corresponding optimization scheme is put forward.

In order to implement the material management under the mode of general shipbuilding, it is necessary to analyze the production logistics of shipbuilding enterprises, point out the problems existing in the process of logistics management, and further optimize the production logistics, so that the material of shipbuilding enterprises can be used reasonably and efficiently. Reasonable and effective material management can shorten the time and cost of ship construction and ensure the quality of ship.

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