The design of ship manufacturing simulation system based on computer virtual

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ABSTRACT

The construction process of ship manufacturing simulation system is based on the model construction by the computer virtual, in which make the data analysis by computer virtual, make the accurately calculation for the production capacity efficiency of the process workers and take the effective mining of the factor affecting the productivity of production plant workers. This paper takes the corresponding reconfiguration based on the data analysis results of simulation model based. In this conducting research process in this paper, we take the pipe production plant as an example to take the effective establishment of its simulation models. Among this process, we did corresponding data analysis for the simulation results of production planning and summed up the impact factors to provide a solid foundation for the theory and data in this article.

KEYWORDS

Computer virtual; Ship manufacturing; Simulation system; Model construction.
INTRODUCTION

This paper made corresponding discussion for the simulation system construction process of pipe production plant construction process during the ship manufacturing process, in which it combined the construction process of simulation model to take effective study for the calculation process of the machining time and capability efficiency of the each workpiece and solved problems generated during the establishment process of model. Secondly, it carried out appropriate introduction for the flexible resource scheduling method of pipe processing plant, in which by listing the corresponding formula computer matrix to discussed the relationship between the fixed resources and flexible resource, and combined the internal links between the two and mutual influence to take effective schedule, which can make the design process of ship manufacturing simulation system with a strong rationality[1].

From the development perspective, the design of ship manufacturing simulation system by computer virtual can have a positive role in promoting production efficiency and production quality, through the effective application of simulation models, it is the effective supplement for perfect for the improvement process for system building to ensure simulation system design is more reasonable and targeted.

ESTABLISHMENT OF THE PRODUCTION PLANNING SIMULATION MODEL OF PIPE PROCESSING PLANT

This paper takes the pipe processing plant as the example to establish the production simulation model during the manufacturing process of ships. Among this process, because the manufacturing process of each segment of the tube are performed independently, resulting in the different type of tubes were constraint during the manufacturing process by the task size, thus resulting in a corresponding change in manufacturing plans, so that the proportion of resources between the various processes load changed. If the load resources can hold without change, then the process at different manufacturing stages will produce different bottlenecks. In this paper through simulation methods discussed in the appropriate process can do the forecast for the bottleneck process in the short term, and combined these bottlenecks process to take the reconfiguration.

During the course of the study in this paper, the pipe processing plant is lack of processing time data for each stage of processing, the real production plan will difficult to achieve due to the lack of data, but this problem can be divided into two aspects for an effective solution. First is the effective collection and collation for basis data and a full range of integrated analysis. Uploaded the production planning which have been identified as well as information about product parameters to the database and use the simulation models for the effective integration of related information, which can make the simulation model can be computed efficiently for its processing time, and finally transfer the calculated data to database for further analysis, then each segment processing time can be efficiently calculated[2].

The second is the simulation of the process scheme based on the calculation result of the above data, and the calculation of the prediction data of the completed time and resource efficiency of each step, which can make the effective analysis for the problems in supply and demand and provide reference for effective scheduling.

The first step in solving the problem can calculate the specific processing time, but it is not a time distribution process, which aim to simplify the preparation of its calculation process. In this process, simulation experiments can be repeated to effectively eliminate this uncertainty factors. The second part of the process is sucked simulation time into the simulation model, but a large analysis number of data may lead to model more slowly, so that the latter part of the results will generate a corresponding impact. The separate simulation process for the second part resolve process of this article can ensure the model running speed can be effectively protected.

In the design process of the conducting pipe plant processing flow chart (Figure 1), the first is for the machining program, the initialized simulation model can read the attribute information for each products from the simulation database; then simulation entities into the carbon steel and stainless steel
production line in accordance with the type of steel belongs respectively, through the material aggregated modules and warehouse picking module to fully prepared for the formal process; each simulation entities enter the final process, turn into the cutting, bending, assembly, welding, grinding, pump pressure module, the final processing. The simulation flow chart of pipe processing plant is shown as Figure 1.

![Simulation flow chart of pipe processing plant](image1.png)

**Figure 1 : Simulation flow chart of pipe processing plant**

**Results of simulation model of pipe processing plant production planning**

Results of simulation model of tube processing plant production planning has two main aspects, one is the processing time of each process in Figure 2 and Figure 3; another for a number of specific programs, through simulation toget resources utilization of various processes (Figure 4) and the processing cycle to different production lines (Figure 5).

![Calculated results of pipe processing time of each segment by carbon steel and stainless steel (unit: seconds)](image2.png)

**Figure 2 : Calculated results of pipe processing time of each segment by carbon steel and stainless steel (unit: seconds)**
The purpose of the flexible resource scheduling of pipe processing plant

In the manufacturing process in shipbuilding industry, pipe production plant is mainly constituted by a single technician and multi-ability workers, while the latter process can corresponds grasp work for multiple processes, where technicians with single capacity were called fixed resource, other craftsmen were called flexible resources\[3\]. However, during the production process, a reasonable allocation of flexible resources between the various processes is the key to improve productivity; the paper takes this issue as a key research. The purpose is the continuous optimization of balance of flexible resource configuration of various processes, which can maximize the value of limited resource flexibility, and then the efficiency of the tube production plant will continue to increase, making the hybrid deployment of flexible resources tend to be more scientific and reasonable.

In the process of research and discussion in this section, it mainly focused on the corresponding impact of rational allocation for flexible resource and produce efficiency for every work piece during the tube production process. When the overall processing program produce change, rational management of resources can meet the needs of flexible production plan, such that the flexible resource allocation process can achieve an effective balance purposes. The first of flexible resource scheduling process should combine with the abstract question of tube production line in production process, which is the allocation of flexible resources, and thus its effective solution for problem, its methods and steps were enumerated.
Mathematical description of flexible resource scheduling problem of pipe processing plant

Whether or not worker has a comprehensive skills can decide multi-step operations of workers, if a worker was in a single step operation for a long time, the worker will be more harness for this process workflow, whereas unfamiliar degree will increase for the other processes. In this process, due to familiarity of the other workflow cannot guarantee supply and demand, then the time required for the process to complete the process will be significantly increased, thus leading to the efficiency be affected. Every process consisting of a single skilled worker in the workshop, and in the number of options to ensure complete tool case, the efficiency of the workers can possible to obtain a fundamental guarantee, thus the production quality for the jar can also to a certain degree of increased[4].

We started from the current simply situation in the manufacturing process of tube workshop, and envisaged flexible resource allocation problem on multi-lines, of course, the assumption of this problem has a certain abstract. There are many production lines (with m to represent), \( M = \{L_1, L_2, \ldots, L_n\} \), the i production line \( L_i = \{P_{i1}, P_{i2}, \ldots, P_{in}\} \) has \( n_i \) production processes, \( P_j = \{R_{ij1}, R_{ij2}, \ldots, R_{ijn}\} \) has \( W_j \) flexible resource to allocate. However, in such a production line, the establishment process of ability efficiency of the process resource \( R_{ij} \) matrix is shown below.

\[
A_{ij} = \begin{bmatrix}
\alpha_{i1} & \alpha_{i2} & \cdots & \alpha_{in} \\
\alpha_{11} & \alpha_{12} & \cdots & \alpha_{1n} \\
\vdots & \vdots & \ddots & \vdots \\
\alpha_{im} & \alpha_{im} & \cdots & \alpha_{mn}
\end{bmatrix}
\]

Here we use \( \alpha_{ij} \) to refer to the k resource in j processes among the i production line, and R carried out the production line in the production process capability b efficiency factor. And to ensure that between i and m are less than equal to 1, and also between a and m less than equal to 1, and between b and n are to be maintained less than or equal than 1, k and wij is less than or equal 1, \( \alpha_{ij} = 0 \) illustrated the working efficiency in \( P_{ab} \) step does not exist, but also illustratedthat workers cannot do this process. However, \( \alpha_{ij} = 1 \) indicated the worker \( P_{ab} \) ability in production line is 1, when \( \alpha_{ij} \) greater than 0 and less than 1, it indicated that the productivity of production line \( P_{ab} \) was low. However, we make \( \alpha_{ij} \) more than 1; productivity of worker in \( P_{ab} \) process significantly exceeded the expected range with the working efficiency. However, the effectively use of \( R_{ijk} \) resources in production process \( P_{ab} \) and maintain \( \alpha_{ij} \) greater than 1, then the worker can fully capable \( P_{ab} \) process work, its efficiency can be guaranteed, and do not be influenced by other factors[5]. For such conditions, the establishment process of a matrix is as follows:

\[
X_{ij} = \begin{bmatrix}
x_{i11} & x_{i12} & \cdots & x_{i1n} \\
x_{i21} & x_{i22} & \cdots & x_{i2n} \\
\vdots & \vdots & \ddots & \vdots \\
x_{im1} & x_{im2} & \cdots & x_{imn}
\end{bmatrix}
\]

Keeping the i and m are less than equal to 1, and a and m less than equal to 1, and b and n are to be maintained less than or equal 1, then \( \{0,1\} \). As can be seen from the formula, the represent is the assigned number of \( R_{ij} \) of b step in a production line during pipe processing, in which the specific ratio of working hours and total resource load of workers can be reflected. However, when it was 1, which shows the \( R_{ij} \) distribution of the \( P_{ab} \) job step, if 0, then it is not the \( R_{ij} \) distribution of the \( P_{ab} \) job step.
In the $P_{ab}$ process of workshop, processing resources are made of flexible resources and fixed resources together, the fixed resources equivalent ability usually represent by $FC_{ab}$, while the equivalent capacity of flexible resources normally used $CC_{ab}$ instead. When the fixed resource efficiency capabilities are 1, then the fixed number of resources allocated $FC_{ab}$ and processes $P_{ab}$ are equal, the equivalent productive capacity $Cab = FC_{ab} + CC_{ab}$ of flexible resource allocation of the workshop process $Pab$, and then be able to deduce the following formula.

$$C_{ab} = FC_{ab} + \sum_{i=1}^{m} \sum_{j=1}^{n} \sum_{k=1}^{n} (X_{ijk} \cdot a_{ijk})$$

For example: there are a number of much-needed pipe processing in the workshop, $Plan = \{Plan_1, Plan_2, ..., Plan_j, ..., Plan_m\}$, however, must ensure that the $Plan_i$ to product in $L_i$ production line, which can be obtained $Plan_i = \{WP_{i1}, WP_{i2}, ..., WP_{iq}, ... WP_{iqn}\}$ the total number of artifacts are $Q_i$. However, the relationship formed between $Q_i$ and $q$ is successively reduced and less than 1, among this process all parts of the processing line can be determined and its passes order are $P_{i1}, P_{i2}, ..., P_{ij}, ... P_{ini}$. And among this, the processing tools in workshop can meet internal needs; processing equipment to improve their ample number, so restricting factor for shop worker productivity only has one, which is one of the flexible resources, which are multi-skilled workers. In the process of $WP_{iq}$ workpieces, the need for workers to step on a particular application process to complete its operation, and its operating characteristics and the ability to complete the work efficiency is both constraints.

From the above discussion of the processes, it can be concluded if the processing capacity of its own worker efficiency is 1, the distribution function for each of the workpieces in different steps can be calculated through the statistic of historical data and the its characteristics. The machining time of different workpieces in different processes is only related to its own characteristic parameters and regardless of other factors. Plan $Plan_i$ processing time matrix:

$$PT_i = \begin{bmatrix}
    f_{11} & f_{12} & \cdots & f_{1b} & \cdots & f_{1n} \\
    f_{21} & f_{22} & \cdots & f_{2b} & \cdots & f_{2n} \\
    \vdots & \vdots & \ddots & \vdots & \cdots & \vdots \\
    f_{ib} & f_{i2} & \cdots & f_{ib} & \cdots & f_{in} \\
    \vdots & \vdots & \ddots & \vdots & \cdots & \vdots \\
    f_{iq} & f_{q2} & \cdots & f_{iq} & \cdots & f_{qn} \\
    f_{q1} & f_{q2} & \cdots & f_{q1} & \cdots & f_{qn}
\end{bmatrix}$$

Among this, $f_{qib}$ represent the distribution function of the time for the $q$ component of the $b$ process in the $L_i$ production line when the efficiency was 1.

Due to the special nature of processed products, with the change in plans, the amount of processing tasks in different production line and different processes will be changed, and the processing time cannot be accurately measured, this will result in the imbalance of different production line or process for different batch processing Plan, that is suitable for a number of program resources on the front lines of the various production processes configured, if not reconfigured, it may lead to the imbalance between next batch production line or process capacity, so that the total processing cycle becomes longer.

Assuming the processing cycle of Plan, $PC = \{pc_1, pc_2, ..., pc_1, ..., pc_m\}$ represents the processing cycle of different production lines. The purpose of the study is how to allocate limited resources at different batches plan conditions, and make the total processing cycle $T$ for Plan to be shortest. Establish the following objective function:

$$Object: T = \text{Min Max}\{PC_1, PC_2, ..., PC_1, ..., PC_m\}$$
Solutions and step for flexible resource scheduling

Since the production system of discrete event is difficult to establish the analytical expression of its objective function, we establish the multi-line simulation models under the principle of discrete event modeling and simulation, use OptQuest simulation to take the optimization modules and find the best configuration for flexible resource[7]. The OptQuest applied package in Arena applied the tabu search and scatter search and other heuristic algorithms, moving skill fully control variables in the input space, to the best combination of variables near the input control to achieve fast in an iterative way, to achieve the rapid and reliable proximity to the object. Of course OptQuest module has certain range of applications; we can take the preparation of a targeted optimization program integrated into the Arena's VBA modules to achieve optimization purposes by the actual simulation.

CONCLUSIONS

This is the design process for pipe production workshop production planning simulation system combined shipbuilding industry in this paper, corresponding discussion of the simulation system of pipe production plant construction process. We did the effective research for the calculate process of machining time and the efficiency about all part of the workpieces combined the establishment process of simulation model, solved issues generated during the establishment of the model. Secondly, it is carried out appropriate introduction for the scheduling method of flexible pipe processing plant resource by listing the corresponding formula into a computer matrix, thus providing an effective theory and data support for follow-up research process. This paper did the discussion for related data relationship analysis to all aspects of the process, hoping to have a positive role in continue promoting shipbuilding productivity of industrial pipes.

REFERENCES