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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 isthe 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.

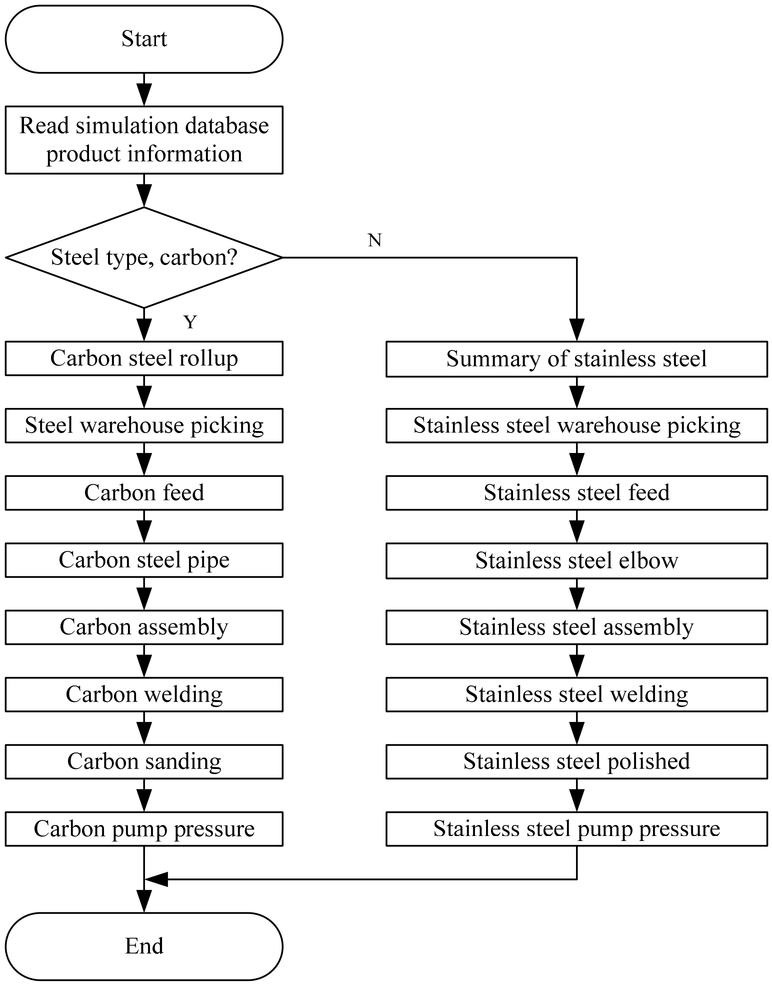
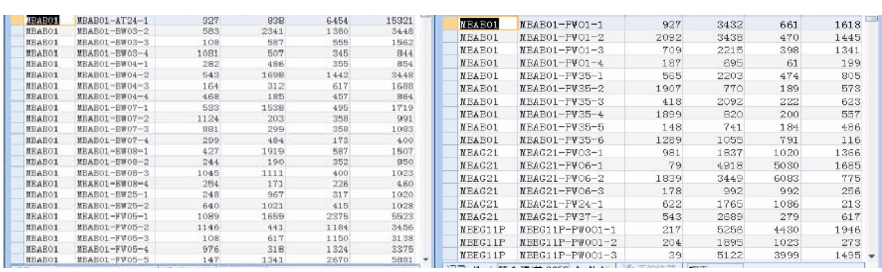


Figure 1 : Simulation flow chart of pipe processing plant

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).



NBAB01	NBAB01-AT24-1	327	938	6454	15321
NBAB01	NBAB01-BW03-2	583	2341	1380	3448
NBAB01	NBAB01-BW03-3	108	587	555	1562
NBAB01	NBAB01-BW03-4	1081	507	345	844
NBAB01	NBAB01-BW04-1	282	486	355	854
NBAB01	NBAB01-BW04-2	543	1698	1442	3448
NBAB01	NBAB01-BW04-3	164	312	617	1688
NBAB01	NBAB01-BW04-4	468	185	457	864
NBAB01	NBAB01-BW07-1	533	1538	495	1719
NBAB01	NBAB01-BW07-2	1124	203	358	991
NBAB01	NBAB01-BW07-3	881	299	358	1083
NBAB01	NBAB01-BW07-4	299	484	173	400
NBAB01	NBAB01-BW08-1	427	1919	587	1507
NBAB01	NBAB01-BW08-2	244	190	352	850
NBAB01	NBAB01-BW08-3	1045	1111	400	1023
NBAB01	NBAB01-BW08-4	254	171	226	460
NBAB01	NBAB01-BW25-1	248	967	317	1020
NBAB01	NBAB01-BW25-2	640	1021	415	1028
NBAB01	NBAB01-FW05-1	1089	1659	2375	5523
NBAB01	NBAB01-FW05-2	1146	441	1184	3456
NBAB01	NBAB01-FW05-3	108	617	1150	3138
NBAB01	NBAB01-FW05-4	976	318	1324	3375
NBAB01	NBAB01-FW05-5	147	1341	2670	5881

NBAB01	NBAB01-PW01-1	927	3432	661	1618
NBAB01	NBAB01-PW01-2	2092	3438	470	1445
NBAB01	NBAB01-PW01-3	709	2215	398	1341
NBAB01	NBAB01-PW01-4	187	695	61	199
NBAB01	NBAB01-PW35-1	565	2203	474	805
NBAB01	NBAB01-PW35-2	1907	770	189	573
NBAB01	NBAB01-PW35-3	418	2092	222	623
NBAB01	NBAB01-PW35-4	1899	820	200	557
NBAB01	NBAB01-PW35-5	148	741	184	486
NBAB01	NBAB01-PW35-6	1289	1055	791	116
NBAG21	NBAG21-PW03-1	981	1837	1020	1366
NBAG21	NBAG21-PW06-1	79	4918	5030	1685
NBAG21	NBAG21-PW06-2	1839	3449	6083	775
NBAG21	NBAG21-PW06-3	178	992	992	256
NBAG21	NBAG21-PW24-1	622	1765	1086	213
NBAG21	NBAG21-PW37-1	543	2689	279	617
NBEG11P	NBEG11P-PW001-1	217	5256	4430	1946
NBEG11P	NBEG11P-PW001-2	204	1895	1023	273
NBEG11P	NBEG11P-PW001-3	39	5122	3999	1495

Figure 2 : Calculated results of pipe processing time of each segment by carbon steel and stainless steel (unit: seconds)

MBBG21P	14.80829	40.24416	51.12226	101.5289
MBBG21S	19.48956	46.87424	35.55191	83.49554
MBBG22C	5.730098	16.01781	26.31643	46.56042
MBBG22P	18.58525	60.26945	89.60407	188.3414
MBBG22S	43.00921	95.57935	83.85549	192.2039
MBBG23P	27.85948	71.41209	76.01602	178.7139
MBBG23S	25.84406	71.90031	111.3185	255.1649
MBFBU01	1.510442	1.12038	3.158965	8.245973
MBFG02	12.40402	29.21127	63.3131	145.0609
MBHD01	.147572	.3960021	.1095902	.2574136
MBPD01P	15.30205	29.76591	43.37283	105.0294
MBPD01S	10.5374	26.41236	31.44314	75.3292
MBPD02P	17.13478	39.23702	60.40799	130.7479
MBPD02S	22.15117	53.73598	54.30121	111.8313
MBPD03P	11.28621	22.64681	58.95549	133.8278
MBPD03S	6.873386	11.83503	36.34743	73.08959
MBPD10	14.19453	34.12048	101.0342	188.595
MBPD11	11.64179	27.76604	33.68641	69.98109
MBPD20	10.38483	18.26506	48.12011	100.9826

MBEG22S	5.20115	11.81611	8.584577	4.964904
MBEG23P	1.378974	8.117036	3.986041	2.694777
MBEG23S	3.202232	8.841812	4.279852	5.047864
MBHD01	4.40225	8.012298	6.91414	10.78454
MBHD02	4.087848	7.822727	5.652909	5.19407
MBHD03	.4501569	.5405548	2.794657	8.224097
MBHD04	11.4105	10.53629	9.380911	6.263426
MBHD05	.2916362	.4620789	3.119329	7.674036
MBHD06	3.972304	7.649377	4.820166	5.020765
MBHD07	4.204099	8.010626	7.361649	11.85414
MBHD08	.9738973	1.589621	4.592863	9.07156
MBPD01P	6.748888	12.88735	8.092156	3.386722
MBPD01S	11.31286	26.03432	20.51112	8.895305
MBPD02S	.3922969	.6493505	.745691	.1388165
MBPD10	1.880762	7.800812	6.185299	2.940017
MBPD11	7.183386	17.9444	12.45015	5.02391
MPD1A	4.553199	11.92108	31.16002	10.315
MPD1A1	38.8091	122.0226	311.5307	107.9571
MPD1B	57.20787	153.6538	358.533	121.8823

Figure 3 : Calculated results of pipe processing time of each segment by carbon steel and stainless steel (unit: hour)

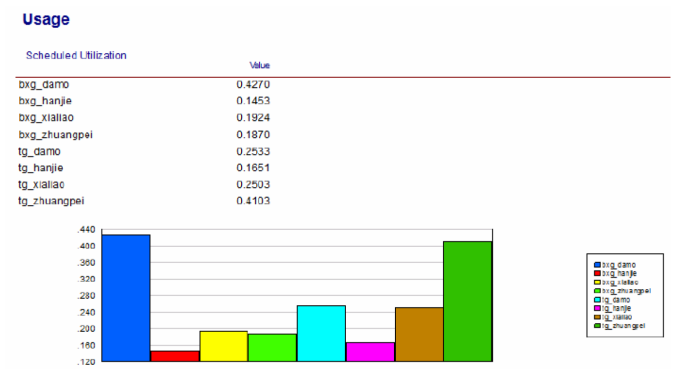


Figure 4 : Example figures of simulation results of each resource utilization

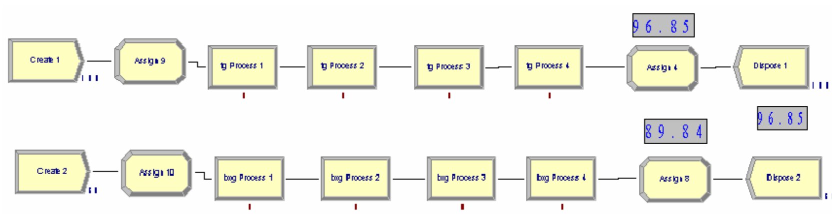


Figure 5 : Example figures of processing cycle simulation result by carbon steel and stainless steel production line.

FLEXIBLE RESOURCE SCHEDULING METHOD OF PIPE PROCESSING PLANT

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 corresponding 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 harnessfor this process workflow, whereas unfamiliar degree will increasefor 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, then 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), $M = \{L_1 , L_2 ,\ldots, L_i ,\ldots , L_m\}$,the i production line $L = \{P_{i1} , P_{i2} ,\ldots , P_{ij} ,\ldots P_{ini}\}$ has n_i production processes, $P_{ij} = \{R_{ij1} , R_{ij2} ,\ldots , R_{ijk} ,\ldots , R_{ij} w_{ij}\}$ has W_{ij} flexible resource to allocate. However, in such a production line, the establishment process of ability efficiency of the process resource R_{ijk} matrix is shown below.

$$A_{ijk} = \begin{Bmatrix} \alpha_{ijk11} & \alpha_{ijk12} & \cdots & \alpha_{ijk1b} & \cdots & \alpha_{ijk1n_1} \\ \alpha_{ijk21} & \alpha_{ijk22} & \cdots & \alpha_{ijk2b} & \cdots & \alpha_{ijk2n_2} \\ \vdots & \vdots & & \vdots & & \vdots \\ \alpha_{ijka1} & \alpha_{ijka2} & \cdots & \alpha_{ijkab} & \cdots & \alpha_{ijkan_a} \\ \vdots & \vdots & & \vdots & & \vdots \\ \alpha_{ijkm1} & \alpha_{ijkm2} & \cdots & \alpha_{ijkmb} & \cdots & \alpha_{ijkmn_m} \end{Bmatrix}$$

Here we use α_{ijkab} 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 1, k and wij is less than or equal 1, $\alpha_{ijkab} = 0$ illustrated the working efficiency in P_{ab} step does not exist, but also illustratedthat workers cannot do this process. However, $\alpha_{ijkab} = 1$ indicated the worker P_{ab} ability in production line is 1, when α_{ijkab} greater than 0 and less than 1, it indicated that the productivity of production line P_{ab} was low. However, we make α_{ijkab} 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 α_{ijkab} 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:

$$X_{ijk} = \begin{Bmatrix} x_{ijk11} & x_{ijk12} & \cdots & x_{ijk1b} & \cdots & x_{ijk1n_1} \\ x_{ijk21} & x_{ijk22} & \cdots & x_{ijk2b} & \cdots & x_{ijk2n_2} \\ \vdots & \vdots & & \vdots & & \vdots \\ x_{ijka1} & x_{ijka2} & \cdots & x_{ijkab} & \cdots & x_{ijkan_a} \\ \vdots & \vdots & & \vdots & & \vdots \\ x_{ijkm1} & x_{ijkm2} & \cdots & x_{ijkmb} & \cdots & x_{ijkmn_m} \end{Bmatrix}$$

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_{ijk} 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_{ikj} distribution of the P_{ab} job step, if = 0, then it is not the R_{ikj} 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.

$$C_{ab} = FC_{ab} + \sum_{i=1}^{m}\sum_{j=1}^{ni}\sum_{k=1}^{wij}(X_{ijkab} * a_{ijkab})$$

For example: there are a number of much-needed pipe processing in the workshop, $Plan = \{Plan_1, Plan_2, ..., Plan_i, ..., Plan_m\}$, however, must ensure that the $Plan_i$ to product in L_i production line, which can be obtained $Plan_i = \{WP_{i1}, WP_{i2}, ... WP_{iQ}, ... WP_{iQi}\}$ 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 factorfor 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[6]. 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:

$$PT_i = \begin{Bmatrix} f_{i11} & f_{i12} & \cdots & f_{i1b} & \cdots & f_{i1n_i} \\ f_{i21} & f_{i22} & \cdots & f_{i2b} & \cdots & f_{i2n_i} \\ \vdots & \vdots & & \vdots & & \vdots \\ f_{iq1} & f_{iq2} & \cdots & f_{iqb} & \cdots & f_{iqn_i} \\ \vdots & \vdots & & \vdots & & \vdots \\ f_{iQ_i1} & f_{iQ_i2} & \cdots & f_{iQ_ib} & \cdots & f_{iQ_in_i} \end{Bmatrix}$$

Among this, f_{iqb} represented the distribution function of the time for the q component of the b process in the L_i production linewhen 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, $PC = \{pc_1, pc_2, ..., pc_i, ..., p_{cm}\}$ represents the processing cycle ofi production lines. The purpose of the study is how to allocate limited resourcesat different batches plan conditions, and make the total processing cycle T for Plan to be shortest. Establish the following objective function:

$$Object: T = Min\ Max\{PC_1, PC_2, ..., PC_i, ..., PC_m\}$$

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 fastin 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.

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