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CONSTRUCTION OF SIMULATION SYSTEM AND ITS IMPLEMENTATION FOR JOB DISPATCH OF INPROCESS WAREHOUSE ON FLEXIBLE PRODUCTION LINE

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ABSTRACT The constructing method of a simulation system is discussed in this paper. It is for a Decision Support System (DSS) of main in-process warehouse on a large scale flexible production line. This system is decomposed into three function blocks: DSS, support environment for simulation, simulating dispatch module. It has a fine structure and works coordinatively to complete whatever assignment for simulation tasks of a complicated production system.

KEY WORDS logistics, in-process warehouse, DSS, simulation system

The hardship of power crisis in the world stimulates strongly steel continue-casting (CC) and continue-rolling (CR) forgoing rapidly. That implies, linking-up CC with CR, which is highly automatic, integrated and synthesized production system, will be a powerful means to overcome the crisis.

The slab yard — a kind of in-process warehouse — between CC and CR will store slabs from CC and provide CR with them on time. The yard is an important logistical center on CC-CR production line. Once it clogs, it may be a bottle-neck on line, or even a disaster spot interrupting the production process of whole factory.

As far as large scale, highly automatic and flexible production line of CC and CR is concerned, the work in the yard has such characteristics as large quantities of jobs per day, high frequence of input/output of slabs, great varieties of grades of stored slabs, and strickly regular time for feeding high speed rolling mill with slabs.

Such a computer management system of job dispatch is a large scale and complicated one. Normal mathematical analysis modeling is not effective enough to solve the problem. However, an effective approach which leads to a global optimalization goal possibly exists. It is to build a Decision Support System (DSS) for slab store-retrieval dispatching. By use of human experiences of dispatching in form of a special set of rules, the system can make reasonable decisions under some constrains.

Running the DSS directly on a real production line at the first time would be very dangerous, because it would be limited by equipments, and even worse, the whole line would be broken completely. So it is necessary to simulate the behavors of DSS by means of simulation technique.

1 CONSTRUCTING THE SIMULATION SYSTEM AND ITS OBJECTIVES

The concept of separating modeling from experiments has developed greatly, since Ziegler proposed a frame of simulation modeling[1, 2]. A real production system, as it builds on the basis of integrating the material flow and information flow, is very complicated. To realize simulation of job dispatch for a slab yard, the system must have a rational and ingenious structure. It should consist of the following three blocks:

(1) DSS for dispatch decision of store/retrieval slabs; (2) support environment of simulation; (3) simulating dispatch module.

The simulating dispatch module is the kernel of simulating system. It runs DSS in order to achieve the following objectives of simulation for DSS:

(1) Verifing correctness and effectness of dispatch decision. (2) comparing the gain/loss of various decisions; (3) determining proper parameters of system; (4) analysing utilization ratio of equipments; (5) detecting bottle-necks in the operation of system; (6) evaluating performances of DSS.

2 DSS FOR SLAB STORE-RETRIEVAL

On the aspect of slab-yard management, there are lots of requirements of decision-making for solving numbers of complicated problems, including reasonable pilling-up of slabs, optimal dispatch of slabs store-retrieval, rational use of conveyance in yard.

The DSS will be decomposed into subsystems according to various decision problems. Every subsystem has many modules and rule-sets for decision-making, there are

(1) Rules of storing slabs. These rules are used for optimalizing the allocation strategy of storing slabs in accordance with many factors, such as properties of slabs, load ability of conveyance and distrabution state of unoccupied locations for pilling, etc..

(2) Rules of retrieving slabs. In according to required slabs related with assigned specifications and quantites for the needs of successive work procedure, the piles will be searched for proper slabs to reduce times of restore, the distance for conveyance to go and to speed up work rhythm of slabs retrieval.

(3) Dispatch rules of conveyance. Some suitable sort conveyances are chosen by rules for a certain job and works under a good condition with balanced loads.

(4) Rules of restoring slabs. Some appropriate locations are spotted by rules to pile up slabs for restoring.

3 SUPPORT ENVIRONMENT OF SIMULATION

Support environment is a foundamental module for simulation. It consists of the following subsystems:

(1) Database. A global database plays an important role in decision-making process. It keeps data completely intact and shares them to other subsystems. All decisions of job dispatch are made in the light of data from the database.

(2) Database management subsystem. As jobs in yard proceed continuously and automatically in a large scale, the material flow is accompanied with great amount of information, and the dynamic and real-time performances of system must be maintained. Correspondingly, in the process of simulation, the database will be accessed and operated frequently and rapidly. Obviously, a management system is needed for operating on the database and interfacing with other subsystems.

(3) Communication subsystem. This subsystem transfers original data from computers at worksite to simulation computer. The original data will be processed — transformed or interpreted — and then stored in the database of simulation computer.

(4) Data interactive subsystem. It is a human-machine interface for data exchange. The parameters of real system can be changed and the results can be displayed, even the current state of system can be viewed in graphics through windows on screen.

(5) Evaluation subsystem. It has a series of systematic evaluation indexes and evaluation models. It processes result data of simulation statisticaly, then evaluates and estimates every individual index and/or synthetical indexes.

(6) Moving picture demo subsystem. It is a human-machine graphical interface which demonstrates the behaviour of system. It reproduces the simulation process visually, and guides people to understand the whole process directly. The performances of system, such as bottle-neck phenomena, handling capacity, etc., can be grasped macroscopically through moving picture demo. Furthermore, it is easy to debug the simulation programs by the demo. So this demo is also an aided tool for debugging simulation modules. Moving picture demo subsystem utilizes trajectory data of conveyance and moving slabs — these data are obtained and reserved in simulation — to reproduce the dynamic process. Therefore, the following items can be displayed on screen:

(a)distribution of pile locations in yard; (b)movements of all kinds of conveyance; (c) trajectory of moving slabs; (d) indication of timer; (e) jam of slab queues of input/output the yard; (f) adjustment of speed of moving picture; (g) pause or interruption of demo.

4 SIMULATING DISPATCH MODULE

This module, functioned as a high-level dispatch module for the whole DSS simulation, enables all independent subsystems to work coordinately in order to simulate the operation of real system dynamically. In the real system, various jobs in yard can be well described by a series of event-driven activities. These activities will exert affection on the global database, which contains records and state-variables of real system, and cooperate with DSS to solve complicated and unstructured problems of job dispatch in yard.

In this simulating dispatch module, event-dispatch/timer-driven algorithms are

adopted. A brief description of the process is shown in Fig.1

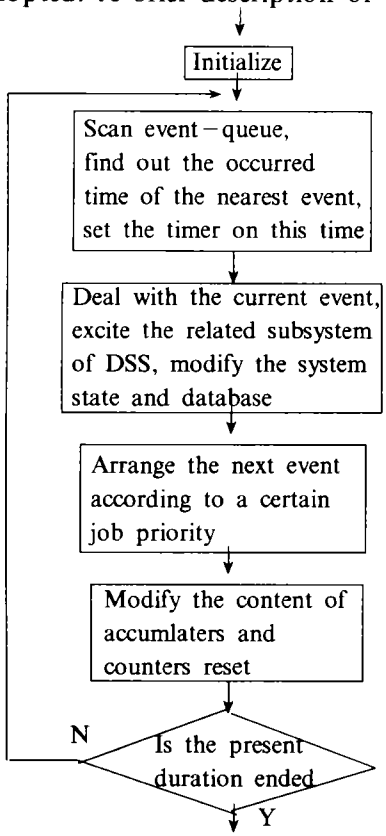

Fig. 1 A brief description of the simulation process

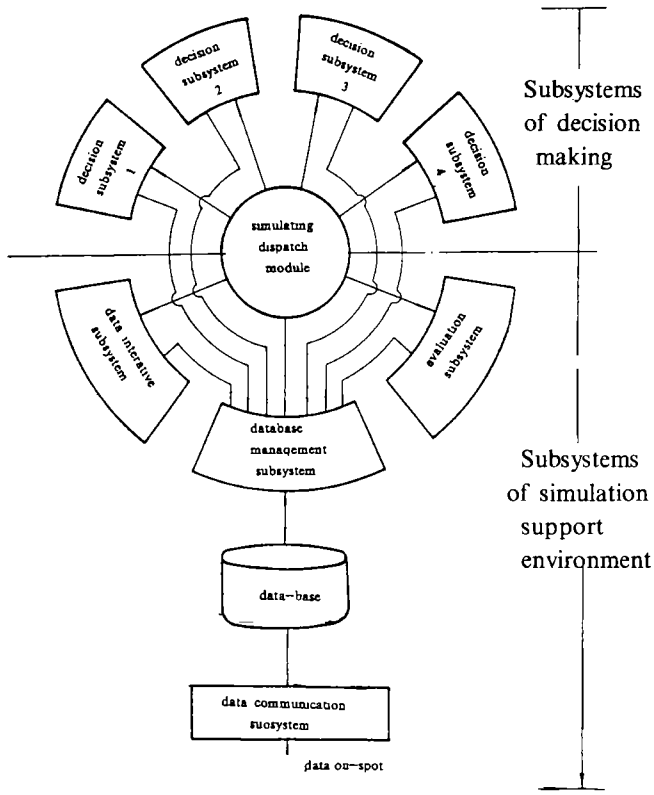

Fig. 2 Architecture of simulation system

5 STRUCTURE OF SIMULATION SYSTEM AND ITS CHARACTERISTICS

Block diagram of the simulation system mentioned above is in Fig.2. It shows a structural relationship between DSS and support environment.

This structure realizes seperate processing of modeling, testing and parameter adopting. It has the advantages of modularity and flexibility because of the separation of data, knowledge and control.

The practical experiences of simulation for a really existed slab yard indicate that, for the complicated simulation problems of a large scale slab yard, such a structure is certainly a successful one with coordinative beauty as well, even if it is possibly not the only feasible.

6 CONCLUSIONS

In-process warehouse is the key link in a procedural chain of flexiable production and integrated production systems. There exist a great number of decision-making problems. In these systems, it is necessary that they should be researched and developed by means of discrete event simulation technique. The suggested structure of simulation system for DSS of job dispatch in warehouse is given in this paper. The practice verified that such a structure is rational and successful.

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柔性生产线中间作业仓库工件调度仿真系统的构建和运行

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摘要 讨论了一仿真系统的构造方法．该仿真系统服务于一大规模柔性生产线上主要中间作业仓库作业调度的决策支持系统(DSS)．系统分解为3个部分：DSS，仿真支撑环境，仿真调度模型．系统具有良好的结构，使之各部分能协同地完成任何复杂生产环境下的各种仿真任务．

关键词 物流，中间仓库，DSS，仿真系统