HUMAN ORIENTED PRODUCTION SYSTEM ARCHITECTURE

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ABSTRACT

Present factories have been aiming at realizing fully automated production processes, however, factories with human workers/craftsmen will be increasing also. It is required to develop the management method to fulfill both the effective utilization of production facilities and the working satisfaction of them. This paper introduces the management architecture for human oriented production systems and explains how to assign jobs in such systems.

The proposed architecture includes two technologies ; one is the communication network in the factory with using the active database system, and the other is the dynamic scheduling method to fulfill workers' satisfaction. The active database system is used to gather the real-time information on the floor and deliver the on-going schedule workers in order to collect their reply for dynamic scheduling.

Keywords: human oriented, production system, system architecture, dynamic scheduling, active database

1. INTRODUCTION

Factories have been aiming at fully automated production processes, and consistent information processing through CAD/CAM to flexible automation systems.

Levels of automation has been achieved to enhance the efficiency in production as synthesis of CAD/CAM systems, automated facilities and scheduling systems. CAD/CAM have predominated over production process, and alteration has taken place in CAD/CAM even if modification has been required in the actual production process. Therefore, this system is unprotected against potential failures, such as sudden change in production plan or failures of facilities.

In order to cope with these problems, distributed manufacturing system with the help of "auction" is effective[1]. Hierarchical architecture among the total system, the cells and the stations add more flexibility when the cells behave independent of each other.

On the other hand, industrial products are required more added values that also requires the craftsmanship on products by skilled labor. It is necessary, taking the above circumstances into consideration, to develop the management method to deal with both the effectiveness of automated facilities and the working satisfaction of human workers and craftsmen.

Craftsmen select the desired jobs by various measures, and the measures are changing by the situation where they are standing. It is difficult to set up the measures in advance. At each time when the job is given, the real time condition of the craftsman concerns not only with the measures of working satisfaction but also with what the craftsman is interested in, that leads the decision whether the craftsman accepts the given job or not. This precess is simular to the decision making process of each intelligent controller in the distributed production systems[1, 2, 3].

2. PRODUCTION SYSTEM ARCHITECTURE

One feasible architecture of autonomous production systems is constructed using a kind of active database system, which is a connection of network system and database system[4]. The database consists

of cell database and job database. Cell database stores present and future forecasted both cell and AGV ability, and the status is reported from the cells and AGVs. The job database stores the production requirements of how many and what parts are to be machined, and present status of each work.

In a surrounding area, production scheduling system and CAD/CAM systems are connected to the core part. Actual machining cells are connected also in this surrounding area. Details of parts are described in the CAD system using machining features with procedure constraints extracted through recognition process in the CAM system[5, 6]. Functionality of machining cells are characterized by feature classes, accuracies and maximum dimensions.

The active database can be elaborated when the triggers occur. Three types of triggers are considered ; the first is the change in production plan that comes outside the database, the second is the alternation in cells or AGVs such as failures and recoveries, the third also comes from cells or AGVs such as evidence discrepancy between the estimated machining/transportation time in the scheduling system and the cell/AGV.

3. PRODUCTION SCHEDULING

Production requirements are given to the active database. Requirements consist of the product representation and required ordered number for each product. The active database stores them in the job database, and deliver each of them to the selected cells that are feasible for machining each product referring to the cell database.

Cell controllers calculate the machining time for given processes and reply the estimated machining time to the active database. Collected estimations are sent to the scheduling system where the processes are assigned to the cells.

Figure 1 shows how the actual task takes place when triggers occur. First, the active database sees the job database and picks up the unstarted processes. Then, cells are selected for each of processes. It must be clear that cells are assigned processes according to their abilities which is stored in the cell database. Each process is delivered to the selected cells each of them estimates the machining time. The estimated machining time by each cell is transmitted to the active database. After sometime the gathered information is send to the scheduling system to generate the production schedule.

4. HUMAN ASPECTS

The above proposed architecture for autonomous production systems can be applied to the human oriented production systems. It is required to develop the following technological subjects in order to apply the architecture to the human oriented production systems.

First is to consider the working hours of each worker. Working hours consist of normal hours and extra hours. Extra hours provide the better commission rate to workers.

Second consideration is the financial awards. In many of the present Japanese factories, workers get salary partially by fixed income and partially by the commission referring to the working results. When workers want to get more salary, they must work harder. For instance, enlonging working hours is one way. They can declare their working hours independently according to their life style and expecting salaries. When the scheduling system assigns the given jobs to the workers within their declaring working hours, the system also shows the expected salary to each worker after calculating the expected commission according to the assigned jobs.

The factory starts to run according to the original schedule, while workers can cause the trigger when they want to change the working hours because of intending getting more commission or enjoying the after working hours by shortening the working hours and so on.

When the trigger is caused, the active database starts to re-generate the new schedule referring to the modified working hours that workers change. The re-generation takes some minutes, and the system sets the negotiation time by experience. All jobs that would start within the negotiation time are assigned to the original workers.

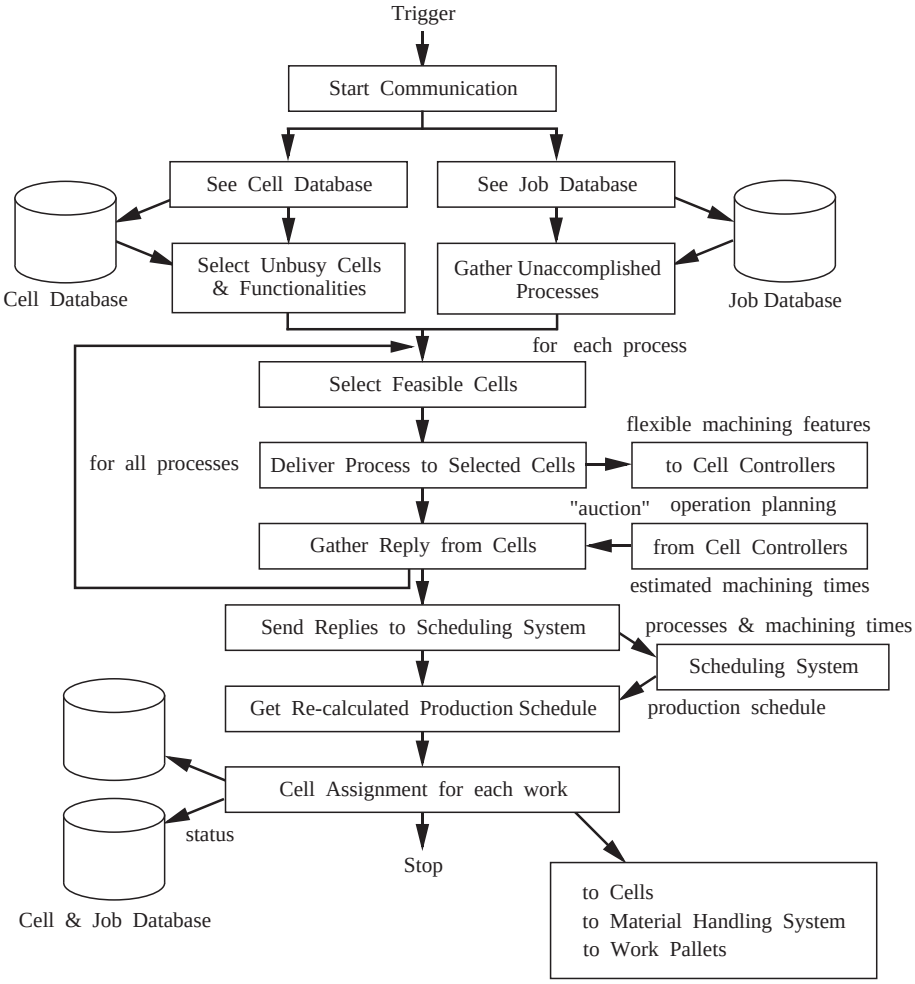

Fig. 1 Process flow raised by trigger

Another trigger may be caused by another worker who changes his/her working hours. Chains of triggers generate those of modified production schedules which are not guaranteed to be converged where all workers satisfy, while the factory continues running to accomplish the given jobs.

5. CASE STUDY

Figure 2 shows the original schedule where the short vertical lines show worker's working hours. The commission oriented salary is shown by the points in the figure. When the worker of cell 5 wants to get more salary somewhile after the factory starts to run, he/she cause the trigger and declares to enlong the working hours which generates the new schedule shown in Fig.3. Job assignment to cell 5 increases, that causes the decrease of salaries of other workers.

Again the worker of cell 4 wants to cause the trigger after somewhile, the production schedule is re-modified as shown in Fig.4. Only workers of cell 4 and 5 increase the commission points. Chains of triggers may be generated while the factory continues to accomplish the given jobs consequently.

6. CONCLUSION

The management architecture of human oriented production systems is proposed that includes two technologies ; one is the communication network system in the factory using the active database system, and the other is the dynamic scheduling method to fulfill workers' working satisfaction.

Although the conversed satisfactory production schedule for all workers can not be generated, the mechanism is proposed that generates chains of production schedules according to the triggers which

workers want to change the present schedule when they feel unsatisfactory. Technological subjects still remain, however, the proposed system architecture must provide the trigger for the fruitful discussion in the near future in this area.

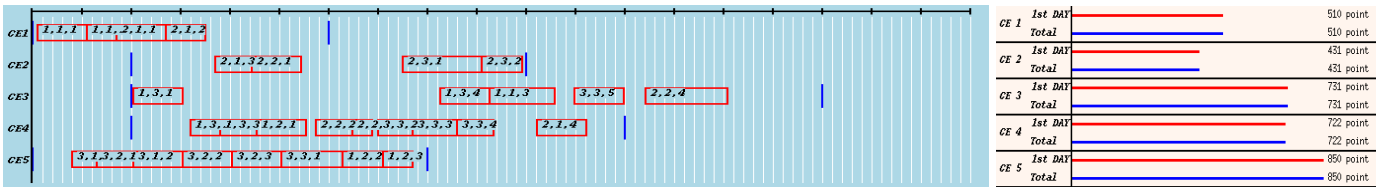

Fig. 2 Original schedule and workers' points for commission

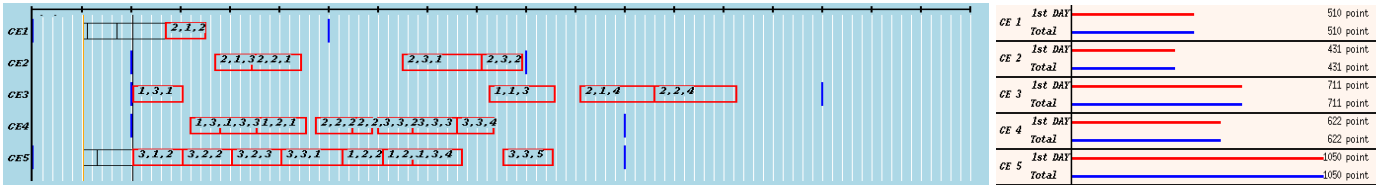

Fig. 3 Result of rescheduling by trigger of cell 5

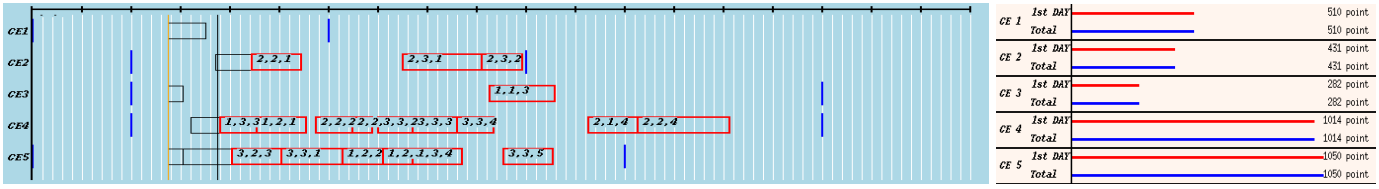

Fig. 4 Result of rescheduling by trigger of cell 4

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