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Design for a Hybrid System of Integration Kanban with MRPII

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ABSTRACT

There have been some studies about hybrid production system, which integrate push system and pull system. Most of them are based on the simple production system considering one product line. Though there are many studies about hybrid production system, it's not practical to implement them for real factory, because most of them did not consider various factors about real factory. On this study we designed hybrid production system considering some factor - one is automatic kanban generation, the other is dispatching rule for Multi-tasking worker, and the last one is the priority of kanban. At last, We give simulation results for a real company, which produce various cameras in Korea.

Key words: MRPII, Kanban, Kanban priority, Multi tasking worker

1. Introduction

The methods of manufacturing are different by the number and type of their products and they are mainly divided into two methods: the first is multi-variety and small-volume production; the second is small variety and high-volume production. According to the different manufacturing environment, there are some different manufacturing methods, such as MRPII (Manufacturing Resource Planning), JIT (Just in Time), GT (Group Technology), Cell Manufacturing and FMS (Flexible Manufacturing System). But the life cycle of manufacturing is so sort and the variation of demands is so fast recently, it is difficult to find the most valid method of manufacturing for a certain product.

Many researchers study the possibilities of the integration MRP with JIT, but they are not practical to implement them to real industry, because most of them do not consider various factors about real manufacturing environment. In this paper, we will study the problems on integration MRP with JIT, which is practicable in real industries.

For improvement the forecasting of demands for the parts of products, J. Orlicky divided the demands for the parts of products into two kinds: independent demand and dependent demand in 1970 (see [5]), which is the advantage of the MRP (Material Requirements Planning). After that, MRP was developed to closed loop MRP by integrating the CRP (Capacity Requirements Planning) and feedback systems, and then the closed loop MRP was developed to MRPII by integrating the financial accounting system. The following research was concentrate on lot sizing problems for decreasing the WIP (Work in Process)(see [2]), finite capacity planning, DRP (Distribution Resource Planning) and the integration MRPII with service management system (see [3]).

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JIT is very successful to decrease the WIP which is controlled by kanbans to get exact amount of parts from the upstream on time for the downstream at early time in Toyota (see [4]). After that, there many studies on JIT, such as optimum number of kanbans in JIT (see [6]), performance measurement for JIT (see [1]), mixed product line sequence in JIT and the integration of MRPII with JIT et al.

The common characters of job shop, which applies the hybrid system, are given as follows:

First, most of them are the ATO (Assembly to Order) environment. The structure of BOM (Bill of Material) is hourglass type and the interarrival of demands is long, but there need less time to finish the last procedure when the demand arrives, because the production implements according to the module production based on shadow BOM to keep some WIP.

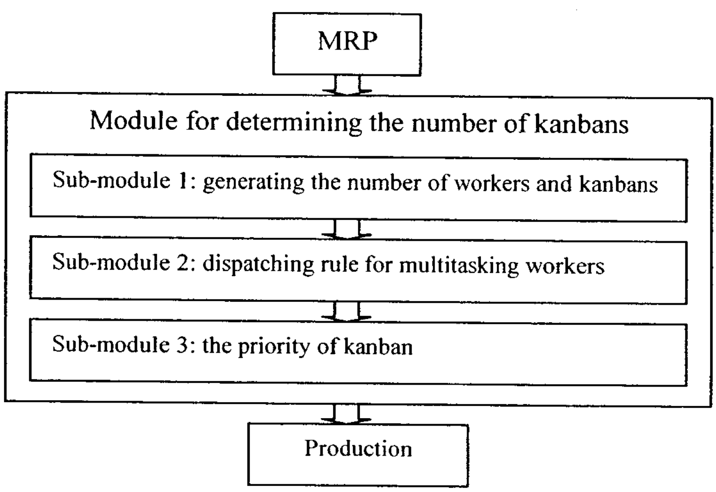
Second, variation of demands for materials is very frequent and the variety is also great. The number of modules of BOM becomes small, but the number of combination of materials becomes great. There are many varieties of last products and the demands for them are also variational.

Some materials in the module of BOM are common parts. So demands for these materials are more stable than others and they are suitable to process in JIT system with kanbans. By contraries, the interarrival time of demands for the parts, which are not common parts, are long and variation of amounts of them is also frequent, so they suitable to process in MRPII system.

2. Design for a hybrid system of integration kanban with MRPII

2.1 Main structure of the hybrid system

The hybrid system of integration kanban with MRPII, which will be studied in this paper, has three sub-modules: the first one determines the number of workers in production lines, the second one determines the dispatching rule of multitasking workers and the third one determines the priority of kanbans. The main structure of the hybrid system of integration kanban with MRPII is given as [Fig 2.1].



[Fig 2-1] The structure of the hybrid system

2.2 Module 1: generating the number of workers and kanbans

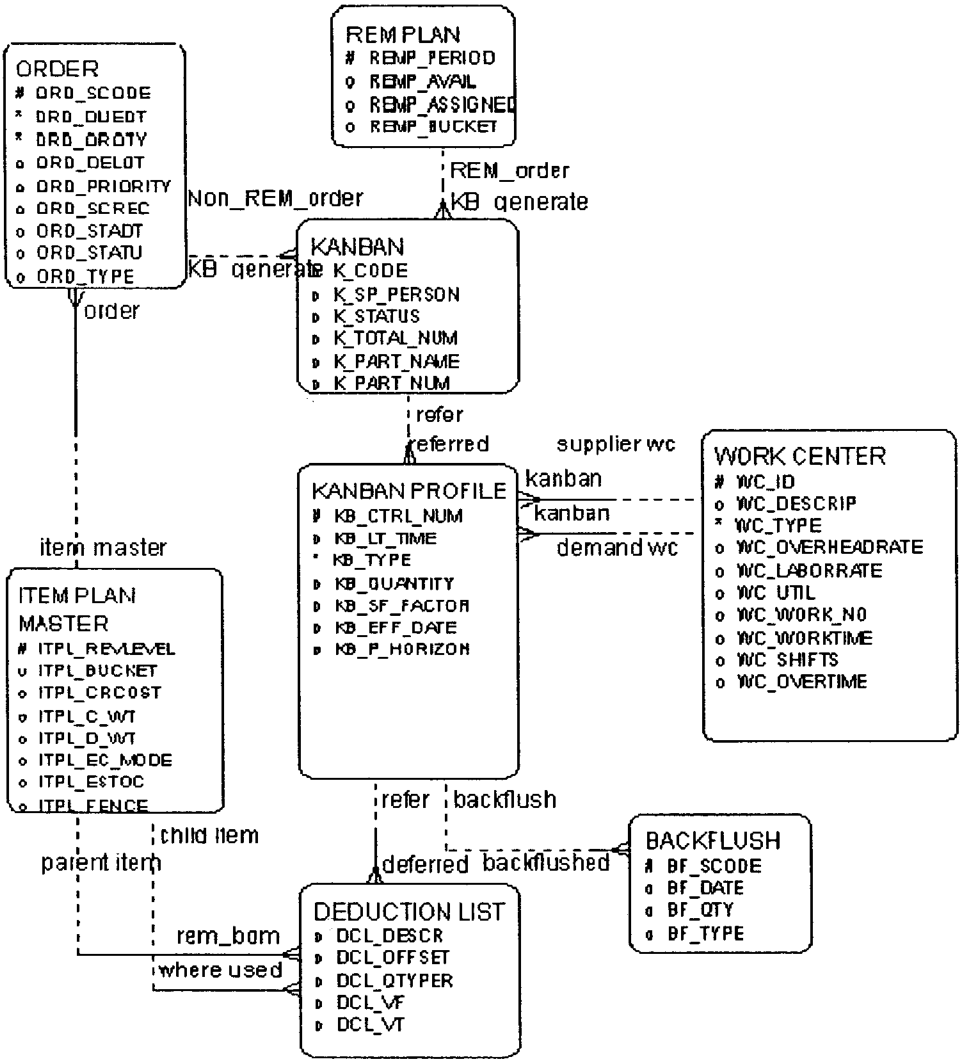
The number of workers in each work center is generated by the following formula:

$$The\ number\ of\ workers = \frac{D \times LC}{T}$$

where D denotes the amount of demands per week, LC denotes the work time needed for a product and T denotes the work time per week. The number of kanban is generated by the following formula:

$$The\ number\ of\ kanbans = \frac{D \times L \times (1+\alpha)}{C}$$

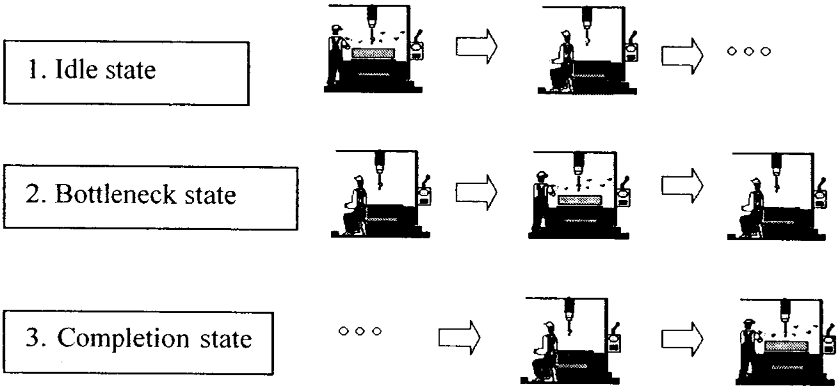
where D denotes the amount of demands of the downstream work center, L denotes the lead time of production, α denotes the safety stock coefficient and C denotes continuing capacity. The ERD of the standard MRP by above formulas is given in [Fig 2.2].



[Fig 2.2] ERD of the standard MRP

2.3 Module 2: dispatching rule for multitasking workers

In Module 2, it is important that multitasking workers may move the other production line for the different process according to variation of daily demands. We consider possibility for movement of multitasking workers to the other production line in the JIT environment. There are three states in a production line, when the multitasking worker may move to another line. These three states are given as follows:



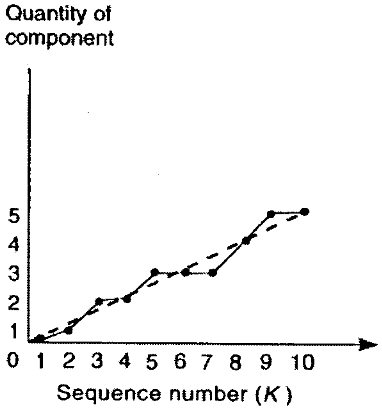
[Fig 2.3] Three state of needing to dispatch multitasking workers

There are four methods of dispatching multitasking workers, such as FIFO (first in first out), SPT (shortest processing time), LNQ (length of the queue) and LSF (last station first). Thus, combining the three state of a production line and four methods of dispatching multitasking workers, we may obtain twelve dispatching rules of multitasking workers.

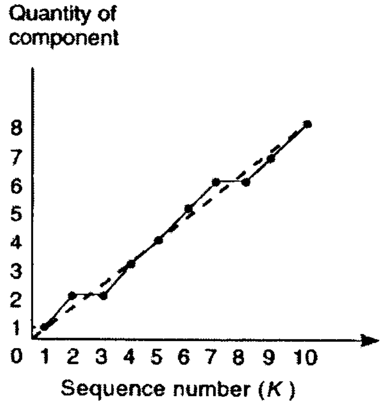
2.4 Module 3: determining the priority of kanbans

It is general situation to accumulate many kanbans in box and delay the corresponding production as the general method for selection kanbans. When there exist product mix, this method has advantage for the serial production line, but it is unsuitable to the ATO environment.

[Fig 2.4] and [Fig 2.5] show the variation of the quantity of component.



[Fig 2.4] curve of demand for general component



[Fig 2.5] curve of demand for stable component

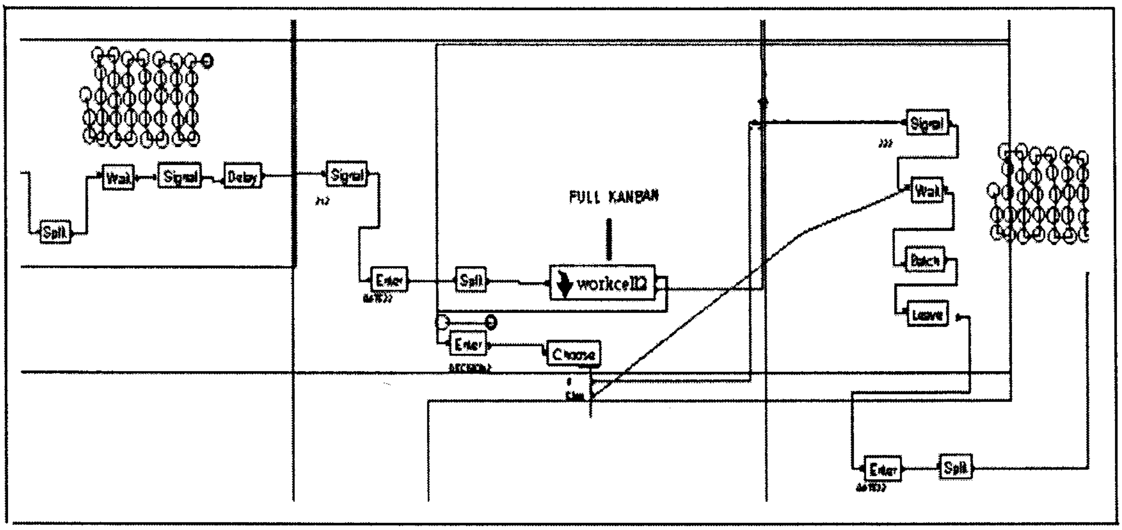
In Module 3, the demand of total components is controlled as in [Fig 2.5] to decrease WIP in ATO environment, as given following formula:

$$D_{ki} = \sqrt{\sum_{j=1}^{\beta} \left(\frac{KN_j}{Q} - X_{j,K-1} - b_{ij}\right)^2}$$

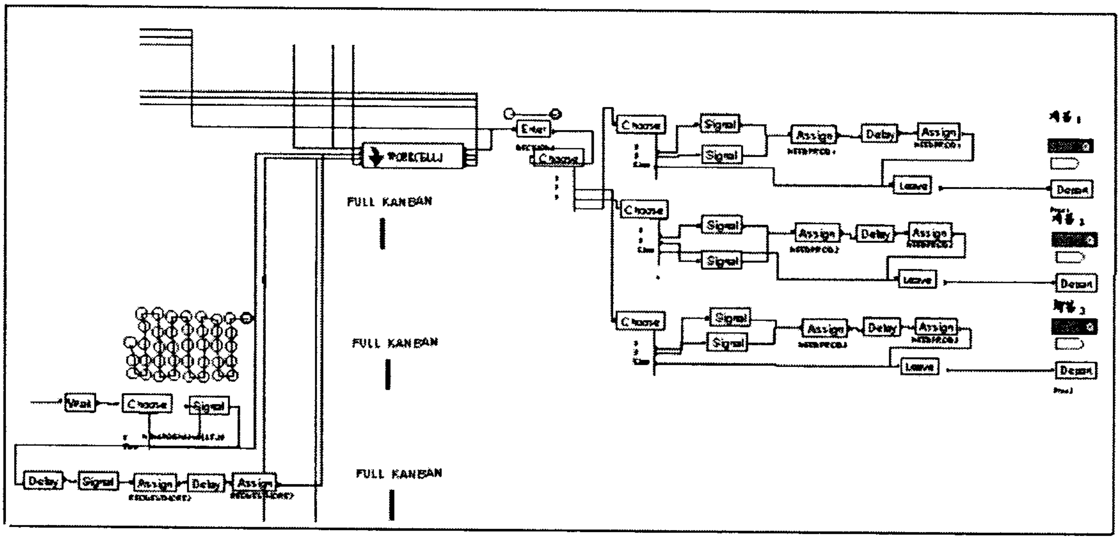
where D_{ki} denotes the distance to be minimized for sequence number K and for end product i, β denotes the number of different components required, K denotes the schedule sequence number of the current end product, N_j denotes the total number of the component j required in the final assembly sequence, Q denotes the total number of end products to be assembled in the final assembly sequence, $X_{j,K-1}$ denotes the cumulative number of component j actually used through assembly sequence $K-1$ and b_{ij} denotes the number of component j required to make one unit of end product i (also see [7]).

3. Simulation Results

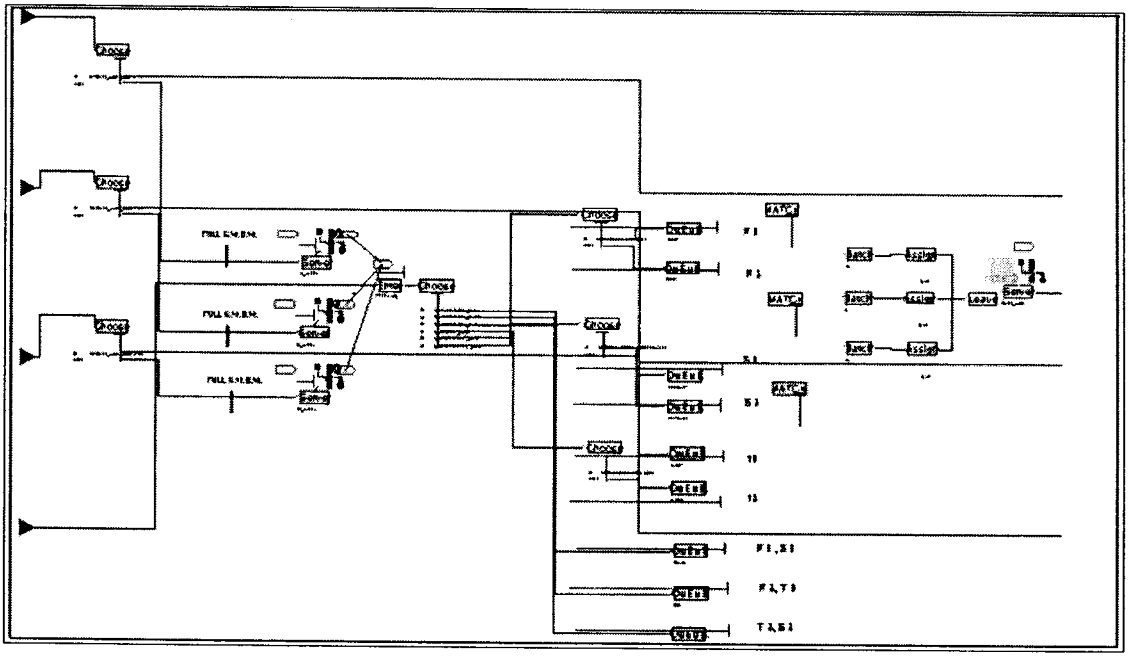
In this section, we use the simulation software Arena 3.5 to simulate a real company, which produce various cameras in Korea. The modeling of the manufacturing system are given in [Fig. 3.1], [Fig. 3.2] and [Fig. 3.3].



[Fig 3.1] The modeling of pull system



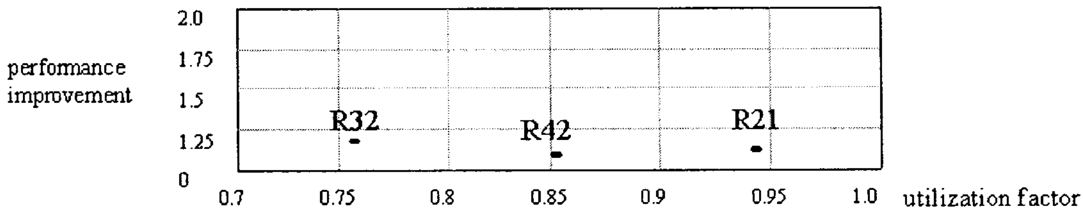
[Fig 3.2] The modeling of assembly line



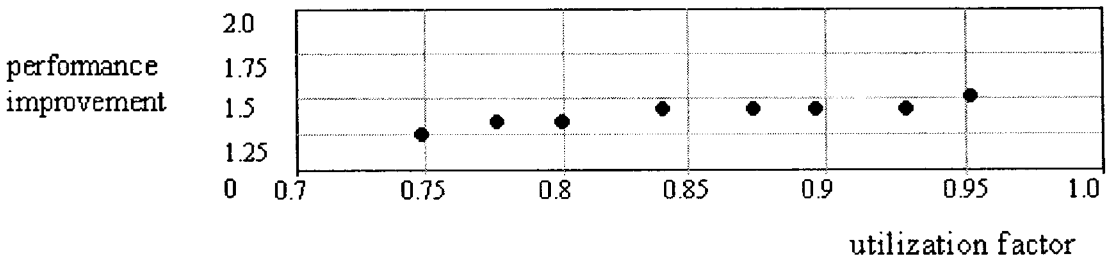
[Fig 3.3] The modeling of sub-assembly line

Some simulation results are given in [Fig 3.4], [Fig 3.5] and [Fig 3.6], where MV denotes the number of multitasking workers, CV(H, H, H) denotes the coefficient of variation of demand for three product mix are high, Rij denotes the dispatching rule of multitasking workers by j-th method in j-th state.

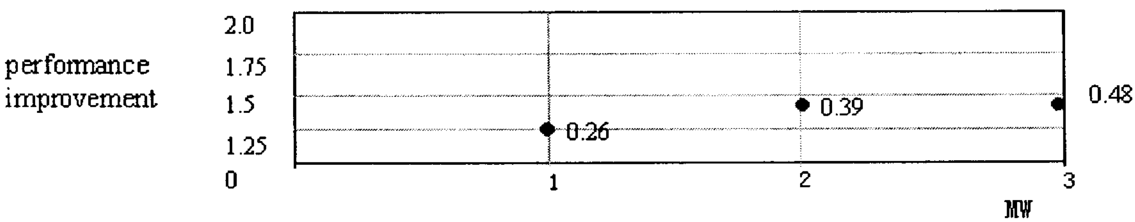
MW = 1, CV(H, H, H)



[Fig 3.4] The best choice of the dispatching rule when MV=1 and CV(H, H, H)



[Fig 3.5] Graph of utilization factor



[Fig 3.6] Graph of multitasking worker

4. Conclusion

There is no principle for choice one of dispatching rule of multitasking workers and each dispatching rule is suitable to certain special situation. The main variation factors which determining the choice of dispatching rule are the numbers of multitasking workers, utilization factor and variation of demands. Although amount of production increases when the number of multitasking workers increases, but their relation is not linear.

One of R21, R22 and R23 is the best choice for dispatching the multitasking workers when the quantity of utilization factor is high, and one of R31, R32 and R33 is the best choice for dispatching the multitasking workers when the quantity of utilization factor is low. R43 is the best choice for dispatching the multitasking workers when the variation of demand is high, and R41 is the best choice for dispatching the multitasking workers when the variation of demand is low. The three factors, which influence the dispatching rule of multitasking workers, also influence WIP by the feedback mechanism of MRPII system and make for decreasing the number of kanbans. On the other hand, hybrid system in integration kanban with MRPII has high efficiency when there exists product mix. Increasing the efficiency of production line is our main purpose in this paper.

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