A JIT/MRPII INTEGRATED MODEL FOR A REPETITIVE MANUFACTURING ENVIRONMENT

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Abstract: This paper deals with the Manufacturing Resource Planning(MRPII) and Just-In-Time(JIT) philosophies, integrating both in a harmonic and simple form, as one method to explore the simplification of the planning process and the programming and control of the manufacturing system. The scope of the model here described refers to the repetitive manufacturing environment. This paper proposes a JIT/MRPII integration model in order to facilitate the management task of a flow-shop type production company. The necessary aspects for this integration as well as the essential elements are here considered.

Keywords: JIT manufacturing; Material balance control systems; Order reduction; Closed-loop systems; Capacity; Production systems

1. INTRODUCTION

Presently most manufacturing companies are searching for low cost solutions for business management. In a highly competitive market, due to a global economy process, it is necessary to make a full revision of the organization, in order to identify the potential waste sources. The effect of this revision is the establishment of simple, low complexity solutions, where expressive savings can result. These savings can occurs through the simplification of the manufacturing process as a whole, from of materials planning until finished goods shipping.

This paper deals with the MRPII and JIT philosophies, integrating both in a harmonic and simple form, as one method to explore the simplification of the planning process and the programming and control of the manufacturing system. The scope of the model described here refers to the repetitive manufacturing environment. Following a short literature review is presented to show what has been done in the field of JIT/MRPII.

2. LITERATURE REVIEW

Rao and Scherega (1988) present a mechanism to move from MRPII to JIT manufacturing. It requires that changes should be done in each MRPII module, from Shop Floor Control(SFC) to Master Planning Scheduling(MPS) module. These visionary aspects from Rao and Sherega, can be found today in commercial MRPII softwares. Also, the authors suggest a form of check-list to evaluate the MRPII softwares available in the world market. To Miltenburg and Winjngaard (1991), many organizations are experimenting with JIT, and most of them are having difficulties in making it work. In order to facilitate the implementation process, the authors proposed a three-step methodology. It begins with a two-bin inventory system, move to a pull system with kanban, and then to a continous flow production system. These aspects are important to the proposed model, and they show that a gradual implementation is as important as the JIT techniques and the Material Requirements Planning(MRP) software required for implantation. Flapper et al. (1991) described a three-step framework which makes use of MRP's backflushing and phantom features that allows the JIT principles be used.

The results of the research work of Krajewski et al.(1987), show that the kanban system alone is not enough to improve the overall performance of the system, it is only one part of the whole manufacturing philosophy intended to reduce inventory investment, increase productivity, and customer satisfaction. The authors explain that these results were obtained in laboratory studies. Gupta and Brennan (1995) related that major difficulties were found with the implementation of MRP systems due to the uncertain nature of the manufacturing environment. The principal aspects apprised by the authors comprehended supply and manufacturing process uncertainties. Lee and Paek (1995) highlight the importance of considering the role played by customers in a JIT implementation. This aspect is not taken into account in this research work.

Lundrigan (1986) related the principal rules of Optimized Production Technology(OPT). Among them the use of the concept of flow balancing instead of Capacity and that constraints determine nonbottleneck utilization are the most important for the model here proposed.

3. PROBLEM CHARACTERIZATION

A relatively small number of world class manufacturing companies or class "A" companies have implemented in full the MRPII philosophy. The class "A" companies are those that make full use of the Capacity Requirement Planning(CRP) and Shop Floor Control Modules. The CRP module has been the module that presents more difficulties to ordering operations production. For repetitive manufacturing companies this is even more difficult due to small item lead-times and due to the accuracy of them.

In the 80's, the MRPII was developed and implemented mainly in a job shop environment, instead of repetitive manufacturing environment. The framework of the MRPII package makes it difficult the "closed loop" process. However, even though the MRPII hasn't had much success with the CRP module, its capacity of data organization and the facility in the treatment of long and medium term planning has to be considered as strong positive features and should be maintained. Unfortunately, MRPII has not given to its users the necessary confidence in order to implement the concept in full. In this proposal, specific functions related to the repetitive manufacturing environment are proposed in order to adapt the software to a flow shop situation.

On the other side, the JIT philosophy and the kanban concept can be applied in serial-line production, where the items present small lead-times and the planning is a short term planning. These features of flow shop manufacturing environment match very well with the JIT philosophy. Its capacity in dealing with process control, process layout and operation sequencing should be fully used.

4. MRPII SOFTWARE

To validate the adherence of the available software with technical literature about integration of JIT and MRPII philosophies, a research with principal vendors of MRPII software in the Brazilian market was carried out. One relevant aspect was the reference of these software in the research of Gartner Group as MRP solutions. The principal result of this research was the conclusion that the software, usually, make it easy the integration of the two philosophies as far as the correct parameters are used.

5. ESSENTIALS REQUISITES FOR THE INTEGRATION

The integration JIT/MRPII isn't immediate, occurring in a time span depending on the complexity and size of the company. Within this aspects some requisites are indispensable for this combination. For this integration to occur in a simplified manner, a revision and analyses of some points are necessary:

5.1 Cultural Adaptation Of Organization With New Paradigms

The human involvement and contribution is necessary for the success of this integration. Without human involvement the consolidation will remain under obligation. A framework based on JIT concepts requires that the organizational and human elements like cross training, leadership, flexible labor and others necessary JIT elements referring to human aspects be present at the organization.

5.2 Information System Adaptation

The information system has to be completely changed for the MRP system be able to respond promptly to the hybrid condition of JIT/MRPII. The use of data collectors, for instance, will give a greater dynamism to the plant improving production and movement reports of materials.

5.3. Planning, Process And Control Methodology

The production process should attend the new paradigm which combines the push and pull system simultaneously. All process organization criteria such as cell production, setup reduction, warehouse elimination and flow type processes should be established. The management systems should foresee solutions to facilitate the production programming through rate production, reduction of production reports, production programs instead of productions orders and kanban tags emissions. These points allows the system to operate with simplicity. The methods used to define the planning and control tasks has to be adapted to the new reality. The new process organization encourage this adjustment.

5.4. Gradual Implementation

A gradual implementation is required in order to achieve a successful model application. The change can not occur immediately. The incremental process provides the consolidation of each project phase in the organization. Several topics can admit gradual implementation and these should be identified before it starts.

5.5. Parameters Revision

Parameters such as order policy, queue time, setup time, movement time and others, form the necessary data base for the operation of MRPII,. The fact is that the union JIT and MRPII requests a judicious evaluation of this data.

6. MANAGEMENT MODEL

The following elements are required in order to create the model. They should be estimated at the onset . Also a brief discussion as how this model defines the JIT / MRPII integration as well as some cautions are done following.

6.1 Ideal Environment To Model Application

The determination of the ideal environment for model application is fundamental to the success of the project. For both concepts JIT and backflush the ideal condition is that inventory level should be the minimum possible. Despite this, the Brazilian reality makes it difficult to achieve these ideal conditions, in function of long distances between the suppliers and customers and the lack of qualified raw materials suppliers. This brings undesirable effects to the application of JIT concepts. Therefore the model attempts to create ideal conditions to the application of these concepts.

To apply the JIT components the model tries to isolate the problems generated by high inventory levels, high supplier lead-times and low frequency of material/components delivery. This problem isolation is done through inventory segregation. In others words, this means that three different warehouses are created: Raw Material, In-Process and Finish Good warehouses(see Fig. 1).

The segregation of inventories makes it possible to apply simultaneously distinct production planning methodologies. The model proposed here permits "make to order" or "make to stock" production system be implemented without JIT philosophy conflicts.

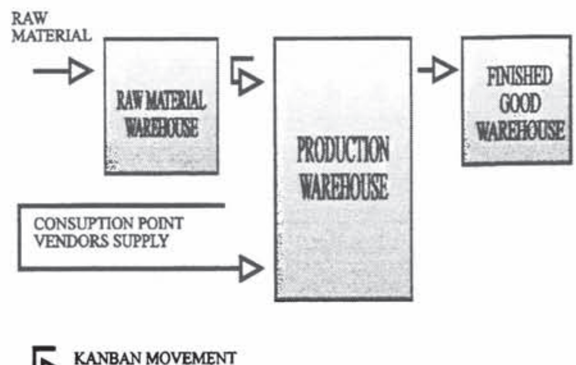

Fig. 1. Warehouses Structure for the Proposed Model

In this condition, the production warehouse will be the JIT environment, where all JIT philosophy components can be applied. This is possible because of the low inventory level. The raw material and finished goods warehouses, represent the non JIT environments. Meanwhile the model contemplate one precise relationship among JIT and non JIT environments(see Fig. 2).

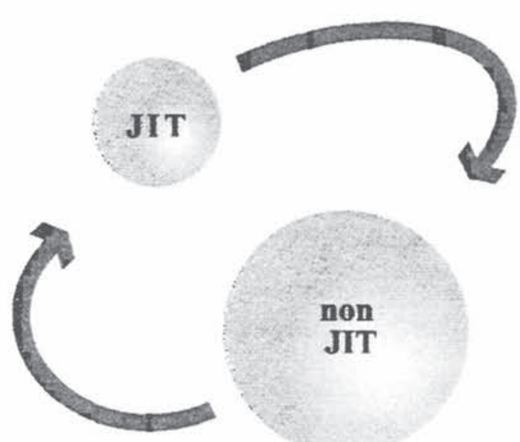

Fig. 2. Model Environment Illustration

6.2 Components Backflush

The backflush, meaning deduction of materials, requires previous studies for its implementation. Because it is a mechanism of inventory control, its application should be limited to the JIT environment. Therefore adequate parameters are employed to assure that the backflush concept will be applied only in the Production Warehouse.

6.3 Control Blocks

The creation of control blocks is done based on the bill of material through the identification of controllable items and respective report points. The report points define the interfaces between the blocks. This concept works very well for repetitive manufacturing, fragmenting the vision of materials in process. The results of the control blocks creation process is the reduction of report points, and the introduction of the philosophy of reporting only what really aggregate value to the final product.
The figure below illustrates this process, where distinct blocks have as input raw material and/or subproducts and as output subproducts or finished products. The differential between inputs and outputs refers to the work-in-process.

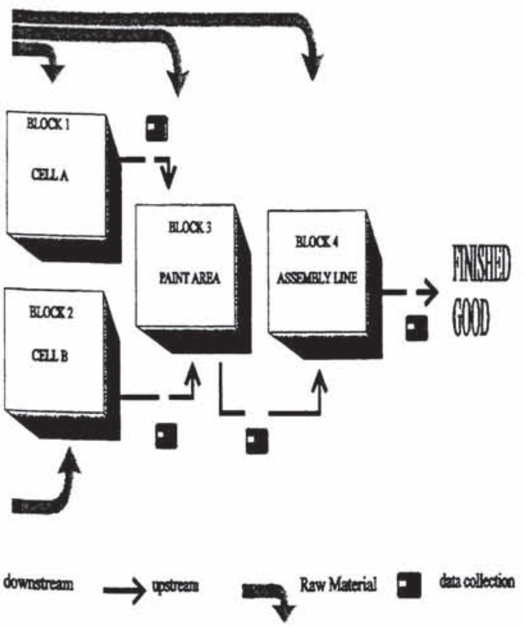

Fig. 3. Control Blocks Concept

6.4 Movement And Storage of Materials

The movement and storage of materials will happen through the selection of supply forms between suppliers and company. The introduction of production, raw material and finished goods warehouses allows a perfect match between the company logistic process and vendors supply capability.

To distinguish the forms of supplies, the model establishes two ways:

Firstly. "shop floor items" should be selected. The "shop floor items" are items that can be stored directly on the shop floor. Its main characteristics are low lead-times, high supply frequency, supply standardization and quality assurance. The supply of these items can be made by the supplier in the consuming point.
In the sequence. "stock items" should be selected. The principal aspects of these items are high lead-times, quality not assured, and low supply frequency implicating in high volumes. These items will have traditional reception treatment like quality control and will be stored in the raw materials warehouse.

An addressing system supported by the information mechanism is required to facilitate the storage and movement of "shop floor items" or / and "stock items".

For an adequate system of material supply between raw material warehouse and in-process warehouse a "pull" mechanism employing kanban tags will be adopted. With this mechanism, low inventory in the shop floor will be achieved.

6.5 Bill Of Materials

This model establishes principles to develop the products' bill of materials taking into consideration intermediate backflush points, including controlled and not controlled items. This bill of materials differs from common JIT practice where the bill of materials has only two levels. The bill of materials here proposed considers phantom items and controlled items to attend spare parts and controlled and acceptable scraps.

A few points that can be considered during the creation of the bill of materials are:

strategic items;
spare parts;
items with notable rework and scrap volumes, when compared the JIT patterns;
items that utilize bottleneck work center;
items with elevated lead-times, when compared with others;
items that waiting for final assembly scheduling;
items elaborated through kanban.

The figures bellow presents the traditional bill of materials to JIT environment, encounted in technical literature concerning integration and the bill of materials proposed for this paper.

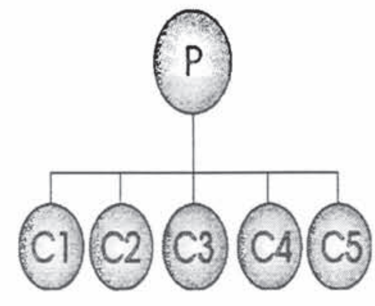

Fig. 4. Bill of Materials - JIT practice

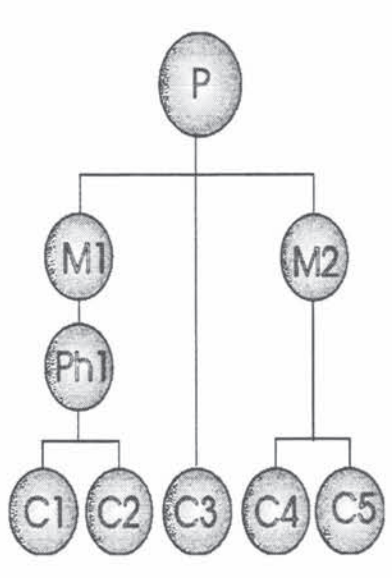

Fig. 5. Bill of Materials Proposed

The combination of phantom items, which are traditionally not controllable and not storable, with standard items, which are controllable and storable, allows the bill of materials structure as proposed.

Based on commercial software study a possibility of linking process planning routing to the phantom items has been envisaged. Consequently, it is possible to determine the capacity requirements and associated costs for these items. Another aspect to be highlighted is the possibility of storing phantom items and the emission of production orders for these kinds of items which make it possible to overcome several difficulties found in existent industrial management systems.

6.6 Proposed Planning Structure

The aspects related with planning for this model assume two important functions:

- Material Planning
- Capacity Planning

Of course these are common instruments for production planning but the difference is in the way they will be used in the proposed model. More details are presented in the sequence.

Materials planning. Concerning the elaboration of the Master Planning Scheduling(MPS) the demands will be accumulated per period whereas for the Material Requirement Planning(MRP) demands will be split in a daily basis. This assures a detailed information which is more appropriate to a JIT environment.

The MRP exception reports, programming (start and due date) and other traditional reports aim to attend the bought and controlled (manufactured) items. The others manufactured items, specially phantom items, will make use of kanban tags. The phantom items net requirements will be converted into kanban tags, respecting the conditions of each items like minimum, maximum and multiple lot.

Capacity planning. The purpose of this model is to permit a strategic vision and not just an operational vision of the capacity requirements. Furthermore, the objective is to limit to the critical resources the analyses of capacity. These resources are represented by work centers, tooling and other measuring resources. The system used to evaluate capacity is the CRP module, through the employment of rough-cut concept. A special effort is necessary to identify the possible constraint resources. These work centers can be assembly lines, manufacturing cells, a group of identical equipment or even specific equipment. The objective of this planning procedure is to work only with the exceptions.
The figure below summarizes the information flow.

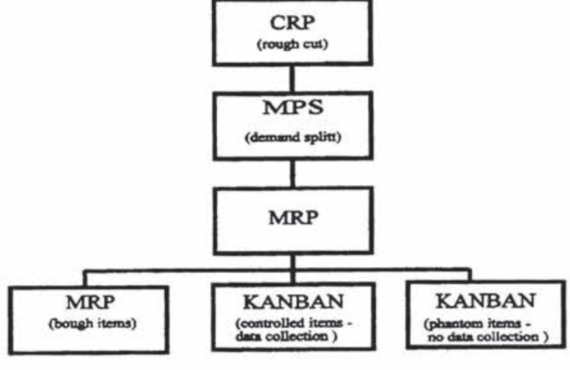

Fig. 6. Planning Structure Model

6.7. Control And Programming Production

The programming activities satisfy the JIT criteria. Programming, sequencing and operations ordering are JIT functions through kanban system.
On the other side, the control is left only to final and controlled items (data collection). The control

model is very simple since it attempts to identify those controls that result in business opportunities.

6.8 Shop Floor Execution

The program execution in the shop floor is developed through kanban system. The kanban system assumes the function of production liberator, coordinating all productive process. The objective is to have a balanced system and a kanban system, transparent to manager system (computer) making data collection unnecessary in most cases.
Although the model treats the kanban system in a transparent form, there is a dependency of the numbers of kanban tags and the net requirement of the planning items, even them being phantom items. The advantage this dependency is to avoid unnecessary productions items, reducing in-process buffers and compromising production with balanced kanban tag emissions. Once again a precaution should be taken with parameters like offset, safety stock and others. The utilization of this resource should be conditioned to low lead-times items and program release near to real needs, avoiding unnecessary release.
With short vision the kanban performs this task with success and the product can be felt through low work in process, low buffers and low number of transactions. Another point is the simplicity of its operation in series productions.

6.9 Orders Production Management

The term order production is replaced by the term program production. All production orders are transparent to the manufacturing system because of the kanban system. The report system is established in order to report the produced quantity of the item, disregarding the order in process. The system treats this case with simplicity selecting the older order.

7. CONCLUSION

The proposed model proved to attain the purpose of facilitating the management of repetitive manufacturing systems, employing JIT and MRPII concepts simultaneously. Besides OPT concepts were also explored to schematize this modeling. The movements reduction, low number of reports and low number of transactions can be viewed easily and the coexistence of JIT and MRPII philosophies in the same environment is practicable. The MRPII software research demonstrated that the software has adherence with current technical literature. The Repetitive Manufacturing modules shows a MRPII software further appropriated to flow shop environment, allowing better adaptation with pull and push paradigms. An important contribution of this model is planning, control and programming facilitation, operating in most cases as mechanism of simplification(see Fig. 7).

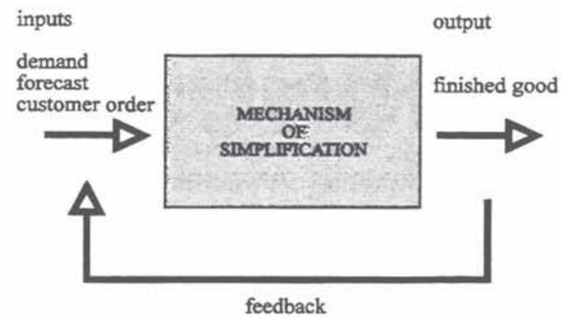

Fig. 7. Operation Model: Mechanism of Simplification

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