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Intelligent integrated MRP, MPS and Detail Scheduling

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Abstract

In most of manufacturing companies, material requirement planning, master production schedule and detail scheduling are performed in a hierarchical method. The material requirement plan is made according to the inventory available and the additional requirement of the material due to new demand. There is coordination and sharing of information between the material requirement plan and master production schedule. Later the master production schedule which gives the priorities of the production orders and order release information, is then used to make a detail schedule in the shops. However, there is strong interdependency between the master production schedule, material requirement planning and detail planning in the shop which cannot give global solution if they are not intelligently integrated and coordinated in planning simultaneously. When new orders arrive, the material requirement plan, master production schedule and the detail scheduling are required to be considered simultaneously to generate new plan for better service and operations and it is highly desired to continuously transfer information flow and material flow in the plans. Therefore, current research focuses on the development of an intelligent integrated MRP, MPS and detail scheduling procedure for global optimal solutions. An overview of information sharing and intelligent integration of MRP, MPS and detail scheduling system is presented. Moreover, additional problems of intelligent integration of system are presented.

Keywords

Master production schedule, material requirement planning, detail scheduling, global optimal solution.

1. Introduction

Production planning and detailed scheduling are two levels of planning in the manufacturing industries. In the production planning level, master production schedule is developed to select different customer orders according to some selection criteria. This selection also depends on the material requirement planning (MRP) information. For example, if the required material is not available in the inventory, then the selection or rejection of orders decision are made in coordination with the MRP. Moreover, scheduling of the selected orders is made and the material requirement of the selected orders is prepared and order release schedule are prepared. This is at medium level planning and do not involve the detail shop floor activities schedule. The mid-term planning could be for one month period or for more time. The master production schedule contains the information of order priorities, their detail release information including release date, the quantity to release and other requirement etc and it is made in coordination with the MRP. MRP is also used to prepare purchase order, if some material is not available in the company at the required time. The production order release information is generated by the MPS while the shop prepares production schedule for small planning horizon in accordance with the plan order release. The orders schedule is given to the shops and the shops can make detail schedule of operations, the material delivery plan to the machines on short horizon etc. In automobile manufacturing industries, the detail scheduling can involve the mix model production schedule on the machining lines or transfer lines. Similarly, the detail scheduling of final assembly shop involves mix model assembly line sequencing etc. The customer orders, or the plan of complete assembled product is planned in the MPS while the product sequencing, machining sequencing and mixed model sequencing etc are the detailed scheduling problems for the MPS.

The planning problem of acceptance and selection of customer orders (Hinidi and Ploszajski 1994; Bolat, 2003; Gans, 2008; Volling, 2009; Wang et al. 2010; Manavizaheh et al. 2013) and scheduling of orders has been presented in literature for the medium level planning (Manavizaheh et al. 2013). For example, Chen (2014) proposed a two-step order fulfillment structure in which multiple number of sites for order allocation and single site shop floor scheduling. In the first step, the order allocation problem is solved and in the second step, an ideal order release is performed. Moreover, the detailed scheduling problem has also been investigated by many researchers for production (Juan M. Novas and Gabriela P. Henning, 2012; Rami As'ad and Kudret Demirli, 2010; Patrizia Beraldi et al., 2008). In most of the research, the planning problem and the detailed scheduling problems has been investigated separately, however, these two problems are interrelated to each other. There is strong interdependency between these two problems and solution of one problem can affect the optimality of the other planning problem. The planning problem and detailed scheduling problem has been studied in hierarchical way in some researches (Hax and Meal, 1975; Julian Englberger et al., 2016). Traditionally, the planning problem is solved to predict the production targets and material flow over the mid-term planning horizon to satisfy the customer demand, the scheduling problem is usually is performed once the planning has been done (Julian Englberger et al., 2016). There are number of hierarchical planning research found in literature (Bassett et al., 1996; Munawar and Gudi, 2005; Erdirik-Dogan and Grossmann, 2006) which considered medium level planning and then they do short term planning problems. For example, Wang et al., (2010) proposed the problem of order scheduling in multiple mixed model assembly lines. Moreover, Wang et al., (2013) used a two-step procedure to get order scheduling and mixed model sequencing using hierarchical method. In the first step, order which can meet the due date are selected and later order schedule is performed. In the second step, the mixed model product sequence is performed based on the order schedule formed. The planning problem and scheduling problem are highly interrelated and treating each problem independently can give local optimal results of the schedules. Moreover, the MPS also depends on the MRP and MRP depends on the MPS. The schedule of orders is not feasible some time if it has not considered the material requirement planning in it. Moreover, MPS and MRP collectively are required to generate the plan for purchase order release, outsourcing and production order release. The production order release is not optimal or feasible if it so not considers the continuous information of the capacity of the resources and availability of the resources during generation of order release plan. In literature and in most of the production companies, the plan order release is made from some inventory information and material requirement plan. The detail scheduling is made from the prepared plan order release which may consider the capacity limitations in detail planning but it may not be significant to the order release plan because, the detail schedule plan made in these shops might be optimal for one specific case of the order release plan and may give local optimal results. There is requirement of continuous information flow from shop floor and from MRP for making plan order release. Moreover, the continuous flow of material and information between MRP, MPS and detail scheduling is significant in making the plan order release according to the demand and capacity availability to significantly satisfy the demand for better service and operations and it is highly desired to coordinate the information flows and material flow in making plans.

2. Integration of MPS, MRP and detail scheduling

2.1 Hierarchical approach for MRP, MPS and detail scheduling

In most of the companies, the two mid-term planning problem and detail scheduling are performed at different time. The plan generated in MRP and MPS is sent to the production shops and based on this, detailed scheduling of operations in the shops is performed. The detail scheduling can give the production plan of the products or the sequence of products and production operations etc. The detail schedule is made for short time horizon with certain objectives including minimize makespan, flow time etc. The hierarchical planning of MRP, MPS and detail scheduling is indicated in figure 1. It can be seen from figure 1 that, the MPS, MRP and detail scheduling of the production shops is performed in a hierarchical method. The plan generated by the mid-term planning is used in the detail scheduling.

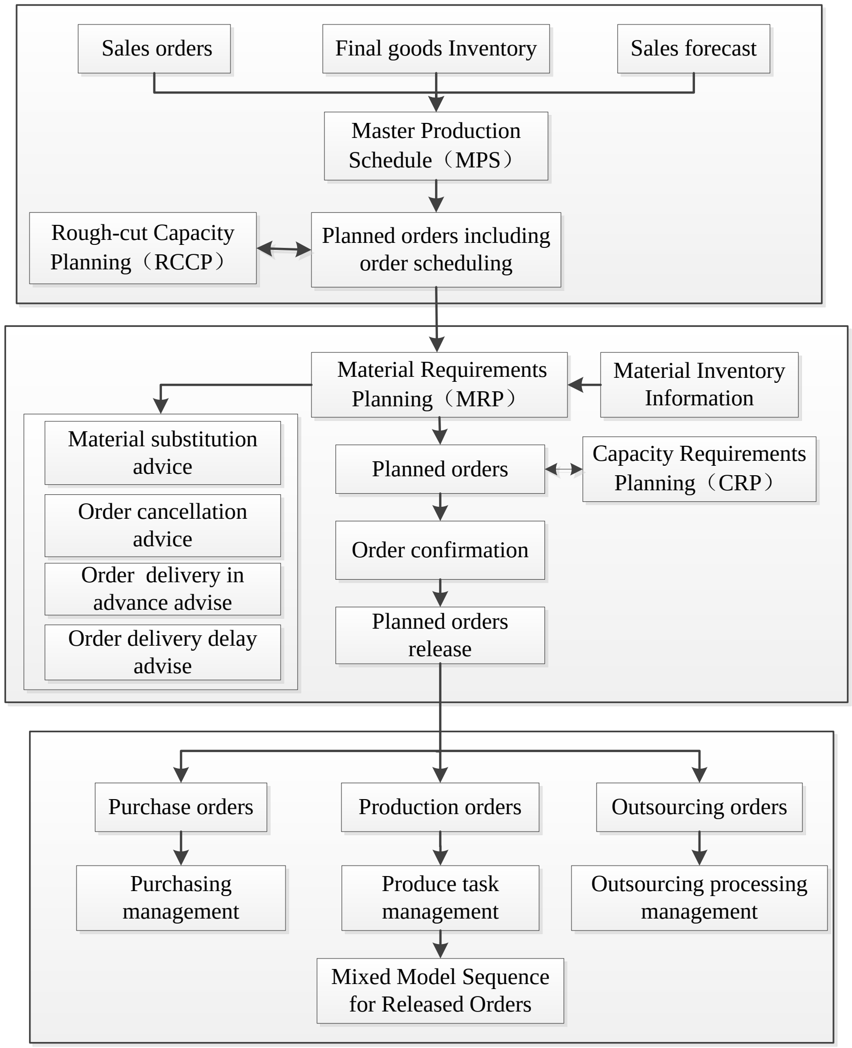

Figure 1: Hierarchical approach for MRP, MPS and detail scheduling

2.2 Interdependency between MRP, MPS and detail scheduling

Mid-term plan and short term scheduling in shops is interdependent to each other in the production companies. When companies receive several customer orders, the mid-term planning involves the identification of material in stock from which it can generate the MRP and create the master production schedule. The master production schedule is made according to the capacity of the resources in the shops. The master production schedule contains the information of the plan order release which is then used by the shops to make schedule of the products on different resources. The resources take the material from inventory and produce the products. The material already in inventory in the shops, the work in process, the requirement of the material and its sequence of delivery to each machine depends on the detail schedule. However, the sequence of delivery of material to resources in the shops is not considered while making the order release plan. The material requirement plan depends on the inventory information and the order schedules. While scheduling of order also need information of the material availability and its sequence of arrival. In addition, the MRP, MPS and the scheduling in shops are highly inter related and depend on each other.

In most of the companies, the real time information of the work in process, material in stock, resource availability, new orders arrivals etc is not shared effectively. The MPS generates the plan without taking into consider the real time availability of resources and this may create infeasible plans, or even if the order release is feasible, when it is used by shops to make the schedule, it may give optimal but this optimal solution is optimal for only one order release plan. As a result, this may give local optimal solutions. The simultaneous consideration of material information, inventory, work in process in the shops, inventory in buffers near each resource, the order due date and demand can make an order release plan with optimal schedule in shops. The global solution can be obtained if there are mathematical relations between each scheduling steps. For example, the time to compete the work in process in the shops can be used to calculate the unavailable time of resources for the new coming orders. Moreover, the time of arrival of the material to the shops can be integrated with the machines processing times, so that the sequence of arrival of material to the machines in the shops can get material and arrival of material is synchronized with the sequence of products on machines. Moreover, the order release and lot size of product models can be integrated with the constraints including bottleneck resource and material deficiency so that the order acceptance, rejection and order schedule can be made with real time information.

3. Intelligent integration of MRP, MPS and Detail scheduling

The MRP, MPS and detail scheduling problems are interrelated and need data and results from each other. The hierarchical planning of MRP, MPS and detail scheduling can give a local optimal solution or the solutions are not feasible. The interdependency of MRP, MPS and detail scheduling results require to integrate them for efficient planning. This needs to integrate all mathematical models to each other to digitally transfer the scheduling plans or results from one planning phase to the next at the same time, simultaneously. The real time information sharing between all planning phases needs an efficient method to transfer the information and results obtained from the real time simulation of mathematical models of planning problems of each planning phase simultaneously. The method of information sharing for intelligent integration of MRP, MPS and detail scheduling is illustrated in figure 2. It can be seen from figure 2 that all the information used for MRP and MPS is integrated and is obtained in the real time. The real time simulation of the mathematical models of the detail scheduling, order scheduling and material delivery scheduling can give real time global solution of the current situation.

The simultaneous consideration of MRP, MPS and detail scheduling can give efficient plan for customer order scheduling and customer order selection and rejection decisions. The integrated models for order scheduling on production lines synchronized with material delivery in different shops is significant for intelligent MRP, MPS and detail scheduling. The customer orders are arriving dynamically and the order scheduling on multiple production lines, the delivery of material to the final production lines and material delivery schedule to the production shops are indicated in figure 3, 4 and 5 respectively which are used to make the integrated models for the intelligent integration of MRP, MPS and detail scheduling system.

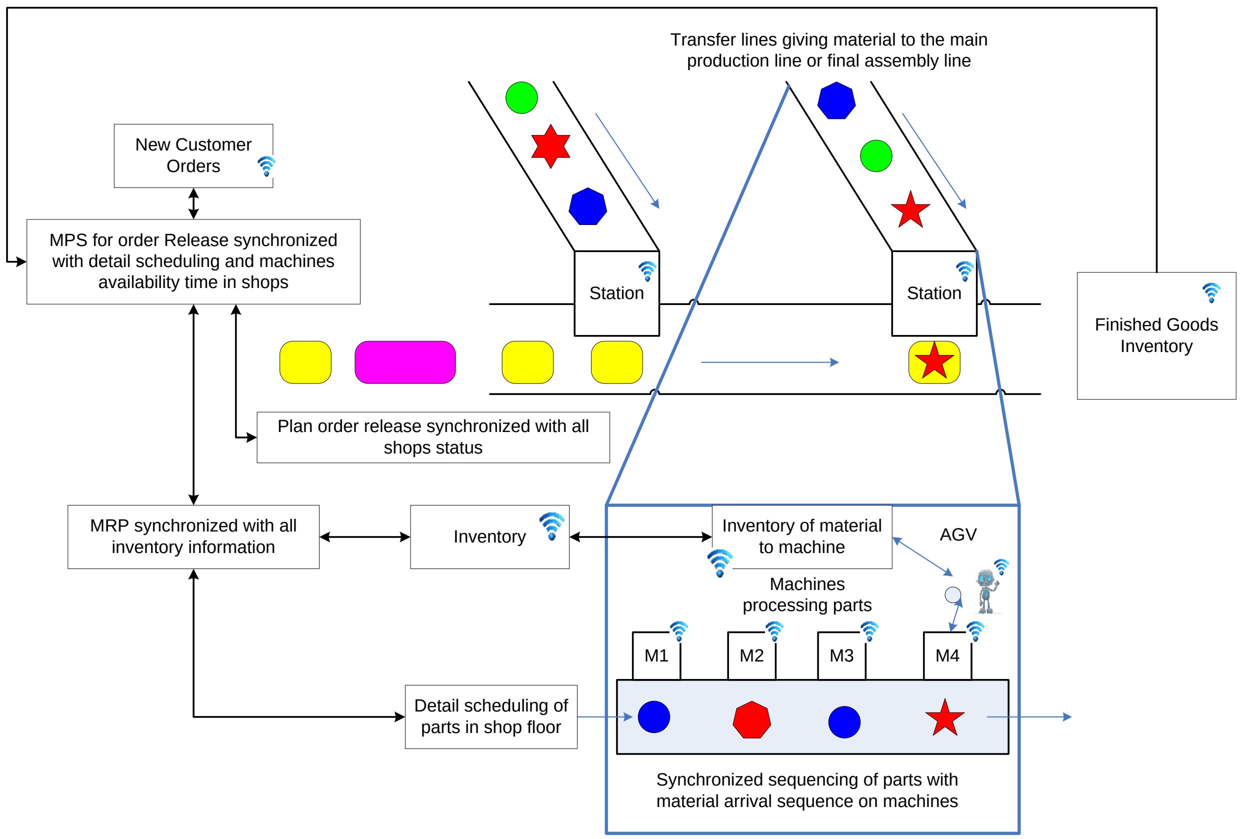

Figure 2: Information sharing and intelligent integration of MRP, MPS and detail scheduling

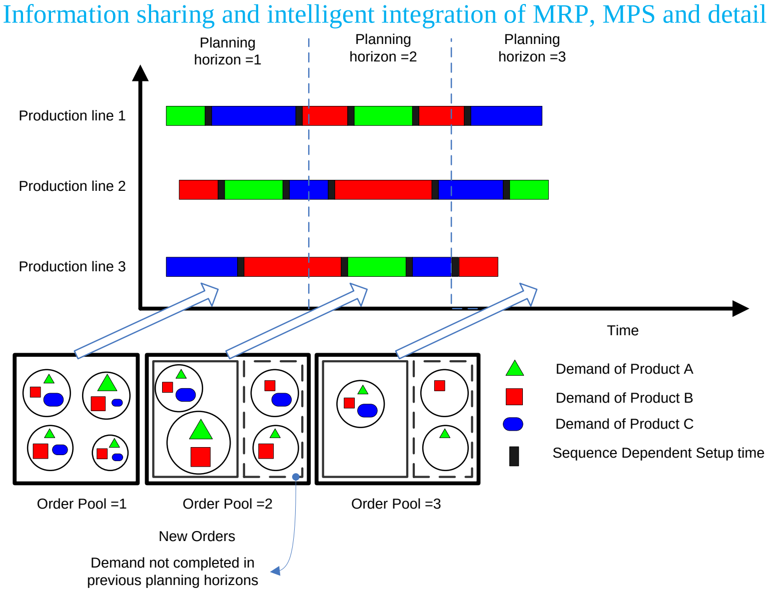

Figure 3: Dynamic arrival of orders with uncertain demand and their planning in different planning horizons

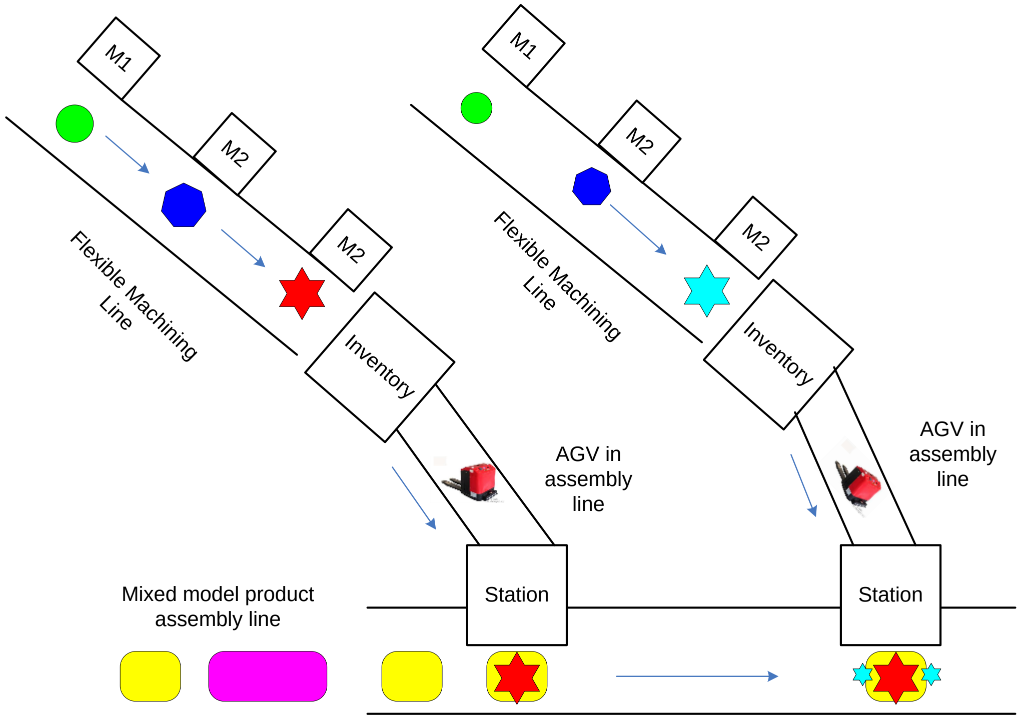

Figure 4: Flexible machining lines synchronized with the assembly line

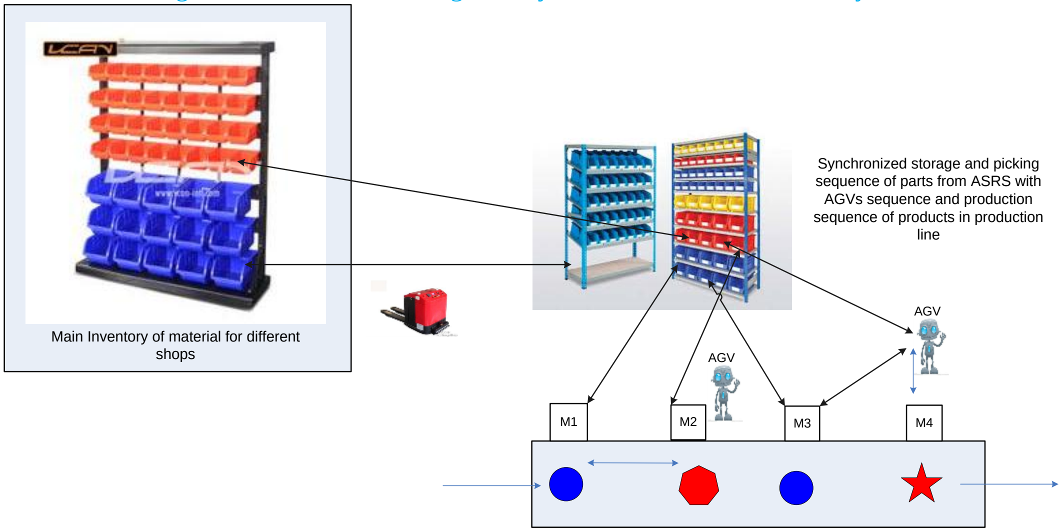

Figure 5: Sequencing of material storage in inventory synchronized with the production scheduling and AGV transport schedule

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Biography

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