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Conceptual Design of Production Planning and Scheduling Module to Improve Delivery Quality

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Abstract

The procedure and implementation of an simulation based production planning and scheduling system. Production planning and scheduling is important problem in manufacturing field. It is so important for delivery quality as well as productivity, too. In this paper, heuristic production planning and scheduling module for improving delivery quality and productivity will be discussed. Beginning with total demand and initial work in process, the algorithms for production scheduling and planning can efficiently generate a feasible production resources and capacity schedule results in high resource utilization, minimum number of the late orders and reduced labor variability. The algorithm is executed to achieve the best on time delivery performance. The developed heuristic algorithms in the module will be expected to provide the better delivery performance and productivity.

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1. Introduction

The developing process for production planning and scheduling is one of the most complicated problems. It would require a great deal of effort and cooperation between the general department and marketing department, production department as well as research and development teams. Generally, each department of company has set its goals and priorities before coming into a meeting to negotiate with each others over their priorities in the production plan[3].

Filling committed orders first is perhaps the primary goal and has the most impact on sales people. The marketing team will request a ramp up of new products which determine the future of the company. General managers will push hard for resources to achieve their total production levels. Production managers are concerned about what to produce and when they have to produce it.

These conflicts in goal and priority of each department result in lengthy negotiations requiring a continual re-planning process. To be competitive, a manufacturer must be able to innovate proprietary designs, reduce cost, improve return on assets, and be responsive respond to the marketplace. Therefore, production planning and scheduling reflect all requirements from shop floor, production department, sales and marketing department by optimizing many objectives[2].

The proposed production planning and scheduling procedures are to be based on simulation. It can be implemented as a decision support system for production planning and scheduling, order fulfillment and capacity panning activities. It also provides users with the near real time information needed to make critical decisions about day to day operations, and the flexibility to respond to changing order priorities, fluctuating demands, inaccurate forecasts, bottleneck shifting, shortages, and other contingencies in a timely fashion.

It is also designed to allocate lots from work in process and parts from finished goods inventory in order to maximize on time delivery[1]. The outputs of production

planning and scheduling module include starts and outs schedules, order status, unfilled orders, order lot status, finished goods inventory status, late order.

2. Problem statement

Currently, production planning and scheduling is accomplished by using spread sheets, manufacturing resource planning based systems or optimization based system like as linear programming[5][6]. In order to achieve a feasible production planning and scheduling requires product mix, variable capacity, product substitutions. However, manufacturing resources planning systems have not been effective in satisfying such requirements. While linear programming based planning systems are designed to scope with this shortcoming, they require a certain set of inputs including product cycle times and work in process.

In many cases, such information is not easily attainable which results in sub-optimality of the final solution. Therefore linear programming based planning system are recommended for medium and high volume production system in which the sub-optimality is not very sensitive. Optimization based planning systems are implemented for corporate level planning rather than lot level production planning and scheduling purpose. Simulation based systems fulfill many gaps between manufacturing resource planning systems and linear programming systems. Simulation based systems become more popular because a real world system is normally too complicated to be evaluated and analyzed without any simplification. In the process of constructing a simulation model, one will not only understand more about day to day operations, but also discover ways to improve them.

The difficulty of the production planning and scheduling problems in the real production world is that cycle times are very variable with lot priorities, fluctuating demand, process specifications, capacity, and queuing due to unavailability of operators and resources. These factors reveal that production cycle times are very sensitive in according to capacity, and hence, finite planning and scheduling with simulation based systems is the key.

3. Conceptual design of production planning and scheduling

The proposed procedures are intended to be an effective and efficient tool for production planning and scheduling in the assembly industry. The objectives for the proposed procedures are to meet the due date for orders - maximizing on time delivery quality-while maintaining the shortest possible quoted lead times as shown in figure 1.

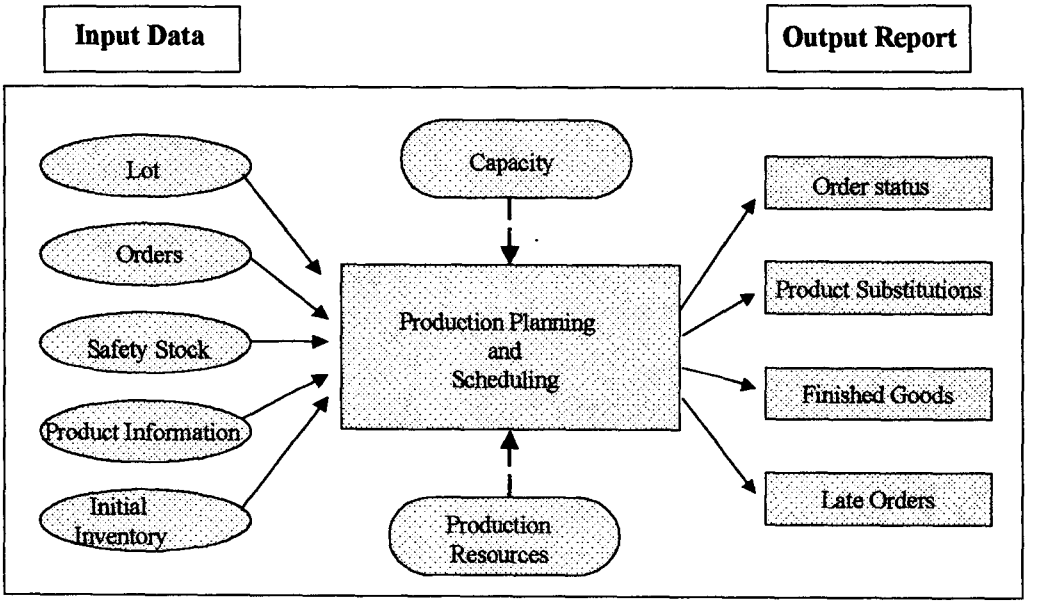

Figure 1. A conceptual frame of the production planning and scheduling modules

The second is to load leveling starts to maximize overall throughput and productivity of the facility. The developed module is capable of supporting the following functions: multiple priorities, demand class, initial inventory download, safety stock and reservation replenishment, product availability schedule, medium to long term simulation and scheduling horizons and operators schedules, and so on.

The developed module also provides various functions that allow users to create factory simulation models. for example, users can define parameters such as mean time between failure, mean time to repair, loading and unloading time, set up time, etc. they are given flexibility to define an unlimited number of receipts used to produce different products.

In summary, the module takes production stars generated by the planing module and runs a simulation on the model. The simulation provides output results including cycle time, start and out schedules, work in process, factory status, in order to calculate lateness, update order status, and other related information. The planning module will attempt to allocate production resources to orders and demand forecasts Then, it will generate additional lot starts as needed for unfilled orders make adjustments to the start time to achieve maximal on time delivery performance. This will continue until either no late jobs remain or no further improvement can be made.

There are two stages in the proposed production planning and scheduling module. In the stage one, orders, safety stock, reservations, and forecasted demands form the planning department. In the stage two, it attempts to allocate the end items inventory, work in process, lot starts to those aggregated demands. If there are shortages realize after the allocation of the available production resources and generating lot start.

The goal of the allocation process is to distribute available production resources among demands in such a way as to maximize on time delivery across all demands. Using the relative priority attribute available for all the items, the user can be provided as the detailed picture as desired of how important each demand item should be viewed.

A production plan may be as simple as assigning a single priority to all demands, or as involved as distributing the demands, among a large number of priority classes. The priority given to demand items determines in what order they get to select lot resources form those available between the demand item's due date and the observed finished date of the lot resources determines.

4. Implementation logic

The designed module's ability to generate additional lot start is provided to identify shortage of the existing production resources and create the appropriate lot starts to fill those shortages. It then employs an iterative approach to finding an appropriate start schedule for the generated lots in an effort to minimize their lateness for the corresponding demand items. The iterative process for generating

lot starts has a number of stages in order to achieve its final goal.

Notation	Definition
J	number of upcoming periods for which start schedule will be linearized
S_f	final start schedule
S_c	temporary linearized schedule
S_c	current best schedule
L_f	total lateness associated with S_f
L_t	total lateness associated with S_t
j	current period for which the start schedule
O_c	number of lots associated with S_c
O_t	number of lots associated with S_t
ε	% tolerance of increase in lateness
δ	absolute tolerance of increase in lateness

The details of the operations at the each iteration and the stoping rule are described below.

Computation procedures:

Begin:
Set j=0
Set S_c = S_f
Loop 1:
Set j = j+1
IF j > J, GOTO End
Loop 2:
IF {no more lots in S_c} GOTO End
IF {L_t >max[L_f ×(1+ε), L_f +δ] or O_t < O_c } Then
GOTO Loop 1
ELSE
Set S_c = S_t
GOTO Loop 2
ENDIF
END:
Generate reports based on S_c

The proposed procedures can be implemented as a planning module which supplies information to other support systems such as total order management systems, material systems, demand forecast systems and factory floor systems. Then the implementation outline is briefly explained in figure 2. The following flow chart in figure 2 is proposed as an outline for implementation of the production planning module to adjust capacity and/or the product mix such that feasible production plan can be developed.

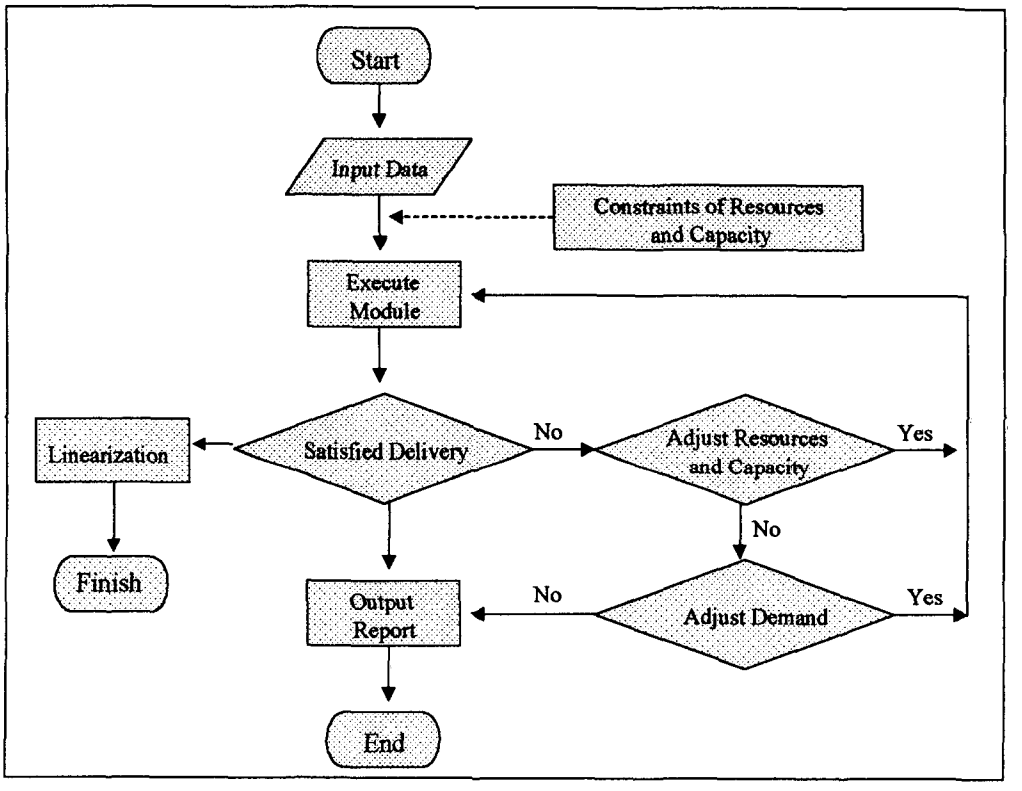

Figure 2. Implementation outline of the proposed module

5. Conclusion

Production planning and scheduling problem is important problem in manufacturing field. It is so important for delivery quality as well as productivity, too. In this paper, a conceptual design of production planning and scheduling

modules to improve delivery quality and productivity has been attempted, which are based on simulation. The proposed heuristic algorithms in the module will be expected to provide the better delivery performance and productivity. It is necessary to develop new heuristic will lead to more efficient, accuracy, and speed in the iterative process.

The process of verification and validation are also needed after implementing the designed production planning and scheduling module. In addition to this, many various reports are generated should be designed to use in the real systems in the future study.

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