南華大學九十七學年度 博士班 招生考試試題卷

系所別：企業管理系管理科學博士班

科　目：管理論文評析（I）

論文評析(I)

(請用中文作答否則不予計分)

1. 請說明 MRP 在何種條件下比 COPPS 為佳(5%)?
   並請詳述其原因(10%)。

2. 將文章中的 Table 1 數據修改如下表，請依照文章中 Table 2 方式將新修改的 MPS 完成。(同本文方式以庫存產品 A 為主，意即產品 B 不予存貨) (15%)。

Month		May	Jun	Jul	Aug
Forecast	Product A	170	210	330	120
	Product B	160	80	150	160
Capacity requirement					
Capacity	Regular hour	320	320	320	320
	Overtime	40	0	40	40

3. 當客戶允許協商交貨時間的機率增加時，請依本文研究結果描述採用 COPPS 排程結果的變化情形。(10%)

4. 請詳述 COPPS 的特性與優點為何？(10%)

Designing customer oriented production planning system (COPPS)

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Abstract

The paper describes a new production planning and scheduling system in which production seats are first created based on forecasted demand, and then orders received are assigned to the seats. This system is named COPPS. The scheduling procedure and advantages of COPPS are discussed. The system performance of COPPS is compared with the traditional MRP through a simulation experiment. Although COPPS theoretically poses some minor problems yet to be solved, some Japanese manufacturing firms already established COPPS-like systems by constructing the information system which integrates both sales and production activities.

Keywords: Production planning; Scheduling; Production seat; Seat reservation; MRP

1. Introduction

Production planning and scheduling has traditionally been based solely on existing customer orders. For instance, MRP develops its complete schedule after all orders are received. However, efficient determination of a feasible schedule satisfying the requirements of the orders such as due date, production capacity and lead-time is difficult [1, 2].

This research proposes a new production planning and scheduling system called COPPS. In COPPS, an initial production schedule is created based on the forecasted demand and on other sales plans as constrained by the production capacity. Then, any customers' orders that are received are integrated into the initial production schedule. The system resembles a train (or plane) seat reservation system. The major advantage of COPPS is its ability to efficiently respond to customer inquiries such as whether the required due date can be achieved. In this system, both sales and production departments can easily access the on-line production schedule and obtain needed information without resorting to troublesome simulation.

The seat reservation system concept has already been presented in several reports from Toshiba Ome-plant [3, 4]. A similar production scheduling system was founded at the Toyoda Machine Work Ltd., in the spring of 1992. However, no theoretical research papers regarding the production scheduling system using the seat reservation concept seem to have been published as yet. The authors have been developing a detailed procedure for a new production planning and scheduling system by applying the seat reservation concept. The COPPS

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research has been conducted independent of actual industrial applications developed by Toshiba and others. The characteristic features and advantages of COPPS are presented along with computer simulation results that suggest its efficiency.

2. Production planning and scheduling system

2.1. Role of the system in CIM

One purpose of computer integrated manufacturing system (CIM) is to improve productivity and to provide high-quality customer service by utilizing a common database and computer communication network among various departments. In the production planning and scheduling area CIM is used to develop a satisfactory production schedule with the assistance of the communication network especially between sales and production departments. The realization of the following objectives for the production schedule is important.

(1) The feasibility for due date of the requested customer order should be provided immediately. If it is estimated that the order cannot be completed by the due date, the scheduling system should be able to provide an alternative date.

(2) At the time of order receipt from a customer, the system should be able to estimate the production schedule for the order with a high accuracy.

(3) For the inquiry about the production progress and a change of order requirement, the response should be able to be returned immediately to the customer.

(4) The production planning and scheduling made must be feasible with respect to the production capacity.

2.2. Traditional production planning and scheduling systems

Some limitations of MRP are listed as follows:

(1) An efficient use of production resources such as man and machine is a main focus. Based on the master production schedule (MPS), the MRP tries to determine an economic production schedule.

(2) Scheduling sometimes becomes difficult at the up-stream processes of the production system, when the production lead-time, capacity, lot sizing, and due date are considered.

(3) Production lead-time is given.

(4) The scheduling procedure is batch oriented and hence on-line access to MRP is difficult for sales department.

(5) Consideration of the production capacity is insufficient.

Some of these criticisms for traditional MRP can be found in Graves et al. [1], and Kerr [2].

3. A relationship between seat reservation of transportation and production scheduling

One efficient system which can immediately respond to a customer's request about a due date is the computer seat reservation system of trains and planes. This seat reservation system first creates the operating schedule and available seats based on the forecasted demand, and then customers' orders are assigned to the empty available seats in the computer memory. By checking the seats occupied, the computer can respond to the new arriving customers regarding whether an additional seat reservation can be made or not. Major differences between the seat reservation system and traditional production scheduling are stated as follows:

Traditional production scheduling

(1) The production schedule is created after all orders are received.

(2) The due date is determined based on the past data with a consideration for time allowance. Customer sometimes take possible delays into consideration and tend to place orders earlier than needed.

(3) At the time of order receipt, such a question as whether a requested due date is achievable or whether a requested amount of the product can be delivered in an earlier time may not be answered.

(4) Excess and shortage of production capacity are unknown until the production schedule is created.

(5) Considering the inventory of final products, the production capacity in terms of workers and

equipment can be determined and then more efficiently utilized.

Operating schedule of trains

(1) The operating schedule is made based on the forecasted demand.

(2) Customer can plan the exact trip schedule depending on the train operating schedule.

(3) The seat reservation system can respond to the customers' order requests immediately. The customers understand that the train operating schedule is punctual.

(4) The information about the number of seats which are occupied and available is obtained easily.

(5) No inventory of seats exists. Therefore, a capacity loss may occur.

4. Design of COPPS

4.1. Design target of COPPS

The BOOK system which has been developed by Toshiba Ome-plant aims at the information integration of the sales and production departments, using the concept of the train seat reservation and establishing database and computer communication network system [3, 4].

The research presented in this paper also aims at the development of a production planning and scheduling system called COPPS which integrates the sales and production activities. Therefore, the COPPS must meet conditions stated in Section 2.1 and also must solve some difficulties existing in MRP.

4.2. Outline of COPPS

To achieve the design target, COPPS introduces the seat reservation concept into the production planning and scheduling system. Some features and advantages of the COPPS are stated as follows:

(1) Rather than creating the schedule after the order receipt, the COPPS creates production seats before accepting orders.

(2) An assignment of incoming orders to the predetermined seats based on standard orders makes the scheduling algorithm easier.

(3) The creation of production planning and scheduling based on the forecasted demand is easier than that based on the accepted orders, because a consideration of the strict due date is not needed.

(4) The development of a database which is commonly available for both sales and production departments is easier.

The framework of COPPS is outlined in Fig. 1. The four main steps of the COPPS are summarized as follows:

(1) Create a master production schedule (MPS) based on the forecasted demand. This schedule corresponds to both the MPS and PP (production plan) in the MRP.

(2) Based on the MPS, a detailed production schedule is developed. This schedule is called "production seats".

(3) Assign incoming orders to production seats. This seat assignment implies the determination of the production schedule.

(4) After adjusting the production scheduling, the COPPS releases the production instructions to the shop floor.

4.3. Numerical example

The basic procedure of COPPS is illustrated by a numerical example. The model description is stated as follows.

Two different types of products A and B are manufactured by a single machine. Even for the same type of products, individual product specifications are slightly different from product to product. Each type of product is manufactured by lot, and the lot size is the amount required for two weeks. To absorb the seasonal variation of the demand, each type of product with standard product specification can be produced in advance, and later a minor change is made to meet the individual specification. Since it is assumed that the production time for each type is reasonably similar, the production capacity is expressed by the production volume. Assume that the demand forecast is carried out on a monthly basis. Using the example, a more detailed COPPS procedure is stated as follows:

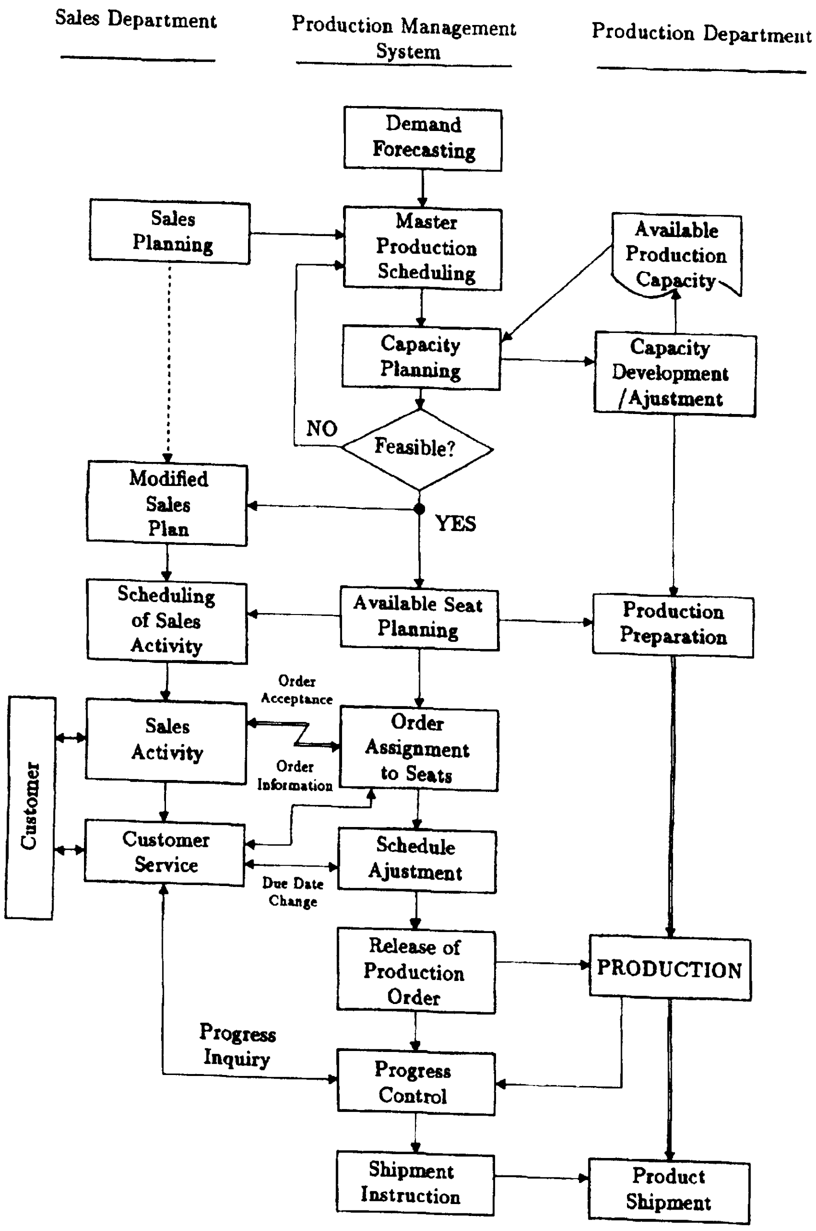

Fig. 1. Outline of COPPS flow.

(1) *Creation of master production schedule* (*MPS*)

Forecasted demand values for the next four months are given in Table 1. Table 1 also shows the production capacity of the regular working hours and overtime hours. Based on the forecasted values of Table 1, the MPS is established. In this example, the demand of July far exceeds the production capacity. Therefore, a production leveling

Table 1
Forecasted demand and planned capacity

	Month		May	Jun	Jul	Aug
Forecast	Product type	A	160	200	310	100
(pcs)		B	160	80	140	200
Capacity requirement (pcs)			320	280	450	300
Capacity	Regular hour		320	320	320	320
(pcs)	Overtime		40	0	40	40

is conducted by producing some products with a standard product specification in advance during May and June to meet the peak July demand. Although the type and amount of products for the advanced production must be determined based on the difficulty of the specification change for the individual order and forecasting accuracy, this example assumes that type A is always produced in advance. However, even with an advanced production, type A still has a shortage of 10 units in July, and this shortage volume is to be produced during August (shown at stock row in Table 2). The information on this production delay is sent to sales department to understand the tightness of the production schedule in July. The monthly schedule is then leveled and broken down to the weekly schedule, assuming four weeks per month (Table 2).

(2) *Settlement of production seats*

To illustrate how COPPS can be applied to the lot production, this numerical example deals with the lot production case. Table 3 shows the production schedule in April and May. The table also shows that the first lot of 100 units of type A is scheduled during the first and second weeks in May, since April production ends with a lot of type B.

(3) *Assignment of the accepted orders to production seats*

Accepted orders are assigned to available production seats. The optimum assignment should be made considering such factors as to which empty seats the orders should be assigned, whether the number of seats should be increased by using the overtime, and whether the order could be assigned to the empty seats reserved for another product type.

(4) *Release of production instructions*

Assume that the production instructions are released once a week in this example. Table 4 shows

Table 2
Master production schedule

	Month	May				Jun				Jul				Aug			
A	Forecast	160				200				310				100			
	Master	200				240				220				110			
	Stock	40				80				− 10				0			
	Week	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
	Forecast	40	40	40	40	50	50	50	50	78	77	78	77	25	25	25	25
	Master	50	50	50	50	60	60	60	60	55	55	55	55	28	27	28	27
	Stock	10	20	30	40	50	60	70	80	57	35	12	− 10	− 7	− 5	− 2	0
B	Forecast	160				80				140				200			
	Master	160				80				140				200			
	Stock	0				0				0				0			
	Week	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
	Forecast	40	40	40	40	20	20	20	20	35	35	35	35	50	50	50	50
	Master	40	40	40	40	20	20	20	20	35	35	35	35	50	50	50	50
	Stock	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 3
Planned production seats (production schedule)

Month	Apr							May																			
Week	3		4					1					2					3					4				
Day	14	15	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Seats A	16	16	17	1	0	0	0	18	18	18	18	18	10	0	0	0	0	18	18	18	18	18	10	0	0	0	0
B	0	0	0	15	17	16	16	0	0	0	0	0	8	18	18	18	18	0	0	0	0	0	8	18	18	18	18

Table 4
Planned and occupied seats for product type A

Month	Apr	May										Sum of empty seats
Week	4	1					2					
Day	20	1	2	3	4	5	6	7	8	9	10	
Planned seats	0	18	18	18	18	18	10	0	0	0	0	
Occupied seats	0	14	15	13	18	18	10	0	0	0	0	
Empty seats	0	4	3	5	0	0	0	0	0	0	0	12

Table 5
Average demand per day in each month

Month		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dev	Average
Product type	1	8	7	8	12	14	16	10	8	7	10	10	10	10
	2	10	10	10	10	10	10	10	10	10	10	10	10	10

both currently occupied seats and empty available seats of type A in the first and second weeks of May. The sum of empty seats available for the manufacture of type A standard products is 12, while the planned amount of stock at the end of 2nd week of May is 20 in Table 2. Namely, the shortage becomes 8 units. If this amount of shortage is allowed, 100 units of type A are released, and 18 units would be completed daily in the first week of May.

The above example assumes a single-stage production system, but the COPPS procedure can easily be extended to the multi-stage production system.

5. Simulation experiment

5.1. Experimental conditions

To compare the COPPS performance with MRP, a computer simulation was performed. The input data and conditions of the simulation experiment are summarized as follows:

(1) Conditions with respect to the product types, lot production, and lot sizing rules are the same as the assumptions of the numerical example stated in Section 4.3.

(2) The net lead-time necessary for production and shipment is 5 days, i.e., one week.

(3) The daily maximum production capacity is 22 units, 20 units during a regular working hours and 2 units during overtime.

(4) The delivery lead-time which is the allowed time from an order acceptance to the shipment of the ordered products follows a uniform distribution [20, 50] days.

(5) Average requirement per order is 10 units.

(6) Average daily demand for each product type by month is summarized in Table 5.

(7) Five days a week and four weeks a month are assumed.

(8) Demand forecasting is not made for either COPPS or MRP.

(9) Let D_{ij} be the demand for product type i to be completed at the jth week. Then, in the MRP, production order quantity released at the beginning of the jth week, denoted by R_{ij}, is given as follows:

$$R_{1,2j-1} = D_{1,2j+3} + D_{1,2j+4},$$
$$R_{2,2j+1} = 0,\ R_{1,2j+2} = 0,$$
$$R_{2,2j+2} = D_{2,2j+4} + D_{2,2j+5},\quad j = 0,1,\ldots \qquad (1)$$

(10) The following two ways of scheduling production seats are considered in COPPS:

Table 6
Some simulation results

Evaluation factors	MRP	COPPS (Daily)		COPPS (Weekly)				
		Pr = 0%	Pr = 100%	Pr = 0%	Pr = 25%	Pr = 50%	Pr = 75%	Pr = 100%
Tardiness order (%)	3.7	10.2	0	5.9	4.8	3.3	1.6	0
Average tardiness per tardiness order (days)	1.8	5.3	0	4.8	4.8	4.7	4.8	0
Average earliness per no tardiness order (days)	6.0	7.0	0.1	6.8	5.5	4.3	3.0	1.8
Average stocks (pcs)	119.8	124.3	8.5	123.8	103.1	83.6	62.6	42.2
Time in system (days)	35.7	36.1	30.0	35.9	34.8	33.7	32.5	31.4

Note: Pr is rate of orders whose due date is customer negotiable. Variances of weekly demands for type 1 and 2 realized in the simulation are 703 and 386, respectively.

Case 1: Production seats are established on a weekly basis, and orders assigned to a week are produced in the order of the earliest due date. The number of production seats for product type i planned at the jth week, denoted by S_{ij}, is given as follows:

$$S_{1,2j+1} = 0,\ S_{2,2j+1} = 110,$$
$$S_{1,2j+2} = 110,\ S_{2,2j+2} = 0,\quad j = 0,1,\ldots \qquad (2)$$

Case 2: Production seats are established on a daily basis. When the kth day belongs to the jth week, the number of production seats on the kth day is defined as $[S_{ij}/5]$ where the symbol $[a]$ takes the closest integer of the value a, and S_{ij} is given by Eq. (2).

(11) Repeat the simulation for 11 years, and gather the statistics for the last ten years.

5.2. *Simulation results*

The simulation results are summarized in Table 6. The second column of Table 6 shows the MRP results, 3rd and 4th columns represent results when the production seats are set up on a daily basis, and the following five columns show results when the production seats are set up on a weekly basis.

The 3rd and 5th columns of Table 6 show the simulation results with the assumption that the due date proposed by the customer is fixed and unchangeable. The 4th and 9th columns show the results with the assumption that the due date is negotiable with the customer and it can be changed based on the estimated completion date of orders at the time of order receipt. The small values of average earliness and average stock in these columns imply that the accuracy of the estimated order completion date compared with the actual completion date is so high and that the COPPS can suggest more reliable due dates to the customers at the time of order receipts. Therefore, the design targets (1), (2) and (4) stated in Section 2.1 are accomplished.

When the customer due date are nonnegotiable, the number of orders which exceed the customer due date (called tardiness orders in Table 6) is smaller in MRP than COPPS. In this case, MRP also shows better performance for the average deviation of order completion date from the customer due date. The reason is explained as follows: In the MRP, since the schedule is made after orders are received, orders which have relatively earlier due date are usually completed earlier than the orders with later due dates. However, in COPPS, the seat assignment pattern is sometimes reversed because orders are assigned in sequence of arrival. This aggravates the simulation results. In other words, both arrival date and due date of orders are considered during the assignment in COPPS, while MRP considers only due date in its production scheduling. This discussion relates to the stochastic machine scheduling problem [1].

The 6th–8th columns in Table 6 show the simulation results when the number of customers who allow the change of their due date to the estimated completion date is given as a probability.

6. Conclusion

The paper proposed a new production planning and scheduling concept called COPPS in which the scheduling is created in the form of production seats based on the forecasted demand, and then the incoming orders are assigned to the production seats. A numerical example was shown to present the scheduling procedure utilized in COPPS. Advantages of the COPPS system were discussed.

Some minor problems such as the way to assigning orders to the production seats are not completely solved in this paper. However, an industrial application (the BOOK system of Toshiba Ome-plant) has already justified the effective use of the production seat concept presented in this paper.

References

[1] Graves, S.C. et al., 1993. Handbooks in Operations Research and Management Science, Vol. 4, Logistics of Production and Inventory, North Holland, Amsterdam, 503–507 and 585–625.

[2] Kerr, R., 1991. Knowledge-Based Manufacturing Management. Addison-Wesley, Reading, MA, 17–40.

[3] Akuzawa, T., 1993. CIM integrating sales and production activities by production seats. Factory Automation, 11(1): 41–44 (in Japanese).

[4] Takashima, Y., 1993. An improvement of operating efficiency by integrating sales and production activities: CIM at Toshiba Ome-plant Commun. OR Soc. Japan, 33(8): 279–285 (in Japanese).

[5] Matsuura, J., 1990. CIM in an assembly process of information processing machinery industry: A case of Toshiba Ome-plant, Automation, 35(1): 91–101 (in Japanese).

[6] Matsuura, J., 1992. CIM with an integration of sales and production activities: A case study of Toshiba Ome-plant, Automation. 37(8): 29–43 (in Japanese).

[7] Orlicky, J., 1975. Material Requirements Planning. McGrawHill, New York.

[8] Vollmann, T.E. et al., 1988. Manufacturing Planning and Control Systems., Irwin, Homewood, IL.