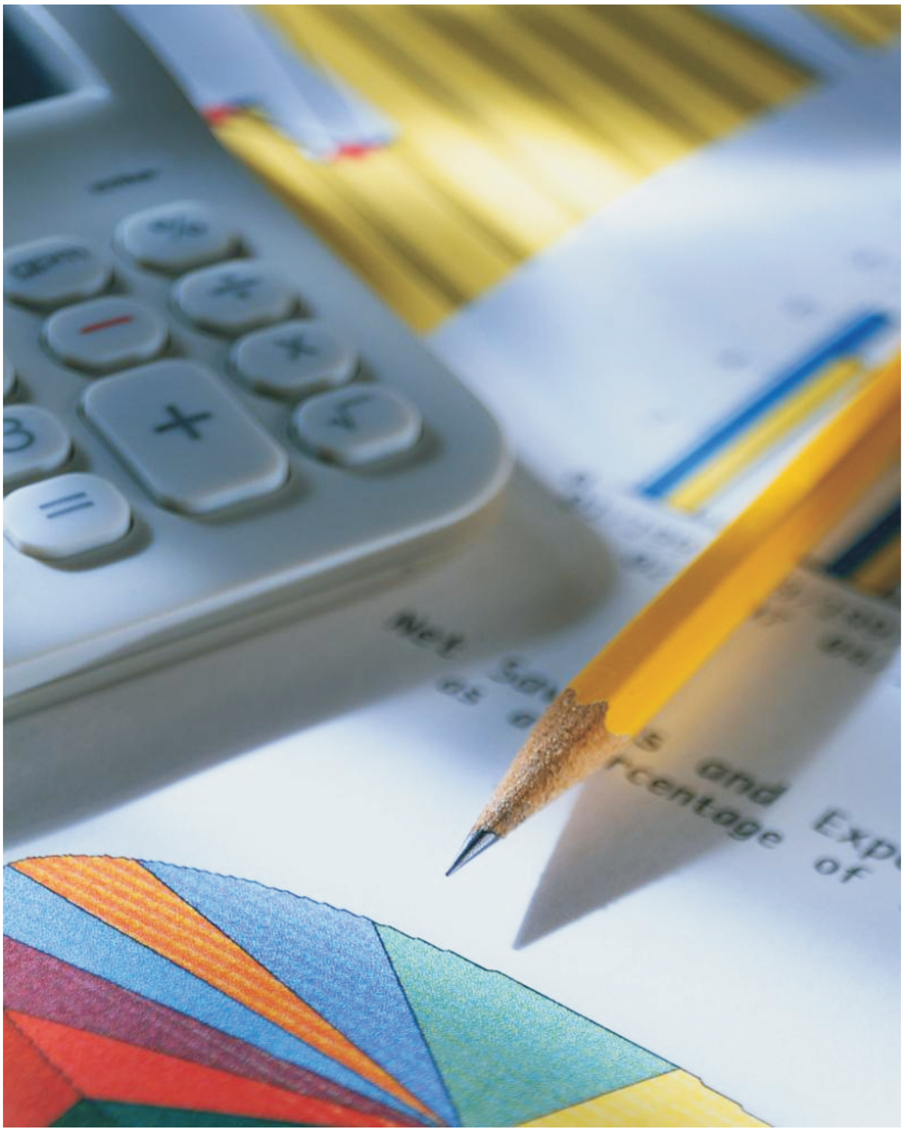
A LOAD SCHEDULE FOR THE ASSEMBLY PRODUCTION OF SPECIFIED ORDERS RELATIVE TO A PLANT'S CAPACITY



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TASK 1:

Using the provided loading case study, make a schedule of the production load for the specified assemblies of components relative to the available production capacity. Estimate the earliest date of delivery ex-manufacturer's warehouse for an order placed in the 20th week for 100 assemblies (product type A). Additionally, estimate the starting and final week for each individual sub-assembly and component and the date of ordering raw materials. Use both forward and backward load.

Key Words: *Schedule; Loading; Forward Loading; Backward Loading; Critical Path Analysis; Critical Path Component; Finite Loading*

INTRODUCTION

Operations and quality management involves the management of resources for the production of goods and services. This includes such functions as work force planning, inventory management, logistics management, production planning and control, resource allocation; and emphasises total quality management principles. Operations managers deal with people, materials, technology and deadlines (Halevi, 2001).

Loading indicates the specified time required to produce a single unit of the specified product in individual manufacturing facilities involved in the production of the product and further placement of orders to production departments, such that: an optimum utilisation of available resources is achieved; facilities overload is avoided; realistic dates of producing ordered quantities are defined; out-of balance production facilities are highlighted in order to take any corrective action as necessary to avoid this situation (Karmarkar, 1993).

Limit loading implies to load the work schedule of a specific production unit until the time corresponding to the specified capacity of this facility is reached. This particular method of load definition is used to determine the realistic dates of delivery of required component parts and products. It is assumed here that a limit capacity has already been defined for each individual production unit to be involved (Powell et all., 1995). Additionally, it is also assumed that loading information for each individual order is already available by the time the order is placed to the production department, as is the case being discussed here. The problem to be solved here is how to distribute this load information among different production units.

The two methods to accomplish this distribution are the Forward and backward loading. The forward loading begins with the present date and loads jobs forward in time. The processing time is accumulated against each work centre, assuming infinite or finite capacity. In this case, due dates may be exceeded if necessary. Since average waiting times are used in queues, the resulting job completion date is only an approximation of the date which might be calculated by more precise scheduling. The purpose of forward loading is to determine the approximate completion date of each job and, in the case of infinite capacity, the capacity required in each time period (Lyons, 2004). Backward loading begins with the due date for each job and loads the processing-time requirements against each work centre by proceeding backward in time. The capacity of work centres may be exceeded if necessary.

The purpose of backward loading is to calculate the capacity required in each work centre for each time period. As a result, it may be decided that capacity should be reallocated between work centres or that more total capacity should be made available through revised aggregate planning as suggested in Kats (2008). Due dates of jobs are always given for backward loading.

In current loading case study, a schedule of the production load for the specified assemblies of components relative to the available production capacity has been created. Estimations also on the earliest date of delivery ex-manufacturer's warehouse for an order placed in the 20th week for 100 assemblies (product type A) have been processed. Additionally, the starting and final week for each individual sub-assembly and component and the date of ordering raw materials have been estimated, using both forward and backward loading.

In present case study, the load scheduling for the production of specified assemblies relevant to the available capacity had to go through the following stages: (a) Make an analysis of preliminary data (structural and quantitative interrelations between product A and its components) and visualisation of the product by means of presenting it in an exploded view; (b) Estimate and analyse times of delivery, manufacturing and assembly of raw materials, component parts and products along with the required quantities of each; (c) Determine the Critical Path Component (by synthesising initial limitations, performing Critical Path Analysis (Shapiro, 1993) and drawing up a preliminary schedule for a simplified set of conditions with the Forward Loading technique; (d) Carry out secondary loading for the production of the rest of the component parts on available free facilities applying the Backward Loading technique (Gamberi, 1998). Determine the high-risk areas taking actions to re-design and optimise the final real version; and (e) based on the schedule and inventory data, determine high-risk areas and suggest measures from a manager's viewpoint.

When loading production departments manufacturing or assembling the specified component parts and assemblies we aimed at fitting the new order into the current production schedule while providing for the following: achieve the earliest possible realistic date of delivery ex-manufacturer's warehouse of the order for 100 assemblies (product A) placed during week 20; achieve efficient loading of manufacturing facilities; ensure for the completion of current orders (without disturbing their specified delivery dates); reduce risks for order completion to a minimum and prevent their occurrence in current orders; avoid risks for orders placed at a later date but with earlier delivery times; guarantee for the interest of customers thus respecting the image of the company (Bobrowski, 1989).

The strategic aim has been to ensure the order was completed with the optimum load on production facilities and observing the delivery times and contractual terms agreed with the client. An integrated solution to the task, which actually comprised the system of interrelated sub-aims, would guarantee achieving not only the strategic aim but also bringing advantages to fortify marketing company achievements (Sarker, 1999).

The achievement of each strategic aim was accompanied by adopting specific tactics, accomplished in two stages: (a) Preparing a preliminary schedule of loading free facilities with the production of the new order using the Forward Loading technique. Extreme load was applied on the facilities since the utmost capacity of every facility involved in the process has already been identified and the loading information is already available for every order by the time it arrives in the production department. The purpose of this stage is to define the Critical Path Component. Loading was scheduled under several simplified preconditions: lack of any rejects, and failure-free operation. (b) Optimisation of the preliminary schedule by means of performing another loading applying the Backward Loading technique relative to the Critical Path Component (Desrosiers, 1995). Identifying the high-risk areas and reducing risks to a minimum by means of adopting appropriate measures.

ANALYSIS AND EXPLODING VIEW OF THE FINAL ASSEMBLY

Performing this type of analysis will help us clarify the structural and quantitative interrelations between assemblies and component parts comprising product A (Fredendall, 2010). Additionally, this will also help identify preliminary limitations in the time aspect such as, which assemblies can be assembled after a particular component part is manufactured.

LOADING CASE SCENARIO

A manufacturer of the product A has received during the 20th week an order for 100 units of the specified product. Product A is an assembly made up of several individual components (see Table 1):

Table 1: Bill of Material for Assy. A

Part No	Qty.	Category	Man. Code
B1	4	PP	Bought out
B2	4	PP	Bought out
B3	1	Assy	Made In
B4	1	Assy	Made In

On the other hand, these components comprise a number of sub-assemblies and individual parts and Tables 2, 3 and 4 show their quantities and category characteristics:

Table 2: Bill of Material for Assy. B3

Part No	Qty.	Category	Man. Code
C1	1	Assy	Made In
C2	2	PP	Made In
C3	1	PP	Bought out

Table 3: Bill of Material for Assy. B4

Part No	Qty.	Category	Man. Code
E1	1	PP	Made In
E2	1	PP	Made In
B1	4	PP	Bought out
B2	4	PP	Bought out

Table 4: Bill of Material for Assy. C1

Part No	Qty.	Category	Man. Code
C2	2	PP	Made In
D1	1	PP	Made In

Table 5 shows the current inventory of component parts and raw materials at the moment of placement of the order:

Table 5: Current Stock Position – Week 20

Part No	Available stock	Ordered
B1	200	Nil
B2	1000	Nil
C2	340	Nil
C3	200	Nil
D1	30	Nil
E2	80	Nil
RM1	600 m	Nil
RM2	60 m	Nil
RM3	120 m	Nil

Table 6 systemises information on production department areas involved in the assembly process for the relevant sub-assemblies along with process times required for: withdrawal from store, assembly, inspection and transfer.

Table 6: Assemblies Manufacturing Information

Part No	Dept. Code	Stores Storage Times	Assembly Time (each)	Inspection / Transfer Time
A	FA	1 week	0.28 h	2 days
B3	SA1	2 days	0.56 h	2 days
B4	SA2	2 days	0.37 h	2 days
C1	SA3	2 days	0.70 h	2 days

Table 7 shows manufacturing information relating to made in component parts and Table 8 shows information for bought out component parts and raw materials.

Table 7: Piece Parts Made In

Part No	Dept. Code	Adjustment Time	Batch Operation Time	Inspection & transfer Time	Matl. E.B.Q.	Raw Matl. Code	Raw Matl. /E.B.Q.
C2	D1	4 h	70 h	1 day	1000	RM2	140 m
D1	T2	2 h	2 h	2 days	500	RM3	130 m
E1	G1	8 h	25 h	2 days	250	RM2	120 m
E2	H2	6 h	30 h	1 day	300	RM1	150 m

Table 8: Piece Part & Row Material Bought Out

Part No	Delivery Time	Economic Order Quantity (E.O.Q)
B1	2 weeks	3000
B2	2 weeks	3000
C3	4 weeks	500
RM1	8 weeks	1000 m
RM2	6 weeks	2000 m
RM3	4 weeks	500 m

Table 9 shows the workload at the moment of receipt of the order for 100 pcs. of type A product:

Table 9: Current Load – Week 20

Dept.	Cap. /Hrs/	O/D /Hrs/	Wk No 20	Wk No 21	Wk No 22	Wk No 23	Wk No 24	Wk No 25	Wk No 26	Wk No 27	Wk No 28	Wk No 29	Wk No 30	Wk No 31	Wk No 32	Wk No 33	Wk No 34	Wk No 35	Wk No 36
FA	40	4	40	40	40	40	38	38	40	40	40	40	40	40	40	40	39	38	0
SA1	40	-	40	40	40	40	40	40	40	40	40	40	40	40	40	38	0	0	0
SA2	40	12	40	40	40	40	40	35	36	37	40	40	35	28	31	3	0	0	0
SA3	40	16	40	40	40	40	40	40	32	36	34	32	30	20	10	5	5	0	0
D1	40	8	40	40	40	40	32	34	40	30	20	20	15	10	8	0	0	0	0
T2	40	10	40	40	40	40	35	30	28	17	17	15	10	9	7	0	0	0	0
G1	40	11	40	40	40	40	35	34	40	20	15	15	12	10	0	0	0	0	0
H2	40	15	40	40	40	40	32	36	39	38	10	10	10	9	0	0	0	0	0

Key;
Dept = Department; Cap. = Capacity; O/D = Overdue Hours; Wk = Week; PP = part; A = product; RM = Raw Materials; FA – Final Assembly; SA = Sub-Assembly; E.B.Q. = Economic Batch Quantity; E.O.Q. = Economic Order Quantity.

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- ***Forward loading***. Begins with the present date and loads jobs forward in time. The processing time is accumulated against each work centre, assuming infinite or finite capacity. In this case, due dates may be exceeded if necessary. Since average waiting times are used in queues, the resulting job completion date is only an approximation of the date which might be calculated by more precise scheduling. The purpose of forward loading is to determine the approximate completion date of each job and, in the case of infinite capacity, the capacity required in each time period.
- ***Backward loading***. Begins with the due date for each job and loads the processing-time requirements against each work centre by proceeding backward in time. The capacity of work centres may be exceeded if necessary. The purpose of backward loading is to calculate the capacity required in each work centre for each time period. As a result, it may be decided that capacity should be reallocated between work centres or that more total capacity should be made available through revised aggregate planning. Due dates of jobs are always given for backward loading.

METHODOLOGY

In the case study provided, the load scheduling for the production of specified assemblies relevant to the available capacity will go through the following stages:

- Make an analysis of preliminary data (structural and quantitative interrelations between product A and its constituent components) and visualisation of the product by means of presenting it in an exploded view;

- Estimate and analyse times of delivery, manufacturing and assembly of raw materials, component parts and products along with the required quantities of each;

- Determine the Critical Path Component by means of synthesising initial limitations, perform Critical Path Analysis and draw up a preliminary schedule for a simplified set of conditions and applying the Forward Loading technique;

- Carry out secondary loading for the production of the rest of the component parts on available free facilities applying the Backward Loading technique. Determine the high-risk areas and take appropriate actions to re-design and optimise the final real version.