Production Planning and Control Systems

L-33

Contents

Production Planning and Control

- It is concerned with the logistics problems that are encountered in manufacturing, that is managing the details of what and how many products to produce and when, and obtaining the raw materials, parts and resources to produce those products.
- Production planning is concerned with (1) deciding which products to make, how many of each, and when they should be completed

(2) Scheduling the delivery and or production of the parts and products

(3) Planning the manpower and equipment resources needed to accomplish the production plan.

Activities within the scope of production planning include

(i) Aggregate production planning
(ii) Master production planning
(iii) Material requirements planning
(iv) Capacity Planning

Production Control

It is concerned with determining whether the necessary resources to implement the production plan have been provided, and if not, it attempts to take corrective action to address the deficiencies.

The major topics covered in this chapter are:

(i) Shop floor control

(ii) Inventory control

(iii) Manufacturing resource planning

(iv) Just-in-time production systems

1) Aggregate Production Planning and the Master Production Schedule

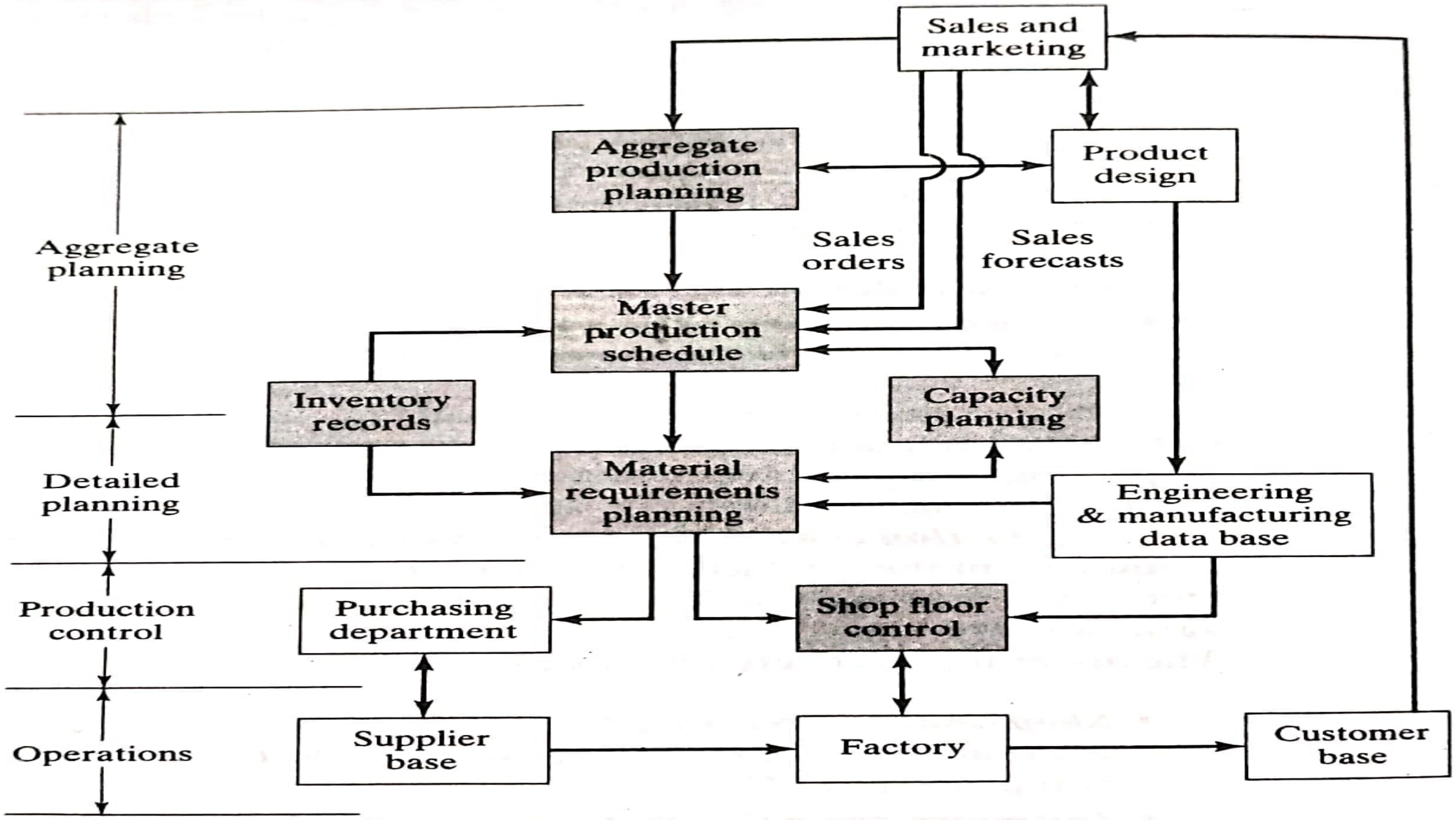

Figure 26.1 Activities in a PPC system (highlighted in the diagram) and their relationships with other functions in the firm and outside.

a) Master Production Schedule (MPS)

- The production quantities of the major product lines listed in the aggregate plan must be converted into a very specific schedule of individual products known as master production schedule.

- Products included in the MPS divide into three categories

(1) Firm customer orders

(2) Forecast demands

(3) Spare Parts

	Week									
Product line	1	2	3	4	5	6	7	8	9	10
M model line	200	200	200	150	150	120	120	100	100	100
N model line	80	60	50	40	30	20	10			
P model line							70	130	25	100

(a) Aggregate production plan

	Week									
Product line models	1	2	3	4	5	6	7	8	9	10
Model M3	120	120	120	100	100	80	80	70	70	70
Model M4	80	80	80	50	50	40	40	30	30	30
Model N8	80	60	50	40	30	20	10			
Model P1								50		100
Model P2							70	80	25	

(b) Master production schedule

Figure 26.2 (a) Aggregate production plan and (b) corresponding MPS for a hypothetical product line.

2) Material Requirements Planning

- It is a computational technique that converts the master schedule for end products into a detailed schedule for the raw materials and components used in the end products

a) Inputs to the MRP System

TO function the MRP program must operate on data contained in several files. These files serve as inputs to the MRP processor. They are:

(1) MPS

(2) Bill of materials file and other engineering and manufacturing data

(3) Inventory record file

MRP

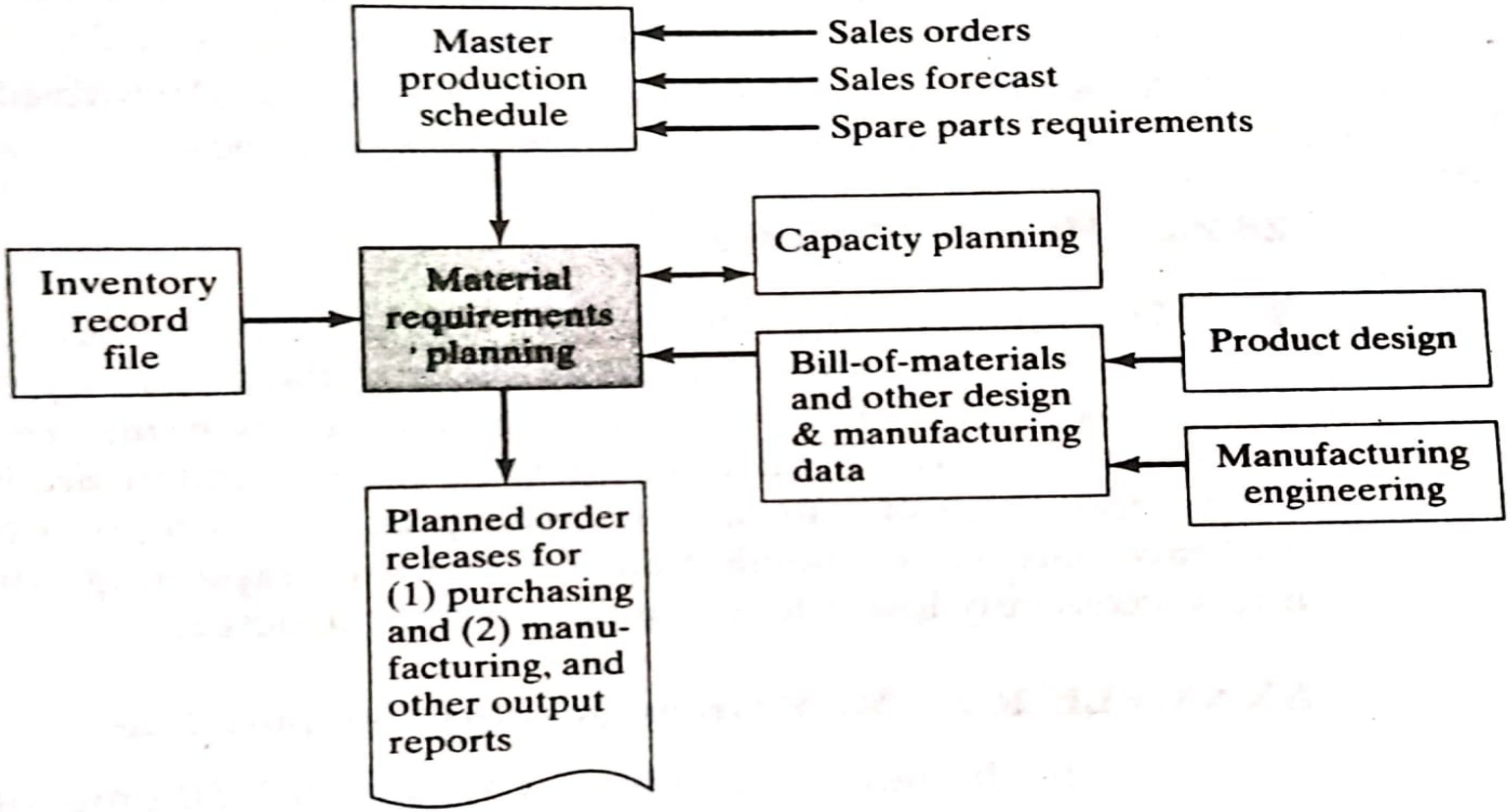

Figure 26.3 Structure of an MRP system.

Inventory Record File

It is referred to as the item master file in a computerized inventory system. The types of data contained in the inventory record are divided into three segments:

(i) Item master data

(ii) Inventory status

(iii) Subsidiary data

b) How MRP Works

- The MRP processor operates on data contained in the MPS, the BOM file and inventory record file
- The master schedule specifies the period by period list of final products required. The BOM defines what materials and components are needed for each product. And the inventory record file contains data on current and future inventory status of each, product, component and material

C) MRP Outputs and Benefits

- The MRP program generates a variety of outputs that can be used in planning and managing plant operation
- The output include:

(i) Planned order releases, which provide the authority to place orders that have been planned by MRP SYSTEM

(ii) Report of planned order releases in future periods

(iii) Rescheduling notices, indicating changes in due dates for open orders

(iv) Cancelation notices, indicating that certain open orders have been cancelled because of changes in MPS.

(v) Reports on inventory status

(vi) Performance reports of various types indicating costs, item usage, actual versus planned lead times and so on

(vii) Exception reports, showing deviations from the schedule, orders that are overdue, scrap and so on

(viii) Inventory forecasts, indicating projected inventory levels in future periods

Benefits of MRP

(i) Reduction in inventory

(ii) Quicker response to changes in demand than in possible with a manual requirements planning system

(iii) Reduced setup and product changeover costs

(iv) Better machine utilization

(v) Improved capacity to respond to changes in the master schedule

(vi) As an aid in developing the master schedule

3) Capacity Planning

- Capacity planning is concerned with determining what labor and equipment resources are required to meet the current MPS as well as long-term future production needs of the firm. Capacity planning also serves to identify the limitations of the available production resources so that an unrealistic master schedule is not planned.
- If the schedule is not compatible with capacity, then adjustments must be made either in plant capacity or in the master schedule.
- Capacity adjustments can be divided into short term adjustments and long term adjustments. Capacity adjustments for the short term include:

a) Employment levels
b) Temporary workers
c) Number of work shifts
d) Labor hours
e) Inventory stockpiling
f) Order backlogs
g) Subcontracting

Capacity planning adjustments include the following types of decisions

(i) New equipment investments
(ii) New plant construction
(iii) Purchase of existing plants
(iv) Acquisition of existing companies
(v) Plant Closings

4) Shop Floor Control

proportion accomplished by computer automated methods.

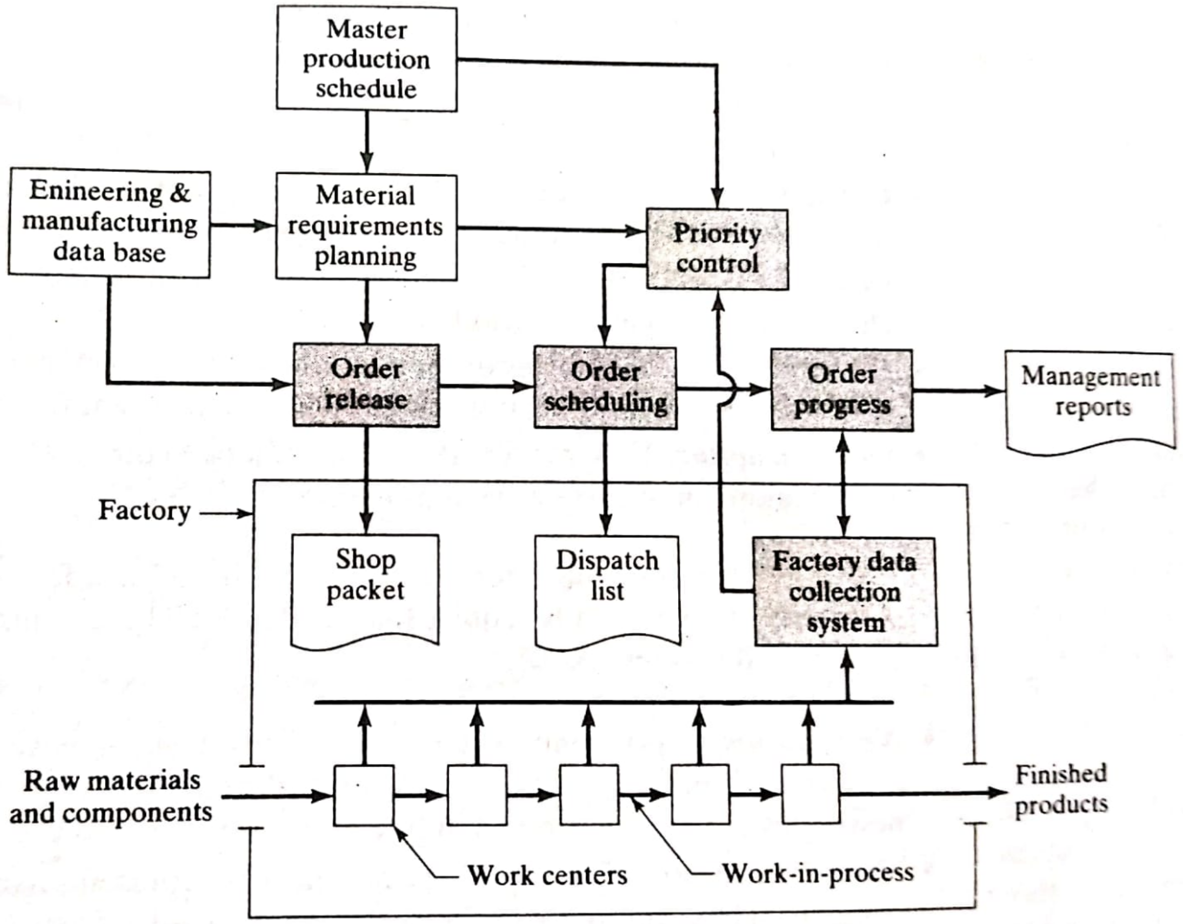

Figure 26.9 Three phases in a shop floor control system.

a) Order Release

- The order release phase of shop floor control provides the documentation needed to process a production order through the factory. The collection of documents is sometimes called the shop packet. It consists of

(i) Route sheet, which documents the process plan for the item to be produced

(ii) Material requisitions to draw a necessary raw materials from inventory

(iii) Job cards or other means to report direct labor time devoted to the order and to indicate progress of the order through the factory

(iv) Move tickets to authorize the material handling personnel to transport parts between work centers in the factory if this kind of authorization is required

(v) Parts list, if required for assembly jobs. In the operation of conventional factory, which relies heavily on manual labor, these are paper documents that move with the production order and are used to track its progress through the shop.

b) Order Scheduling

- The order scheduling module follows directly from the order release module and assigns the production orders to the various work centers in the plant.
- The order scheduling module in shop floor control is intended to solve two problems in production control

(i) Machine loading (ii) Job sequencing

The order scheduling module prepares a dispatch list

Some of the dispatching rules used to establish priorities for production orders in the plant include

(a) First come first serve
(b) Earliest due date
(c) Shortest processing time
(d) Least slack time
(e) Critical ratio

C) Order Progress

- The information presented to production management is often summarized in the form of reports, such as the following;

(i) Work order status reports

(ii) Progress reports

(iii) Exception reports

d) Factory data collection system

(i) Manual data input techniques:

The paper forms include

a) Job traveler
b) Employee time sheets
c) Operation tear strips
d) Prepunched cards

(ii) Automated and semi automated data collection Systems

(a) One centralized terminal
(b) Satellite terminals
(c) Workstation terminals

5) Inventory Control

- Inventory control is concerned with achieving an appropriate compromise between two opposing objectives:

(i) Minimizing the cost of holding inventory

(ii) Maximizing service to customers

The major costs of holding inventory are

(i) Investment costs

(ii) Storage costs

(iii) Cost of possible obsolescence or spoilage

a) Order Point Inventory Systems

(i) Economic Order Quantity Formula

where $D_a C_p$ = annual demand (pc/yr) multipled by cost per item ($/pc).

If the derivative is taken of either Eq. (26.1) or Eq. (26.4), the economic order quantity (EOQ) formula is obtained by setting the derivative equal to zero and solving for Q. This batch size minimizes the sum of carrying costs and setup costs:

$$Q = \text{EOQ} = \sqrt{\frac{2D_a C_{su}}{C_h}} \tag{26.5}$$

where EOQ = economic order quantity (number of parts to be produced per batch, pc/batch or pc/order), and the other terms have been defined previously.

EXAMPLE 26.3 Economic Order Quantity Formula

The annual demand for a certain item made-to-stock = 15,000 pc/yr. One unit of the item costs $20.00, and the holding cost rate = 18%/yr. Setup time to produce a batch = 5 hr. The cost of equipment downtime plus labor = $150/hr. Determine the economic order quantity and the total inventory cost for this case.

Solution: Setup cost $C_{su} = 5 \times \$150 = \$750$. Holding cost per unit $= 0.18 \times \$20.00 = \$3.60$. Using these values and the annual demand rate in the EOQ formula, we have

$$\text{EOQ} = \sqrt{\frac{2(15000)(750)}{3.60}} = 2500 \text{ units}$$

Total inventory cost is given by the TIC equation:

$$\text{TIC} = 0.5(3.60)(2500) + 750(15{,}000/2500) = \$9000$$

Including the actual production costs in the annual total, by Eq (26.4) we have:

$$TC = 15{,}000(20) + 9000 = \$309{,}000$$

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(ii) Reorder Point Systems

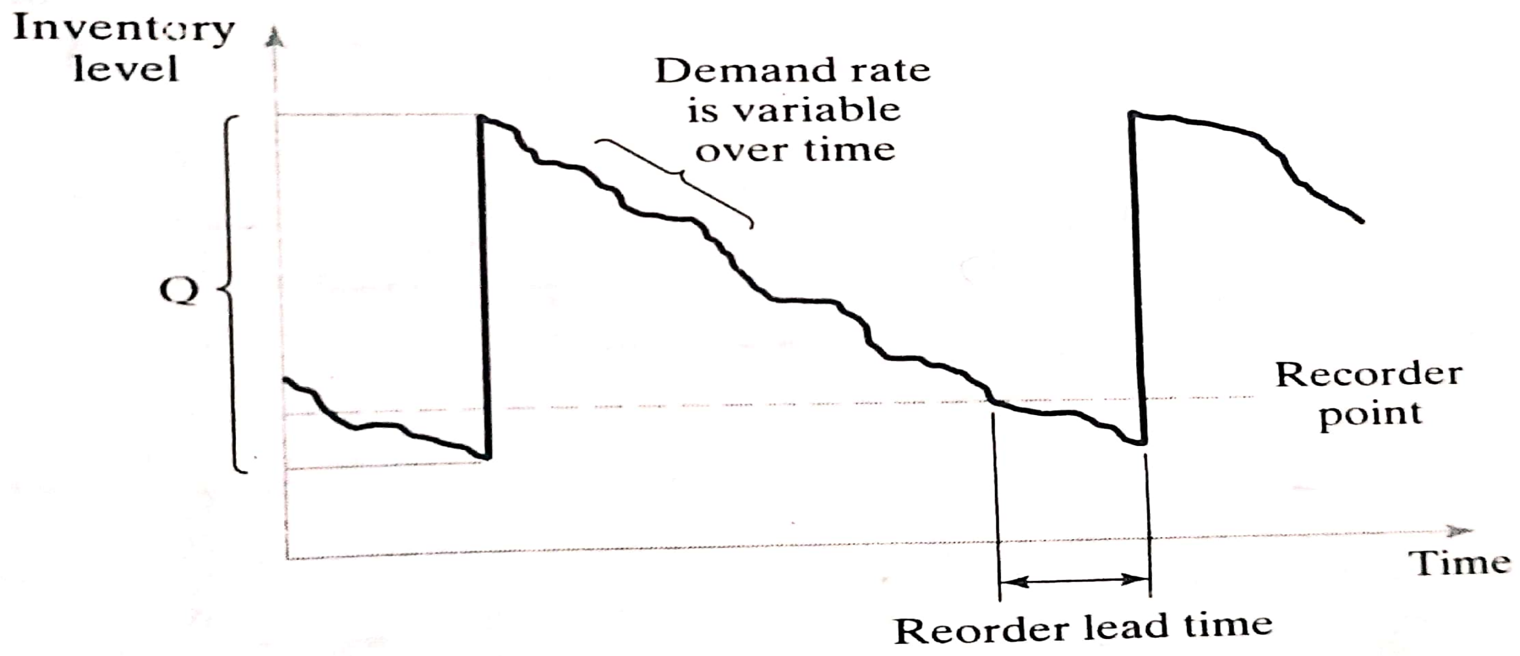

Figure 26.11 Operation of a reorder point inventory system.

b) Work-in-process Inventory Costs

- Work-in-process (WIP) represents a significant inventory cost for many manufacturing firms. In effect, the company is continually investing a raw materials, processing those materials, and then delivering them to customers when processing has been completed.

EXAMPLE 26.4 Inventory Holding Cost for WIP During Manufacturing

The cost of the raw material for a certain part is \$100. The part is processed through 20 processing steps in the plant, and the manufacturing lead time is 15 wk. The production time per processing step is 0.8 hr, and the machine and labor rate is \$25.00/hr. Inspection, material handling, and other related costs average to \$10 per processing step by the time the part is finished. The interest rate used by the company $i = 20\%$, and the storage rate $s = 13\%$. Determine the cost per part and the holding cost.

Solution: The material cost, operation costs, and nonoperation costs are by Eq. (26.6),

$$C_{pc} = \$100 + 20(\$25.00/hr \times .8\ hr + \$10) = \$700/pc$$

To compute the holding cost, first calculate C_p:

$$C_p = 20(\$25.00/\text{hr} \times .8\ \text{hr} + \$10) = \$600/\text{pc}$$

Next, determine the holding cost rate $h = 20\%+13\%=33\%$. Expressing this as a weekly rate $h = (33\%)/(52\ \text{wk}) = 0.6346\ \%/\text{wk} = 0.006346/\text{wk}$. According to Eq. (26.10),

$$\text{Holding cost/pc} = (100 + 600/2)(.006346)(15\ \text{wk}) = \$38.08/\text{pc}$$

$$TC_{pc} = 700.00 + 38.08 = \$738.08/\text{pc}$$

The \$38.08 in our example is more than 5% of the cost of the part; yet the holding cost is usually not included directly in the company's evaluation of part cost. Rather, it is considered as overhead. Suppose that this is a typical part for the company, and 5000 similar parts are processed through the plant each year; then the annual inventory cost for WIP of 5000 parts = 5000 × \$38.08 = \$190,400. If the manufacturing lead time could be reduced to half its current value, this would translate into a 50% savings in WIP holding cost.

6) Manufacturing Resource Planning (MRP II)

- It is defined as a computer based system for planning, scheduling and controlling the materials, resources and supporting activities needed to meet the MPS.

Application modules typically provided in a high end MRP II system include the following

(i) Management Planning
(ii) Customer Service
(iii) Operations planning
(iv) Operations execution
(v) Financial functions

Latest generation of MRP II software from its predecessors

(i) Enterprise resource planning (ERP)
(ii) Customer oriented manufacturing management systems
(iii) Manufacturing execution systems
(iv) Customer oriented management systems

7) Just –In-Time Production Systems

- Just in time production systems were developed in Japan to minimize inventories, especially WIP. WIP and other types of inventory are seen bt the Japanese as that should be minimized or eliminated

a) Pull System of Production Control

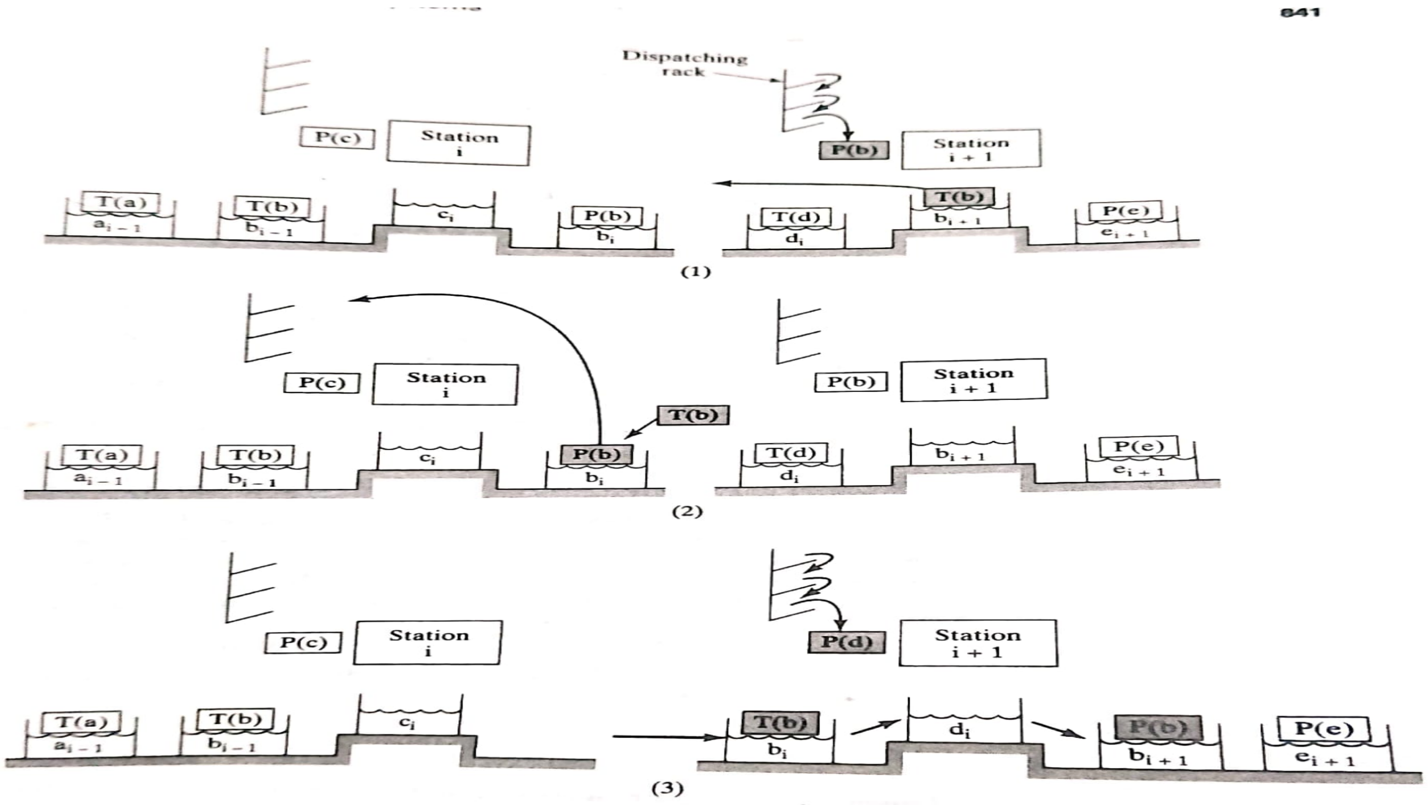

Figure 26.15 Operation of a kanban system between workstations (see description of steps in the text).

b) Small Batch Sizes and Reduced Setup Times

- Separate the work elements that comprise the setup procedure into two categories

(i) Internal elements, those that must be done during the machine stoppage

(ii) External elements, those that can be done while the previous job is still running

(iii) Design the setup tooling

(iv) Use the time and motion study

(v) Eliminate or minimize adjustments in the setup

(vi) Use quick-acting clamping devices instead of bolts and nuts

(vii) Develop permanent solution

(viii) Schedule batches of similar part styles in sequence to minimize the magnitude of changes required in the setup

(ix) Use of group technology and cellular manufacturing

(x) Design modular fixtures

C) Stable and Reliable Production Operations

- Requirements for a successful JIT production system include

(i) Stable production schedules
(ii) On-time delivery
(iii) Defect-free components and materials
(iv) Reliable production equipment
(v) Workforce that is capable, committed and cooperative
(vi) Dependable supplier base.