UNIT - 1

INTRODUCTION

PART- A

1. Define the term production control and mention how it forms the basis for other control (APRIL/MAY-14)

Production control though control mechanism, tries to take corrective action to match the planned and actual production.

The production control involves implementation of production plans by coordinating different activities. It seeks to ensure that production operation and actual performance occur according to planned operations and performance.

2. Define production planning and control. (APRIL/MAY-18)

Production planning control defined as Direction and coordination of firm's resources towards attaining the prefixed goals.

3. What are the three phases of production planning and control? (APRIL/MAY-14) (NOV/DEC-18)

i. Preplanning Phase

ii. Planning Phase

iii. Control phase

4. **What is meant by standardization? (NOV/DEC-18)**

Standardization means setting up standards or measuring sticks by which extent, quality, value, performance or service may be gauged or determined.

5. **What is break Even point and mention is significance? (APRIL/MAY-14) (NOV/DEC-16) (Apr/May 2017)**

The break-even point may be defined as the level of sales at which total revenues and total costs are equal. It is a point at which profit is zero. It is also known as "no-profit no-less point".

If a firm produces and sells above the break-even point, it makes profit. In case it produces and sells less than the break-even point, the firm would suffer loss.

6. Define Break even analysis. (APRIL/MAY-19)

Break-even analysis entails the calculation and examination of the margin of safety for an entity based on the revenues collected and associated costs. Analyzing different price levels relating to various levels of demand, an entity uses break-even analysis to determine what level of sales are needed to cover total fixed costs. A demand-side analysis would give a seller greater insight regarding selling capabilities.

Or

Breakeven analysis is used to determine when your business will be able to cover all its expenses and begin to make a profit. It is important to identify your startup costs, which will help you determine your sales revenue needed to pay ongoing business expenses.

7. List the objectives of planning & control. (APRIL/MAY-15) (Apr/May 2017) (Nov/Dec 2017) (APRIL/MAY-19)

a. To make all preparations to manufacture goods within specified time & cost.

b. To make available supply of materials, parts & components at the right time.

c. To ensure most economical use of plant & equipment by scheduling best machine utilization.

d. To provide information for production management & distribution of goods.

e. To issue relevant orders to production personals to implement the production plan.

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f. To make available materials, machines, tools, equipment & manpower in the required quality & quantity & at the specified time.

g. To ensure production of goods in the required quantities of the specified quality at the pre-determined time.

h. To keep the plant free from production bottleneck.

i. To maintain spare capacity to deal with rush orders.

j. To maintain cordial industrial relations.

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9. **Define standardization and list any one merits (APRIL/MAY-12)**
Standardization may be defined as the process of defining and applying the conditions necessary to ensure that a given range of requirements can normally be met with a minimum variety and in a reproducible and economic on the basis of the best current techniques.

a. reduced choice for customers because of reduced variety

10. List the merits and demerits of batch production (April/May-12)

Merits	Demerits
It employs a process layout In this similar machines are grouped into a department . More flexibility than mass production Better utilization of machines possible, consequently , fewer machines are Required	Since longer and irregular flow Lines result, material handling is more expensive PPC is elaborate Total production time is usually longer Higher grades of skill are required

11. List the functions of production control. (NOV/DEC-14)
The functions of production controls are

a. To implement the production plan into effect by issuing the necessary orders to the right person through proper channel

b. Any correction action in the production activity sent to production management through feedback

c. Optimum utilization of all resources

12. **Brief about the economics of the new design. (NOV/DEC-14)**
According to the Break even analysis, careful analysis to be done on the economics of the new design by determining whether the additional investment is desirable or not? Whether the new design is profitable or not?

13. Define the term production control and mention how it forms the basis for other control. (NOV/DEC-16)

Production control through control mechanism, tries to take corrective action to match the planned and actual production. Thus production control reviews the progress of the work. And takes corrective steps in orders to ensure that programmed production takes place.

The production control involves implementation of production plans by coordinating different activities. It seeks to ensure that production operations and actual performance occur according to planned operations and performance.

The three essential steps in control process are:

- Initiating the production
- Progressing.
- Corrective action based upon the feedback and reporting back to the production planning.
- control of quality.

14. What are the characteristics of job shop production?

i. High variety and low volume.

ii. General purpose machines and equipment to perform wider range of operation.

iii. Flow of material is not continues and supervisor are required.

iv. Highly skilled operators and supervisor are required.

v. Variable path material handling equipment are used.

15. What do you mean by batch production?

In batch production, the products are made in small batches and in large variety. Each batch contains identical items but every batch is different from the others.

16. Differentiate b/w the mass production and process production.

- In mass production, the products maximum two or three types of discrete products are manufactured in large quantities. Example Electronics electrical automobiles bicycles and containers industries.
- Process production is used for manufacturing of those items whose

demand is continuously and high. Example In processing of crude oil in refinery one gets kerosene, gasoline, etc.., at different stage of production.

17. **Differentiate b/w intermittent and continuous production system.**
The job shop production and batch are also known as intermittent production system. The mass production and process production are termed as continues production system.

18. **What types of plant layouts are suitable for job shop, batch and continuous production? (Nov/Dec 2017)**
Job shop production - Process of functional layout

Batch production	- Cellular layout
Continuous production	- Line or product layout

19. **Different b/w product design and product devlopment .**

- The product design, in its broadest sense, includes the whole development of the products through all the premilinary stage untill actual manufactering beings.
- Devising a products to meet the changing requirment of a manufactering products.

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20. **What is the objective of product analysis?**
The main objective of product analysis is to obtain a qualitive as well as qualitive evaluation of the influencing factors which determine primarily the success of a manufactered product.

21. **List the characteristic that influence the product.**

a. Marketing aspects

b. Products characteristic

a) Functional aspects

b) Operational aspects

c) Durability and dependability aspects

d) Aesthetic aspects

c. Ecomomi Analysis

a) Profit consideration

b) Effect of standartization

c) Break even analysis

d. Production aspects

22. Distingush the terms durablity and dependdability.

- Durability refers to the length of the active life or endurance of the products under given working conditions.
- Dependablity refers to the relaiblity with which the products serves its intendent fuction.

23. Mention any four techniques to enhance aesthetic appeal in prod- uct design.

i. Use of special materials (either for the part of the housing or as additional decorations).

ii. Use of colour (either natutral colour of the meterials or colour provided by paints, plantings, spraying, or even lighting.)

iii. Texture as a suppliment to colour (either by appropiate treatment of the given surface or coating.)

iv. Shape denoted by outer and similarly to familiar objects.

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24. What do you mean by design for manufactere and design for assembly?

- Design for manufactre (DFM) maens the design for ease of manufacture of the components of a product.
- Design for assembly (DFA) maens the design of the products for ease of assembly

25. **What do you understand by product standardization?**
Standardization maens setting up standards or maesuring sticks by which extent, quality quantity value , performance or service may be gauged or determine.

26. What are the 3S's with respects to products devolopment techniques?

a. Standardization

b. Simplification

c. Specfication

27. State the objective of standardiztion.

a. To achive maximum overall economy in terms of cost, human ef- fort, and conservation of essential materials as opposed to more readily available materials.

b. To ensure maxuimum conservation in use.

c. To adopt the best possible solution to recuring problems

d. To define requisite levels of quality

e. To facilitate national and international exchange of goods and ser- vice and to devolop mutual cooperation in the sphere of intellectu- als, scientific, technologies, and economic activity.

28. What are the preferred numbers? Mention their uses.

- Prefered numbers are definds as series of numbers selected to be used for standardization purpose in npreferance to other numbers.
- The use preferred number will leads to simplified practice. Therefore, the preferred numbers should be employed whenever possible for individual standard sizes ratings.

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29. Constract Product simplfication with product diversification.

- Product simplification is the process of reducing the variety of products manufactured i.e, variety reduction.
- Product diversification is completely opposite to simplification. Product diversification involves adding new products to achive a balanced products range.

30. What do you mean by specialization?

Speacilization is the process where by particular firms concenrate on the manufacture of a limited number of products or types of products.

31. What are the advantage of specialization?

- Bettrer utiulization of equpments
- Higher productivity
- Greater efficiency

- Better quality,
- Reduced production cost and hence lower unit price and
- Use of stanmdardized methods.

PART - B

1. What you mean by continuous production? Describe various forms of continuous production system. (M/J '12) (Nov/Dec 2018)

Continuous production This type of production is used for manufacture of those items whose demand is continuous and high . here single raw material can be transformed into
different kind of products at different stages of the production processes . ,. in processing of crude oil in refinery one gets kerosene etc at different
stage of production Suitability

The industries like paper, textiles, cement chemicals, automobiles etc

1. Speed of processing very fast
2. Production set up time less than batch production and job production
3. Work-in-process small
4. Finished goods inventory in continuous production is high
5. Labour skill required in continuous production system is medium specialized
6. Labour control of the product value in continuous production system is medium to low
7. Product mix in continuous production system bulk commodities eg., sugar chemicals
8. Introduction of new product with same production facilities and with no addition investment is not possible
9. Types of manufacturing facilities in continuous production system required special purpose machines
10. Types of layout is product layout
11. Capital investment very high
12. Equipment utilization very high

2. What is the production system? Describe the various constituents of production system. (Nov/Dec 2018)

Production is the sequence of operations which transform the given materials into desired products. This transformation from one form to another is carried out either by one or a combination of different manufacturing processes

A system is a logical arrangement of components (physical and conceptual) designed to achieve particular objectives according to plan

A production system is a frame work within which the conversion of input into output occurs. At the one end of the production system are the inputs and at the other end outputs. Inputs and outputs are linked by certain operations or processes which impart value to the inputs and are called transformation process

Types of production system

1. Job shop production
2. Batch production
3. Mass production, and
4. Process or continuous production

Job shop production system

Job or unit production system involves the manufacturing of a single complete unit as per the customers order. This is a special order type of production each job or product is different from others and no repetition is involved .the work is started only when the organization has orders on hand

Batch production

In this type, the products are made in small batches and in large variety. Each batch contains identical items but every batch is different from the others

Mass production

In this production only one type of product or maximum 2 or 3 types are manufactured in large quantities. Standardization of products, process, materials machines and uninterrupted flow of materials are the basic features of this system mass production system offers economics of scale as the volume of outputs is large.

Continuous production

This type of production is used for manufacture of those items whose demand is continuous and high. Here single raw material can be transformed into different kind of products at different stages of the production processes.

3. Explain the characteristic features of (i) Batch Production and (ii) Mass production system. (A/M'14) (Nov/Dec 2018)

Function of comparison	Batch production	Mass production
Speed of processing	Slow	Fast
Production set up time	High	Less
Work- in process	Moderate	Small
Finished goods inventory	Varies; Moderate if storable	High
Labor skills required	High multipurpose	Medium specialized
Labor control of the product value	High	Medium

Product mix	Small bits of large variety products e.g medical equipment	Standardized product Eg: Automobiles
Introduction of new product with same production facilities and with no additional investment	Somewhat easy	Very difficult
Types of manufacturing facilities	Monthly general purpose and some special Purpose machines	Special purpose machine dominate
Types of layout	Process layout	Process layout
Capital investment	Medium (labour intensive)	High (capital intensive)
Equipment utilization	Medium (35% to 80%)	High (80% to 100%)

4. Why it is necessary to analyze the product and explain the various analysis that are carried out? (A/M' 14)

Once the profitable product is selected, then the next step is the detailed analysis of the product with respect to various factors that influence the product design.

The main objectives of product analysis are to obtain a qualitative as well as quantitative evaluation of the influencing factors which determine primarily the success of a manufactured product.

Many factors have to be analyzed related to development and design factors, which vary in character and complexity, and factors related to different fields in production and industrial engineering.

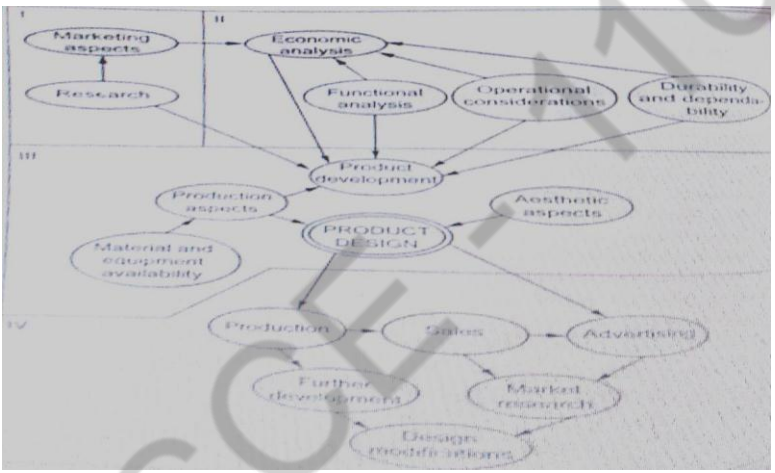
Factors that influence product design can be grouped under four headings. they are:

- Marketing aspects
- Product characteristics
- Functional aspects
- Operational aspects
- Durability and dependability aspects

- Aesthetic aspects
- Economic analysis
  - (A) Profit consideration
  - (B) Effect of standardization, simplification, and specialization
  - (C) Break-even analysis

Production aspects

The various factors that influence product design and their interrelationship, presented by Chitale and Guptha, is illustrated in



5. Discuss the benefits of PPC. (N/D'14)

PPC forecasts sales orders and makes sales order more economical in production. It co-ordinates the operations of several departments.

It ensures better service to customers by delivering quality goods within the specified time period. Reduces production costs through orderly scheduling of work activities and reducing wastages. Reduces employee idle time.

Ensures a better control of material and contributes to efficient buying.

6. Distinguish between the batch production and continuous production (Nov/Dec 2018)

BATCH PRODUCTION

Batch production is defined by American Production and Inventory Control

Society (APICS) "as a form of manufacturing in which the job passes through the functional departments in lots or batches and each lot may have a different routing." It is characterized by the manufacture of limited number of products produced at regular intervals and stocked awaiting sales.

Characteristics

Batch production system is used under the following circumstances:

1. When there is shorter production runs.
2. When plant and machinery are flexible.
3. When plant and machinery set up is used for the production of item in a batch and Change of set up is required for processing the next batch.
4. When manufacturing lead time and cost are lower as compared to job order production.

Advantages

Following are the advantages of batch production:

1. Better utilization of plant and machinery.
2. Promotes functional specialization.
3. Cost per unit is lower as compared to job order production.
4. Lower investment in plant and machinery.
5. Flexibility to accommodate and process number of products.
6. Job satisfaction exists for operators.

Limitations

Following are the limitations of batch production:

1. Material handling is complex because of irregular and longer flows.
2. Production planning and control is complex.

CONTINUOUS PRODUCTION

Production facilities are arranged as per the sequence of production operations from the first operations to the finished product. The items are made to flow through the sequence of operations through material handling devices such as conveyors, transfer devices, etc.

Characteristics

Continuous production is used under the following circumstances:

1. Dedicated plant and equipment with zero flexibility.
2. Material handling is fully automated.
3. Process follows a predetermined sequence of operations.
4. Component materials cannot be readily identified with final product.
5. Planning and scheduling is a routine action.

Advantages

Following are the advantages of continuous production:

1. Standardisation of product and process sequence.
2. Higher rate of production with reduced cycle time.
3. Higher capacity utilisation due to line balancing.
4. Manpower is not required for material handling as it is completely automatic.
5. Person with limited skills can be used on the production line.
6. Unit cost is lower due to high volume of production.

Limitations

Following are the limitations of continuous production:

1. Flexibility to accommodate and process number of products does not exist.
2. Very high investment for setting flow lines.
3. Product differentiation is limited.

7. A manufacturer sells an item for Rs.13 per unit. He incurs a fixed cost of Rs. 60,000 a variable cost of Rs. 8 per unit. Find the break even production quantity and also the number of units to be produced to get a profit of Rs. 12,000

Given data: SP=Rs 13; FC=Rs60000;

VC=Rs 8 Solution: Break-even production

quantity(BEP) BEP=

= = 12,000 UNITS

Number of units to be produced to get a profit of Rs. 12,000

Sales volume =

= = 14,400 units

8. Describes the functions of production control. (A/M'15)

The main functions of PPC are the coordination of all the activities, which exist during production or manufacturing.

Materials: This function is concerned with ensuring that the Raw material, standard finished parts, finished parts of products must be available while starting the operation within the time.

Methods: This function is concerned with the analysis of all methods of manufacturing and selecting the best appropriate method according to the given set of circumstances and facilities.

Machines and Equipments: It is important that methods of manufacturing should to be related to the available production facilities coupled with a detail study of equipment replacement policy. This function is concerned with the detailed analysis of the production facilities, maintenance procedures and equipment policy.

Routing: It refers to the flow of sequence of operation and processes to be followed in producing a particular finish product. It determines manufacturing operation and their sequence.

Estimating: This function is concerned with estimation of operations time. The operation time can be worked Out once the overall method

and sequence of operation is fixed and process sheet for each operation is available.

Loading & Scheduling: It is important that machine should be loaded according to their capabilities performance the given and according to the capacity. It is concerned with preparation of machine loads and fixation of starting and completion dates for a particular operation.

Dispatching: It means the assignment of work to different machines or work places which involve authorities to start of production activities in order of their priority as determined by scheduling.

Expediting: It is also called Follow Up or Progress. Follow up which regulates the progress of materials and parts through the production process. It is closely interrelated with activities of dispatching.

Inspection: It is an important control tool. Its assessment is important in the execution of current program and planning stage of undertaking when the limitations of the processor, method and manpower are known. It forms a basis for future investigations with respect to method, process etc. which is useful for evaluation phase.

Evaluating: This is the integral part of control function. The evaluating function is concerned with providing a feedback mechanism on the long term basis so that the past experience can be evaluated with the aim of improving utilization of method and facilities.

9. Explain the economics of a new design (Nov/Dec 2017)

When the laughing of a new design or model is contemplated a careful analysis of the proposed project has to be undertaken.

As discussed already. The purpose of introducing a new model to the market is twofold:

- To increase the profit of the organization,
- To avoid decline in sales of an existing model due to stiff competition.

Samuel Eilon has proposed a model , which is based on the break –even analysis, to determine whether the additional investment is desirable or not?

Let FC = Fixe cost,

S = Additional investment made,

P_1, Q_1 = Profit accured and quantity sold before the additional investment respectively ,and

P2Q2 = Profit accured am quantity sold after the additional investment respectively.

Now let us compare P_1 and P_2 and justify the new additional investment made.

We known that the slope of the break-even chart

Φ = Profit (p)+Fixed cost (FC)

Quantity sold(Q)

Therefore, the slope of the break –even chart before the additional investment,

$\Phi = P_1 + FC$ or $P_1 = \Phi_1 Q_1 - FC$

Q_1

And the slope of the break-even chart after the additional investment,

$\Phi_2 = P_2 + FC + s$ or $P_2 = \Phi_2 Q_2 - FC - s$

It is desirable that the new profit will be larger than, or at least equal to ,the existing one,i.e.,

$$\therefore \text{i.e., } P_2 \geq P_1$$
$$= P_2 - P_1 \geq 0$$
$$= \left(\phi_2 Q_2 - FC - s\right) - \left(\phi_1 Q_1 - FC\right)$$
$$= \phi_2 Q_2 - \phi_1 Q_1 - s \geq 0$$

This condition tells us how many units of the new design ought to be sold in order to ensure that total profit does not decline.

For $P_2 - P_1 > 0$, using equations (i) and (ii), we get

$$D = \frac{\phi_1}{\phi_2} = \frac{\text{P/V ratio for old design}}{\text{P/V ratio for new design}}$$

$$\frac{Q_2}{Q_1} \geq \left[1 + \frac{s}{P + FC_1}\right] D$$

In equation, when D=1,Q2 must be greater than Q1to justify the additional Investment (s) on design change.

10. Discuss the various aspects of product development and design (N/D'14,A/M'15,N/D'16)

Once the profitable product is selected, then the next step is the detailed analysis of the product with respect to various factors that influence the product design. The main objectives of product analysis is to obtain a qualitative as well as quantitative evaluation of the influencing factors which determine primarily the success of a manufactured product

Many factors have to be analyzed related to development and design factors, which vary in character and complexity, and factors related to different fields in production and industrial engineering.

Factors that influence product design can be grouped under four headings. they are:

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  (B) operational aspects

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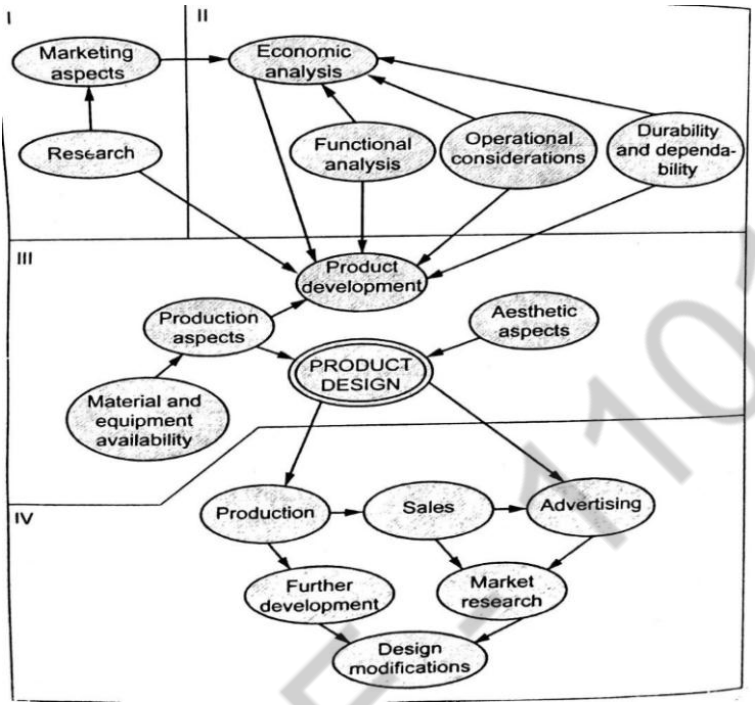


Marketing Ascepts :

Obviously, it is necessary to ensure that the proposed product should ful fill the demand of the market. In the other words, it is very important to assess the marketability of the proposedproduct.

If the is no potential market for the proposed market , then it is meaning activity to design and manufacture the product. therefore before going for the product design and other activities, the marketability of the product should be carefully examined. Amarket analysis is done to determine its size, size the nature of the customer, and possible trend.

The market analysis for the proposed product seeks to give answers to the following questions:

(i) Whether the proposed product offers the functions that are desirable and acceptable to the customers?

(ii) Is it Is it within the buying capacity of thecustomers?

(iii) Does the product satisfy customer's preference in regard to its size,shape, colour, etc.

(iv) Is the product already existing?

(v) Is it entirely new product about which the customer is unaware?

(vi) What will be the expected demand for the product both short-term and long term?

(vii) What are the factors that influence the demand for this proposed product? (viii) Who are the competitors?

(ix) What is the basis of competition for the product?

(x) What are the distinguishing features offered by competitors? (xi) What is the price prevailing in the market?

What is the prevailing distribution system? Etc.

- The estimation of demand for the existing product is comparatively easaier than that for the new product, a through market survey is to be carried.
- The estimation of demand for the existing product can be assessed by consumer research and sales figure for identical and similar products.
- Demand can also be created with the introduction of a new product, either by filling a gap in the market or by offering new features functions. The estimation of such demand can be assessed by market research.
- Therefore it is very essential for an organization to keep in constant touch with the target with the target market and a "feel" its trends.
- If the management wants to achieve maximum satisfaction and desires to supply the consumer with what he /she wants or he/she is supposed to want, it may have to produce a variety of model to suit every taste.
- In practice, product design is a result of sort of compromise between verity on one hand and the designer's concept of the ideal design on the other. In selling his compromise, the management opts for an advertising campaign.

Advertising serves many purposes. Some of the Objectives of advertising are:

(i) To provide general information about the existence of the product.

(ii) To provide technical information about its functional characteristics or utility

(iii) To draw the customer's attention to those special featurestargeted at the customer.

(iv) To create demand among a passive population of customers

(v) To educate the customer, or tell him what he/she should want

It is understood clearly that the input from marketing experts is crucial in deciding the product to make, how many to make, and when to make them .so it may be said that production activities being with the marketing function whose input continues through the management and design functions. Thus, marketing aspects which analysis the factors that influence the demand of the product is a crucial step in product analysis.

11. The fixed costs for the year 2000-01 are Rs.6,00,000 variable cost per unit is Rs.40. Each units sells at Rs. 160. Determine:

i. Break-even point a) in terms of physical units, and b) in terms of rupees.

ii. If a scales volume of 5500 units has been expected, then what will the profit (or less) earned?

iii. If a profit targets of Rs. 1,20,000 has been budgeted, compute the number of units to be sold.

iv. If the company sells 6500 units, calculate the margin of safety and profit.

Given data:

FC = Rs.600000 VC = Rs.40 SP = Rs.160

Solution:

i) a) BEP in terms of physical units

$$Q_{BEP} = \frac{FC}{SP - VC} = \frac{600000}{160 - 40}$$

$$= 5000 \text{ units}$$

b) BEP in terms of rupees

$$\text{BEP in rupees} = \frac{\text{FC}}{1-\left(\frac{\text{VC}}{\text{SP}}\right)} = \frac{600000}{1-\left(\frac{40}{160}\right)}$$

$$= \text{Rs.8, 00, 000}$$

ii) Profit or loss if Q = 5500 units.

$$\text{Sales voloume} = \frac{\text{Fixed cost + profit}}{\text{Contribution}}$$

$$5500 = \frac{600000 + \text{Profit}}{160 - 40} \quad [\because C = SP - VC]$$

$$\text{Profit} = \text{Rs.60,000}$$

iii) Number of units to be sold to earn the profit of Rs.7,25,000:

$$\text{Sales volume} = \frac{\text{FC + Profit}}{\text{SP} - \text{VC}}$$

$$= \frac{6, 00, 000 + 1, 20, 000}{160 - 40}$$

$$= 6000 \text{ units}$$

iv) Margin of safty when Q = 6500 units

$$\text{Marginof safty} = \frac{\text{sales} - \text{Sales at BEP}}{\text{Sales}}$$

$$= \frac{6500 - 5000}{6500} \times 100$$

$$= 23.08\%$$

12. A firm as annual fixed costs of Rs. 3 million and variable costs of 8 per unit. It is considering additional investment of Rs.800000 which will increase the fixed costs by Rs.150000 per year and will increase the contribution by Rs. 2.50 per unit. No change is anticipated in the sales volume or the sales volume or the sales price of Rs. 16 per unit. What is the breakeven quality if the new investment is made?

Given data:

FC = 3000000,VC = Rs. 8, SP = Rs.16.

Solution:

To find Q_{BEP} if new investment is made.

Fixed cos t after an additional inversment = 3000000 + 150000

= Rs.31, 50, 000

Given that new investment will increase the contribution by Rs.2.50 per unit. Therefore the Rs.2.50 increase in contribution will decrease variable cost to (Rs.8-Rs.2.50) = Rs.5.50/unit

$$Q_{BEP} = \frac{FC}{SP - VC}$$

$$= \frac{31, 50, 000}{16 - 5.50} = 3, 00, 000 \text{ units}$$

13. Mansion Industries has the following data on cost at two volumes of production for product that sells for 50.

a) Construct a two volume, break even chart.

b) Compute the variable cost, the contribution and the BEP.

c) Using the contribution from (b)., estimate the profit at a volume of 8000 units.

	Labour	Material	Overlap	Other FC	Total
6000 unit	Rs.60000	Rs.36000	Rs.54000	Rs.80000	Rs.230000
10000 unit	Rs.100000	Rs.60000	Rs.60000	Rs.80000	Rs.300000

Given data:

SP = Rs.50 $TC_{6000\ unit}$ = Rs.230000 $TC_{100000\ units}$ = Rs.300000

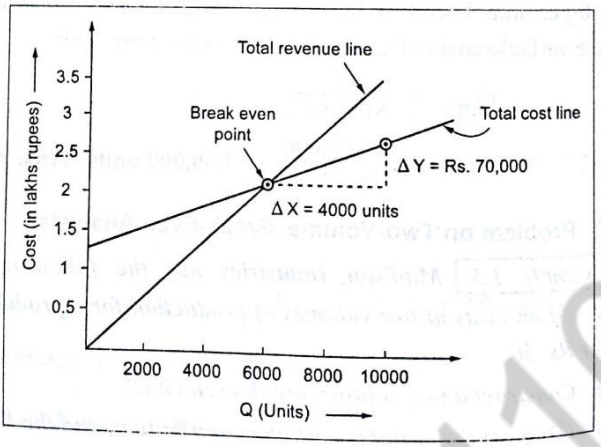
Solution:

a) Construct of two volumes, breakeven chart:

The two volumes breakeven point chart is constructed as shown figure.

b) To find variable cost contribution and BEP:

Variable cost: we know that the slope of the total cost line is the estimated variable cost per unit.



$$\therefore \text{VC} = \frac{\text{Change in Y}}{\text{Change in X}} = \frac{\Delta Y}{\Delta X} = \frac{300000 - 230000}{10000 - 6000}$$

$$= \text{Rs.}17.50 \text{ per unit}$$

$$\text{Contribution (C)}:$$

$$C = SP - VC$$

$$= 50 - 17.50$$

$$= \text{Rs.}32.5$$

BEP: in order to calculate BEP, we have to find fixed cost from first, By subtracting 6000 units or 100000 units of variable cost from the total cost Rs.6000 units or 100000 units.

$$FC = \{\text{total cost @ 6000 volume}\} - (6000 \text{ unit})(\text{Variable cost / unit})$$

$$= 230000 - (6000 \times 17.50)$$

$$= \text{Rs.}1, 25, 000$$

$$\text{Then BEP} = \frac{FC}{SP - VC} = \frac{1, 25, 000}{50 - 17.50}$$

$$= 3846.15 \text{ units}$$

c) Profit at a volume of 8,000 units:

we know that,

Profit = Total revenue – Total cost

Total revenue = SP × Q

$$= 50 \times 8000 = \text{Rs.}4, 00, 000$$

$$\text{Total cost} = FC + VC \times Q$$

$$= 125000 + (17.5 \times 8000)$$

$$= \text{Rs. } 2,65,000$$

$$\therefore \text{ Profit at 8000 units} = 400000 - 265000$$

$$= \text{Rs. } 135000$$

14. Explain standardization and simplification along with their advantages and disadvantages, if any. (Nov/Dec 2018)

Standardization primary means setting up standards measuring stick by which extent, quality, value performance or service may be gauged or determined.

Standardization may be defined as the process of deflecting and applying the condition necessary to ensure that a given range of range of requirement can be normally be met with a minimum variety and in a reproducible and economic manner on the basis of the best current techniques.

Standards means fixation of some approximate size, shape, quality, manufacturing process, weight and other characteristic as standards to manufacture a products of desired variety and utility. For example, manufacture of television sets of standard size of the screen using standard components and technology, shaving blades are made of standard size and shape to suit every kind of razor.

The concept of standardization is applicable to all factors of production namely men, machines, materials and finished goods. These standards can become the basis to evaluate the performance of various components of production in a manufacturing process.

Standardization becomes the basis of production controls operations and works as a catalyst in directing and operating the working of business enterprises.

Standardization is an instrument to manufacture maximum variety of products out of products out of minimum variety of components by means of a maximum variety of products out of minimum variety of machines and tools. This decrease working capital requirement and reduction in manufacturing.

Standardization also implies that non-standard items are not to be manufactured expects when consumers order them specially.

Objectives of standardization

The various aims of standardization are as below:

- To achieves maximum overall economy in terms of
  a) Coal,
  b) Human efforts
  c) Conservation of the essential materials as opposed to more readily available materials.
- To ensure maximum conservation in use. This objective of standardization leads to simplification, rationalization, inter-changeability of parts and freezing of direction of components.
- To adopt the best possible solution to recurring protection.
- To define requisite levels of quality.
- To incllitate national and international exchange of goods and service and to develop manual cooperation in the sphere of intellectual scientific technological and economic activity.

Classification of Standardization

The different type of standardization are presented in table

1. Basic standardization: It is based upon generals consideration of numerical theories. It includes standardization of the various basic elements such as scales and weights, voltages, preferred numbers, preferred size, limit and fits, screw thread profiles, surface texture, drawing paper size and testing procedures.
2. Dimensional standardization: It includes standardization of various engineering components such as nuts, bolts, screws, gears keys reverts and bearings.
3. Materials standardization: The materials that are used in production are standardization in quality size shape and other physical aspects. It includes standardization of raw materials lubricants coolants cotton waste various tools. Etc..,
4. Equipment standardization: the equipment used should also be standardized. This standardization includes the specification relating to various machines and equipments required for production their location layout and performance rating.
5. Process standardization: the operation method in a factory is standardized to get the maximum benefits of case and cheapness in production.

6. Quality standardization: this economical quality (ECQ) to be produced is decided earlier and this assumes the standard for production.
7. Safety measures standardization: This standardization refers to rules and regulation formed to assure the safety of men and machines in a factory.
8. Personal standardization: This standardization refers to works selections trainings and aptitude their wage rated and operating times.
9. Administrative standardization: This standardization refers to office methods and procedures to assume a most efficiency working.

Activities of standardization

The main categories of the activities covered by the standardization are,

1. Physical dimension and tolerance of components with in a defended range
2. Rating of machine or equipments (In units of energy, temperature, currents speeds etc.,)
3. Specification of physical and chemical properties of materials.
4. Methods of testing characteristics or performance.
5. Methods of installation to comply with minimum precautionary measures and convenience of use.

Benefits of Standardization

The importable benefits of standardization are:

i. Reduction of materials waste and obsolescence

ii. Reduced manufacturing cost per unit and hence the reduced price.

iii. Uniform quality of the products.

iv. Reduced maintenance, servicing and replacement of equipment and parts.

v. Reduced work in process and finished products inventories.

vi. Reduced book keeping and other documentation work

vii. Increased customer confidence to buy products

viii. Better and quicker product delivered.

Limitation of Standardization

Some of the disadvantage of Standardization includes:

i. Reducing choice for customer because of reduced variety,

ii. Change in products design or new products design may take a very long time.

iii. Excess standardization of operation and procedure will reduce the initiative and interest of worker.

Simplification

Simplification is the process of reducing the variety of product manufactured ie., variety reduction.

Simplification of product refers to the elimination of excessive and undesirable or marginal line of products to eliminate waste and to achieve economy.

Simplification is concerned with the reduction of products range assemblies parts materials and design.

Simplification is also termed as **Products line contraction.**

Simplification makes a product or assembly, simpler and less complex

Simplification enable the production department to improve planning achieves higher rates of production and machines utilization and simplify control procedures.

Consideration in simplifying products

Before simplifying any products one should ask himself the following questions

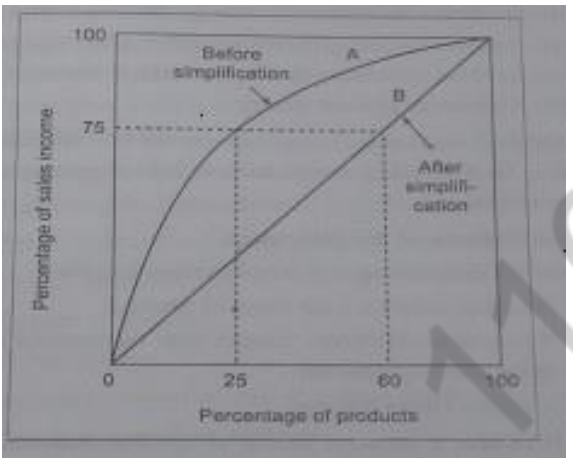
i. Whether simplification cab be achieved effectively for the nature of the given products 2.

ii. How the simplification will affects customer demand and volume of sale?

iii. Does market competition permit simplification or it encourage products diversification?

Effect of simplification

Shows the pareto diagram drawn between the accumulated sales incomes and the number of products offered for scale .



In Fig The curve A reveals that 25% of the products brought in 75% of the income. This is referred as 25% to 75% relationship. This 25% to 75% model is undesirable situation is when responsibility for income is more evently distributed between products as the Curve B (flat curve) in Fig. It is understood that curve B is achieved through variety reduction i.e, Simplification.

Benefits of Simplification

Several benefits of simplification are:

i. It reduces manufacturing operation and risk of obsolescence.

ii. It makes possible the effective utilization special purpose and automatic machines.

iii. It simplifies products planning and supervision

iv. It leads to lower manufacturing costs and higher sales.

v. It provides quick delivery and better after sales service.

vi. It reduce inventory and hence better inventory control.

vii. It improved product quality.

Note: product diversification is completely opposite it simplification products diversification involves adding new products or lines of products to achieve a balanced products range.

Limitation of Simplification

Some of the disadvantages of simplification

i. It cannot satisfy a wide range of demand.

ii. It cannot enable better contact with the demand to study its tastes and required.

iii. It cannot create demand

iv. It creates a constant source of source of confident b/w marketing and production.

15. Explain about Specialization. (Nov/Dec 2018)

As the name indicates, specialization means having specialization or expertise in particular product line, instead of diversification.

Specialisation is the process where by particular firms concentrate on the manufacture of a limited number of products or types of products.

- ✓ Specialisation implies expertise in some particular area or field. The main objective of specialisation is the reduction in the variety of products manufactured by the organisation.
- ✓ It is the extreme case of simplification concentration on a limited number of products, processes, *etc.* In fact, combination of simplification and standardisation leads to specialisation.
- ✓ This term can be applicable to products, processes, materials, resources or any other aspect of management/manufacture/design.
- ✓ The concept of standardisation, simplification, and specialisation are not identical terms and are independent of each other, but they are the principles leading to lay the foundation of mass production at most economic price.

1.11.2. Advantages of Specialisation

Several advantages of specialisation include:

(*i*) Better utilisation of equipments.

(*ii*) Higher productivity.

(*iii*) Greater efficiency.

(*iv*) Better quality.

(*v*) Reduced production cost and hence lower unit price.

(*vi*) Use of standardised methods.

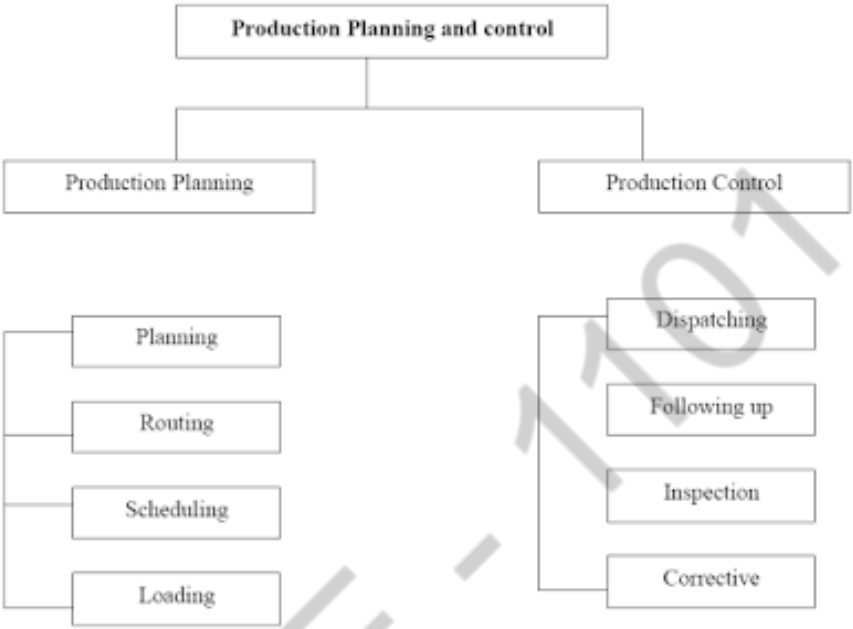
1.11.3. Disadvantages of Specialisation

The disadvantages of specialisation include:

(*i*) Lesser flexibility in adjustments to changed situations.

(*ii*) Monotony in work and loss of initiative.

16. With the help of a simple flow diagram discuss in details about the functions of planning and control. (Apr/May 2019)



The main functions of PPC are the coordination of all the activities, which exist during production or manufacturing.

Materials: This function is concerned with ensuring that the Raw material, standard finished parts, finished parts of products must be available while starting the operation within the time.

Methods: This function is concerned with the analysis of all methods of manufacturing and selecting the best appropriate method according to the given set of circumstances and facilities.

Machines and Equipments: It is important that methods of manufacturing should to be related to the available production facilities coupled with a detail study of equipment replacement policy. This function is concerned with the detailed analysis of the production facilities, maintenance procedures and equipment policy.

Routing: It refers to the flow of sequence of operation and processes to be followed in producing a particular finish product. It determines manufacturing operation and their sequence.

Estimating: This function is concerned with estimation of operations time. The operation time can be worked Out once the overall method and sequence of operation is fixed and process sheet

for each operation is available.

Loading & Scheduling: It is important that machine should be loaded according to their capabilities performance the given and according to the capacity. It is concerned with preparation of machine loads and fixation of starting and completion dates for a particular operation.

Dispatching: It means the assignment of work to different machines or work places which involve authorities to start of production activities in order of their priority as determined by scheduling.

Expediting: It is also called Follow Up or Progress. Follow up which regulates the progress of materials and parts through the production process. It is closely interrelated with activities of dispatching.

Inspection: It is an important control tool. Its assessment is important in the execution of current program and planning stage of undertaking when the limitations of the processor, method and manpower are known. It forms a basis for future investigations with respect to method, process etc. which is useful for evaluation phase.

Evaluating: This is the integral part of control function. The evaluating function is concerned with providing a feedback mechanism on the long term basis so that the past experience can be evaluated with the aim of improving utilization of method and facilities.

17. Discuss in detail about the various functions of Production Plan- ning & Control. (APRIL/MAY-17)

Refer Question No: 8 (Part-B)

18. Explain the functions of production control (Nov/Dec 2016)

Refer Question No: 8 (Part-B)

19. Explain with example the various aspects of product development & design. (APRIL/MAY-17)

Refer Question No: 10 (Part-B)

20. Explain different types of production systems & differentiate between them. (Nov/Dec 2017)

Refer Question No: 2 & 3 (Part-B)

21. Compare between various types of productions. (Apr/May-2018)

Refer Question No. 1,2,5&3 (Part-B)

22. What answers marketing analysis give for the proposed product?

Refer Question No.10 (Part-B)

23. Explain the procedural steps involved in product development (Apr/May 2019)

Refer Question No.10 (Part-B)

24. State the aims and advantages of Standardisation.

Refer Question No.14 (Part-B)

25. Describe the Samuel Eilson's models for economics of a new design.

Refer Question No.9 (Part-B)

UNIT - 2
WORK STUDY

PART - A

1. What are therbligs? Give any two therbligs with symbols. (APRIL/MAY-14)

Therbligs are the symbols used to denote the various activities and movements done for different purposes.

Symbols	Names	Abbreviation	Colour
	Search	Sh	Black
	Find	F	Grey

2. List the steps involved in time study. (APRIL/MAY-14)

(i) Select the work/method/operation /process to be studied.

(ii) Obtain and record all the details about the operations and the operator being studied.

(iii) Breakdown the work into suitable elements.

(iv) Measure the time for each element.

3. Define Method study. (APRIL/MAY-15) (NOV/DEC-14) (Nov/Dec 2017) (Nov/Dec 2018)

(OR)

Define method study and state the three different levels in method study. (Apr/May 2019)

Method study can be defined as the procedure for systematic recording, analysis and critical examination of existing or proposed method of doing work for the purpose of development and application of easier and more effective method.

Three different levels

Economical factor

Human factor

Technical factor

4. Mention any two tools used in time study. (APRIL/MAY-15)

The techniques of time study are:

1. Predetermined time standards system (PTSS)
2. Stopwatch time study
3. Standard data formula time standards

5. What is PMTS?

A work measurement technique whereby times established for basic human motions are used to build up the time for a job at the defined level of performance.

6. Define the term work study. (Apr/May 2017)

"Work study is a generic term for those techniques, particularly method study and work measurement, which are used in all its context and which lead systematically to the investigation of all the factors, which effect the efficiency and economy of the situation being reviewed in order to effect improvement."

The main objective of work study is to improve productivity of men, machines and materials. The aim of work study is to determine the best method of performing each operation and to eliminate wastage so that production increases with less fatigue. The work study is also used in determining the standard time that a qualified worker should take to perform the operation when working at a normal place.

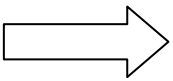
7. What is motion study? (NOV/DEC-14)

Motion study is used to record and critical analyze the existing operation / activity with the use of motion picture, video tapes for the improvement of the operation

8. Distingiush between method study and time delay (APRIL/MAY-12)

Method study	Time delay
Method is a systematic recording and critical examination of existing and proposed ways of doing work	Time delay is a work measurement technique for recording times and rates of working for the elements of a specified job carried out under specified conditions

9. Draw the symbol used in process chart for the activities inspection and transport. (APRIL/MAY-12)

	Inspection	❼ It indicates any type of inspection, check, measurement, visual security for quality and or quality ❼ Example: Measuring the thickness of a plate checking the harness of a bar, counting the quality of raw materials received etc.,
	Transport	❼ It indicates movement of workers, materials or equipments from place to place. ❼ Example: Gear blank moving from milling machine to grinding machine, an operator moving from his work place to the stores etc..,

10. Sate the objectives of work study. (Apr/May 2018)

(i). To find the most economical way of doing work.
(ii). To simplify and standardize the methods, materials, tools and equipment.
(iii). To determine the time required by a qualified worker to perform the work at a normal pace.
(iv). To plan the training programmes for the workers for the new methods.

11. What are the various of process planning activities? (Apr/May 2018)

Study the overall shape of the part, identify every manufacturing features and notes, select machines for each setup, sequence the operations, selection of machine tools, select or design fixtures for each setup, Select the appropriate inspection equipments, evaluate the plan, Select machining conditions and prepare the final process plan document.

12. List out the various techniques of work measurement. (NOV/DEC-16) (Apr/May 2017)

The various techniques used for work measurement are.

a. Stop-watch time study;
b. Work sampling;
c. Predetermined time standards (PTS);
d. Standard data

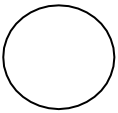
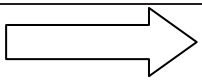
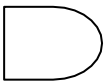
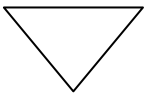
13. List the various method study chart and diagrams. (NOV/DEC-16)

Charts

1. Outline process chart
2. Flow process chart
   a) Man type
   b) Material type
   c) Equipment type
3. Two handed process chart
4. Multiple activity chart
5. Simo chart

Diagrams

1. Flow diagrams
2. String diagram
3. Cycle graph
4. Chronocycle graph
5. Travel chart

S.No	Symbols	Activity
1		Operation
2		Inspection
3		Transport
4		Delay(Temperature storage)
5		Storage(Permanent storage)

14. Differentiate between operation and inspection.

An Operation always takes the material, component or service a stage further towards completion. An inspection does not take the material any nearer to becoming a completed product. It merely verifies that an operation has been carried out correctly as to quality and or quantity.

15. Differentiate b/w permanent storage and delay.

The difference is that a requisition, chit, or other form of formal authorization is generally required to get an article out od permanent storage but not out of temporary storage.

16. What is a process chart? Mention its types. (Nov/Dec 2018)

A process chart is a graphic representation of the sequence of events and related information that occur in the work method or procedure.
The various type of process charts are:
1. Outline Process
2. Flow process chart and
3. Two- handed process chart.

17. Different B/W outline process chart and flow process chart.

a. An outline process chart is process charts given an overall picture by recording in sequence only the main operations and inspections.

b. A flow process chart is a graphical representation of all operations, transportation inspection delays and storage occurring during a process or procedure.

18. Distinguish B/W flow diagram and string diagram.

a. The string diagram must be drawn correctly to scale. The flow diagram can be drawn approximately to scale

b. The flow diagram would look cumbersome when there are too many to and fro movement between different points. But such movements will not affect a string diagram.

19. Different B/W cycle graph and Chronocycle graph.

a. A cycle graph is a record of path of movement, usually traced by a continuous source of light on a photograph.

b. A Chronocycle graph is a special from of cyclograph in which light source is suitably interrupted so that the path appears as a serious of pear- shaped dots.

20. What do you mean by micro motion study?

The micro motion study is used to make a detailed motion study employing either videotapes or motion pictures operating at a constant and known speed.

21. When do use micro motion study?

Micro motion study is best suited for those operation/ activities which are of short duration and which are repeated hundreds of times. These are it is quite difficult to measure time for these motion accurately and the time required by these motions cannot be neglected due to repetitive operations.

22. Differentiate B/W micro motion and memo motion study.

a. Memo motion study developed by Marvin Mundel, is a special type of micro motion study in which the activities are filmed at a much slower speed, say that of 60-100 frames per minutes

b. Memo motion is also a motion study techniques that gives more study and less than micro motion study.

23. What is meant by work measurement? (Nov/Dec 2017)

Work measurement is the application of techniques designed to establish the time for a qualified worker to carry out a specified job at a defined level of performance.

24. What is meant by work sampling?

Work sampling is defined as a method of finding the percentage occurrence of a certain activity by statistical sampling random observations.

25. What do you mean by synthetic data?

Synthetic data is the data derived from the analysis of the accumulated work measurement data in the form of tables and formulas where the data is arranged in a form suitable for building up the standard times and similarly machine processing times by synthesis.

26. What is PMTS?

a. PMTS stands for Predetermined Motion Time System

b. A predetermine motion time system consists of a set of time data which has been developed from many observation of a worker's performance.

27. Give the acronym for the following: MTA,WFS and MTM

1. MTA – Methods Time Analysis
2. WFS – Work Force System
3. MTM – Method Time Measurement

PART - B

1. Discuss the principles of energy motion economy. (M/J'12)

(i) Use of human body
(ii) Arrangement of place work
(iii) Design of tools and equipments

Use of human body:

1. The two hands should begin as well as complete their motions at the same time.
2. The two hands should not be idle at the same time except during rest periods.
3. Motions of the arms should be made in opposite and symmetrical directions, and should be made simultaneously
4. Hand and body motions should be confined to the lowest classification with which it is possible to perform the work satisfactorily

Arrangement of place work:

1. There should be a definite and fixed place for all tools and materials.
2. Tools, materials, and controls should be located close to the point of use
3. Gravity feed bins and containers should be used to deliver material close to the point of use.Drop deliveries should be used whenever possible
4. Materials and tools should be located to permit the best sequence of motions.
5. Provision should be made for adequate conditions for seeing. Good illumination is the first requirement for satisfactory visual perception.

Design of tools and equipments

1. The hands should be relieved of all work that can be done more advantageously by a jig, a fixture, or a foot-operated device.
2. Two or more tools should be combined wherever possible. Tools and materials should be prepositioned whenever possible.

3. Where each finger performs some specific movement, such as in typewriting, the load should be distributed in accordance with the inherent capacities of the fingers.
4. Levers, hand wheels and other controls should be located in such positions that the operator can manipulate them with the least change in body position and with the greatest speed and ease.

2. Explain the different charts and diagrams which are used in method of study (M/J'12)

A. charts and Diagrams	**Purpose**
I.CHARTS	
A.charts indicating process sequence	
1.Outline process chart	Gives bird's eye view of process and records principal operations and inspections.
2.Flow process chart (a) Man type (b) Material type (c) Equipment type	Records (a) Sequence of activities per-formed by worker. (b) Records sequence of activities performed on materials. (c) Records sequence of activities performed by equipment.
3.Two-handed process chart	Records activities performed by worker's two hands.
B.Charts using a Time Scale	
1. Multiple Activity chart	Records activities of men and/or machines on a common time scale.
2. Simo chart	Records activities of worker's hands, legs, and other body movements on common time scale.

II. DIAGRAMS(Diagrams indicating Movement)

1. Flow Diagram 2. String Diagram	These diagrams record path of movement of men and materials.
3. Cycle graph 4. Chronocycle graph	They are used for recording high speed, short cycle operations.
5.Travel chart	Records movement of materials and/or men between department.

Outline process (or operation process) chart

The out line process chart also known an operation process chart, gives a' bird s-eye '**view the** over all view of the whole process

It is a graphic representation of the points at which materials are introduced into a process and of the sequence of all operations and inspections associated with the process

Definition : an outline process chart is a process chart given an overall picture by recording in sequence only the main operations and inspections

The chart does not show where work takes place or who performs it. It is only concerned with operations and inspections. Hence only the symbol of operation and inspection are used in preparing this chart

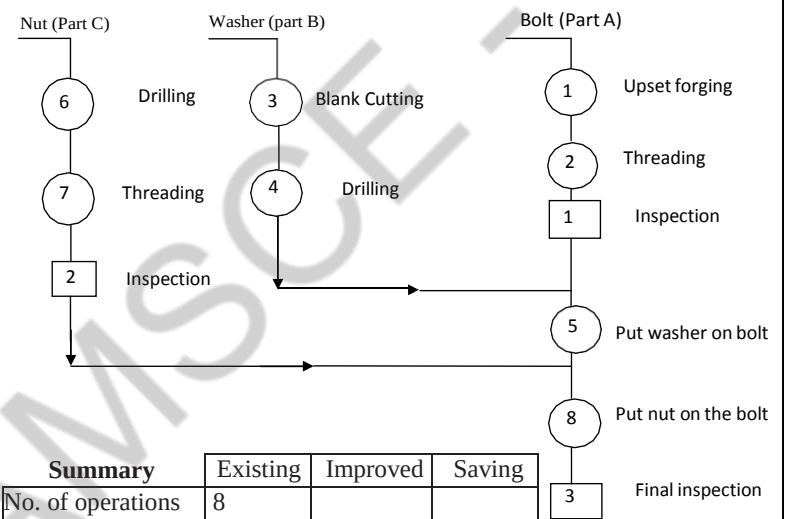
The outline process chart is useful:

(i) To improve the plant layout
(ii) For specifying the basic manufacturing system
(iii) For determining the sequence of assembly
(iv) To introduce manufacturing system to new technical personnel

Construction

The construction of the outline process chart can be explained with the help of an illustration of bolt and washer assembly

Operation Process Chart		Name of the firm:	
Name & description of assembly: Bolt and washer assembly		Sketch:	
Charted by:	Date	Existing	Improved



Summary	Existing	Improved	Saving
No. of operations	8		
No. of inspections	3		

From fig2.5, it is clear that as each operation and inspection takes place , the symbol is entered and numbered in sequence with a brief description on the right hand side

Flow chart process

A flow chart process chart is a graphical representation of all operations, transportation, inspections delays, and storage occurring during a rocess or procedure. This also gives the information regarding distances moved and time required for different items So in addition to symbols used in outline process charts, transport ,delay and storage symbols are also used in these chart. Obviously, flow process charts contain more information that outline process charts

Definition: A flow process chart is a process chart setting out of the sequence of the flow of a product or a procedure by recording all events under review using the appropriate process chart symbols

Three types of flow charts are

Flow process chart- man type : it records what the worker does

Flow process chart- material type : it records how material is handled or treated .

Flow process chart- equipment type: it records how the equipment is used

When do we use it?

The flow process chart is useful:

(i) To fix up the sequence of operations
(ii) To reduce the cycle time by combining or eliminating operations
(iii) To reduce the cycle time by combining or eliminating operations.
(iv) To reduce the distance travelled by men/materials.
(v) To avoid waiting time and unnecessary delays.

Construction

The flow process chart is constructed in the same way as outline process chart but it uses all the five symbols for charting. At a time, a flow process chart can record flow of either man, material or equipment on a single chart. Illustrates the man-type flow process chart for gear cutting.

We can see that both the types of charts are very identical. The difference would be in terms of the active voice or passive voice (for a man-type chart, we talk about the material being handled).

Two-Handed Process Chart

- ✓ **Two-handed process chart** is also known as 'left and right hand process chart'. As the name suggests, activities of a worker's hand are recorded with respect to each other.
- ✓ It is motion study where the motions are analysed in performing an activity. The objective of this investigation is to eliminate or reduce the unwanted motion to minimum and to arrange the best of motions in a possible sequence.
- ✓ **Definition:** The two-handed process chart is a process chart in which the activities of a worker's hands (or limbs) are recorded in their relationship to one another.
- ✓ This is an effective tool:
  - ❼ To balance the motion of the both hands and reduce fatigue.
  - ❼ To eliminate and/or reduce non-productive motions.
  - ❼ To shorten the duration of productive motions.
  - ❼ To train new operators in the ideal method.

FLOW PROCESS CHART	MAN TYPE			
Chart No.1 Sheet No.1 OF1	SUMMARY			
Subject charted: Welding of two places	Activity	Present	Proposed	Saving
Chart begins: man in the workplace Chart ends: man places the welded plates in storage bin	Operation Transport Delay Inspection Storage	4 5 0 1 1		
Method: Present	Distance(m)	7		
Charted by: Approved By: Date:	Time (man-machine)	_		
	Total cost	_		

Description	Symbol					Distance (m)	Time(min)	Remarks
Operator goes to collect unwelded plates						3		
Collects unwelded plates								
Goes to almirah to collect welding rods, storage bin, etc.						1		
Collects welding material								
Goes to work place						2.5		
Keeps the plates and other material at work place								
Goes to switch on electric supply						0.25		
Comes back to work place						0.25		
Does the welding								
Inspects the welded plates								
Keeps the welded plates in storage bin								
Total	4	5	0	1	1	7		

FLOW PROCESS CHART	MAN TYPE			
Chart No.1 Sheet No.1 OF1	SUMMARY			
Subject charted: Gear Chart Begins: Manufacturing Chart Ends: Material in stores finished gear in storage bin	Activity	Present	Proposed	Saving
	Operation	4		
	Transport	5		
	Delay	2		
	Inspection	2		
	Storage	2		
Method: Present	Distance(m)	55		
Charted by: Approved By: Date:	Time (man-machine)	29		
	Total cost	–		

Description	Symbol	Distance (m)	Time(min)	Remarks
Bar from stores				
Sent to cutting machine		10		
Cut to size			2.5	
Sent to lathe		30		
Awaiting			1.5	
Facing, drilling and reaming			2	
Sent to gear hobbing machine		4		
Awaiting			1	
Cut the gear teeth			5	
Inspected			1	
Sent to heat treatment department		10		
Hardening			15	
Inspected			1	
Moved to stores		15		
Stored for reissue				
Total				

- ❼ The two-handed process chart is generally preferred for repetitive operations, when one complete cycle of the work is to be recorded.
- ❼ It can be applied to a great variety of assembly, machining and clerical jobs.

Construction

The two-handed process chart is made up to two columns in which the activities of the hand and the right hand are recorded respectively. They are interrelated by aligning the symbols on the chart so that simultaneous movements by both hands appear opposite to each other. Illustrates the two-handed process chart for assembling two washers and nut to bolt.

Charts using Time Scale

1. Multi Activity Chart

- ✓ Multiple activity charts are the process charts using a time scale. It usually comes in picture when work study man wants to record the activities of one subject with respect to other on a single chart. Subject may be the worker, machine or equipment.
- ✓ Definition: A multiple activity chart is a chart on which the activities of more than one subject (worker, machine or item of equipment) are each recorded on a common time scale to show their interrelationship.
- ✓ Multiple activity chart is useful:
  - ❼ To analyse idle time of the man and machines.
  - ❼ To determine number of machines that can be handled by an operator.
  - ❼ To determine number of operators required in team work to perform the given job.

TWO – HANDED PROCESS CHART					
Chart No.1 Sheet No.1 OF1	SUMMARY				
Subject charted: Assembly of two washers and nut to bolt Chart Begins: Hands free; material in boxes Chart Ends: Completed assembly aside to box	Activity	Present		Proposed	
	Operation Transport Delay Inspection Storage	L.H.	R.H.	L.H.	R.H.
Method: Present	Total				
Charted By:	Approved By:			Date	

LEFT-HAND DESCRIPTION	RIGHT-HAND DESCRIPTION
Moves to bolt	Moves to first washer
Grasps the bolt	Grasps the washer
Moves to position	Moves to position
Holds	Assembles washer to bolt
	Moves to second washer
	Grasps the washer
	Moves to position
	Assembles washer to bolt
	Moves to nut
	Grasps the nut
Moves to box	Moves to position
Aside to box	Assembles nut to bolt

- ✓ Types: some important types of multiactivity charts are:
  - **(i) Man –machine activity chart:** Used when one operator is working on one machine.
  - **(ii) Multiman activity chart:** Used when a group of workers are working on a machine.

(iii) Man-multimachine activity chart: Used when a single operator is working on a number of machines.

(iv) Multiman-machine acticity chart: Used when a group of operators work on a common central machine.

The multiple activity chart is extremely useful in (a) work involving repetitive operations, and (b) organizing teams of operatives on mass production work.

Construction

The multiple activity chart consists of a series of bars placed against a common time scale. One separate bar is allowed for each subject and activities related to the subject are represented in this bar. The task to be recorded is broken into smaller activities and time for each activity is measured with the help of step watch.

SIMO Chart (Simultaneous Motion Cycle Chart)

- SIMO stands for Simultaneous Motion cycle chart.
- SIMO chart is used to record simultaneously on a common time scale the activities of two hands or other parts of worker's body during the performance of a single cycle of operation being investigated.
- The SIMO chart may be constructed from data collected from motion film analysis.
- It is a recording technique for micro-motion study. The SIMO chart is the micro motion form of the man type flow process chart.

It is commonly used on fairly short cycle operation when the machine process time is relatively short and the worker is operation only on machines . since it is often performed with extreme rapidly, it is **generally complied from film analysis**

Definition: A SIMO chart is a chart often based on film analysis used to record simultaneously on a common time scale the therbligs or groups of therbligs performed by different parts of the body of one or more workers

What are therbligs?

Therbligs are the symbols used to denote the various activities and movements done for different purpose

Therbligs refer primarily to motions of the human body at the workplace and to the mental activities associated with them. They permit a much more precise and detailed description of the work than any other recording techniques

The word therbligs is an anagram of the name gilberth (reverse of his name) who was the founder of motion study

Symbol	Name	Abbreviation	Colour
	Search	Sh	Black
	Find	F	Grey
	Select	St	Light Grey
	Grasp	G	Red
	Hold	H	Gold ochre
	Transparent Load	TL	Green
	Position	P	Blue
	Assemble	A	Violet
	Use	U	Purple
	Disassemble	DA	Light violet
	Inspect	I	Burnt ochre
	Pre-position	PP	Pale blue
	Release load	RL	Carmine red
	Transport Empty	TE	Olive green
	Rest for over-coming fatigue	R	Orange
	Unavoidable delay	UD	Yellow
	Avoidable delay	AD	Lemon yellow
	Plan	Pn	Brown

Construction

The SIMO chart for bolt and washer assembly is illustrated . like LH-RH chart, the SIMO chart is constructed to show the activities of both hands on a common time scale . the movements are recorded against time measured in winks (1 wink = 1/2000 minute) these are recorded by a wink counter placed in such a position that it can be seen during filming

SIMO CHART

DRAWING No. AND NAME: 1 Bolt Washer Assembly
Film No.
Chart No.
OPERATION: Assemble 2 washers on bolt
Sheet No.
OP. No. A25
Charted By:
OPERATIVE
Date:

Wink Counter Reading	Left Hand Description	Therblig	Time	Time in 2000/min	Time	Therblig	Right Hand Description
				0			
120	Reaches for bolt	TE	12		12	TE	Reaches for bolt
	Selects & grasps bolt	STG	8	20		STG	Selects & grasps bolt
140	Carries bolt to fixture	TL	16	40	16	TL	Carries bolt to fixture
160	Position bolt into fixture	P	20	60	20	P	Position bolt into fixture
180	Reaches for steel washer	TE	12		12	TE	Reaches for steel washer
	Selects & grasps washer	STG	8		8	STG	Selects & grasps washer
200	Carries washer to bolt	TL	16	80	16	TL	Carries washer to bolt
	Positions washer into bolt	P	8	100	8	P	Positions washer into bolt
220	Reaches for lock washer	TE	12		12	TE	Reaches for lock washer
	Selects grasps block washer	STG	8	120	8	STG	Selects & grasps washer
240	Carries lock washer to bolt	TL	16	140	16	TL	Carries lock washer to bolt
	Position L washer to bolt	P	8		8	P	Position lock washer to
260	Withdraw assembly from fixture	DA	20	160	20	DA	bolt withdraw assembly from fixture
280	Carry assembly to bin	TL	16	180	16	TL	Carry assembly to bin
300	Release assembly	RL	8	200	8	RL	Release assembly

Diagrams

Flow process chart does not show the path of movements it only shows the sequence of various activities necessary for performing the specified work. The path of movement (movement between two locations and the number of times a movement is repeated) can be better visualized by flow diagrams, string diagram,

Flow diagram

What is it?

Flow diagram is a plan drawing , substantially to scale of the working aera showing the location of the various activities identified by their numbered symbols and are associated with the particular flow process chart

Thus the flow diagram is used to supplement the flow process charts in

this diagram , the routes followed in transport are shown by joining the symbols in sequence by aline which represents as nearly as possible the paths or movement of the subject concerned

Construction procedure

To make the flow diagram the following steps may be followed

(i) Draw to scale the plan of work area.
(ii) Mark the relative positions of machine tools benches stores racks etc
(iii) Trace the path followed by the subject under study by the drawing lines
(iv) Number each movement serially and indicate its direction by an arrow
(v) Use different colours to denote different types of movements

A typical flow diagram for the movement of raw material during the production shows how the raw material moves from work station a to work station F before transforming into a product

2. String diagram

The string diagram is a scale plan or model on which a thread is used to trace and measure the path of workers material or equipment during a specified sequence of events

String diagram vs flow diagram:

The important difference between these two diagrams are given below
The string diagram must be drawn correctly to scale the flow diagram can be drawn approximately to scale
The flow diagram would look cumbersome when there are too many to and fro movements will not affect a string diagram
String diagram is used in such situations where the movements are congested and difficult to trace on flow diagram

Construction procedure

To make a string diagram, the following steps may be followed

(i) Study and record the complete information about the movement of various resources

(ii) Draw a scale layout of the working area and mark various features such as machinery, work benches stores

(iii) Mark and insert panel pins at all workstations between which the journeys are made. More pegs/pins may be stretched in between the facilities to trace more or less the actual path followed by men and materials

(iv) A continuous coloured unstrectchable string taken from the or materials . use string /threads of different colours if the movement of more subjects is being shown so that their movements are easily recognized and distinguished

(v) Remove the string to measure their lenghs wich approximately gives distance travelled by aworker or a machine or the material

Travel chart

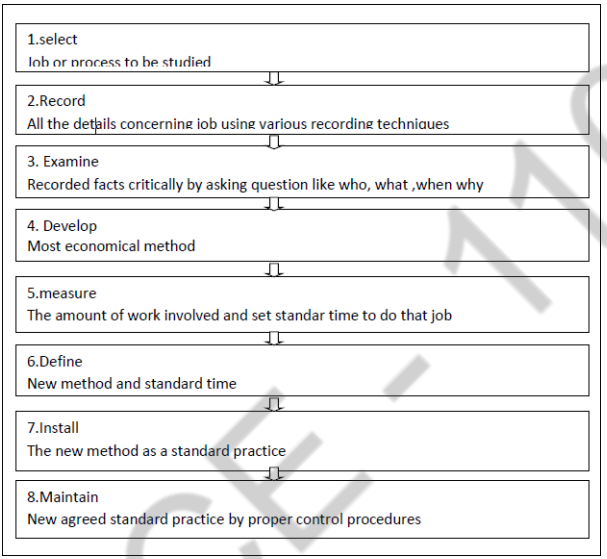
Definition : a travel chart is a tabular record for presenting quantitative data about the movement of workers , materials or equipment between any number of places over any given period of time Though the string diagram is very effective way of recording the movements of the workers or equipment, the preparation of string diagram takes a long time . also when many complex movements along complex paths are involved the string diagram becomes complicated . therefore, when the movement patterns are complex the travel chart is a quicker and more manageable recording techniques A travel chart is a chart or record of the amount of travel by the worker or material –in-process while going from machine to machine or from one department to another . the amount of travel depends upon the frequency of movements between sections or department Travel chart is sometimes reffered as a from to chart a trip frequency chart or a cross chart which is actually an adaptation of the form of a mileage chart commonly found on a road map

Construction travel chart consist of a square , which itself consists of a number of squares now each small square represents a work station . a diagonal line is drawn from top left to bottom right suppose a workplace consists of 10 workstations and the movement of the worker is to be noted down a big square is drawn and it is divided into10×10=100 small square each square represents a workstation now the movement of the worker from station 1 to station 5 is shown in the chart. similarly movement of worker from1 to station 5 is also shown six tick marks are done so as to

indicate that six times the worker has moved from station 2 to station 9 . all the movements and journeys are recorded in the same waythus the workstations between which there is high frequency of movements can be situated nearer to each other to reduce the distance covered during the movements

3. Explain the steps involved in work study. (A/M'14) (Nov/Dec 2018)

Ans. The process of work study essentially consists of eight steps



In 1,2 and 3 occur in every study , whether the technique being use is method Study , whether the technique being used is method study practice, while step 5 calls for the use of work measurement.

Basic procedure for method study as given in table

1. **SELECT** the work to be studied.
2. **RECORD** all the relevant factors about the present method by direct observation.
3. **EXAMINE** these facts critically in the order of sequence using the questioning techniques.
4. **DEVELOP** the most practical, economic and effective method considering all circumstances.
5. **DEFINE** the new method (improved method) so that it can always be identified.
6. **INSTALL** the method as standard practice.
7. **MAINTAIN** that standard practice by regular routine checks.

A brief description of the above seven stages are diagrammatically summarized

4. Briefly discuss the steps in work sampling study. (A/M'14) (Nov/Dec 2018)

Work sampling is a statistically based technique utilized for analysing work performance and machine utilization by direct observation, but without a stop watch. So work sampling is another useful technique of work measurement.

Definition : Work sampling is defined as a method of finding the percentage occurrence of a certain activity by statistical sampling and random observations.

Principle of work sampling

Work sampling is a work measurement techniques in which a large number of instantaneous observations are made at random intervals over a specifie period of time of a group of workers, machines and process. Each observation records the stages of the system observed, the percentage of observations recorded for a particular activity or delay over the specified period is measure (estimate) of the percentage of time during closely to the situation if the specified time interval is taken to be very long.

The fundamental principle underlying work sampling is that the number of observations of the occurrences of an activity or event is proportional to the time that the activity or event actually occurs. Thus the work sampling method consists of taking a number of intermittent, randomly space, instantaneous activity being studied, and determining the percentage of time devoted to each activity of the operation.

Work sampling procedure

The work sampling procedure can be ivided into the three phases, as below:

1. Preparing for work sampling
   - i. Decided and state the main objective of the study
   - ii. Obtain the approval of the supervisor of the department in which work sampling is to be performed.
2. Performing work sampling
   - i. Describe and classify the elements to be studied in detail
   - ii. Design the observation form

3. Evaluate and present results of work sampling
   i. Evaluate the validity and reliability of data.
   ii. Present and analyse data.
   iii. Plan for future studies.

5. Explain the method study procedure (N/D'14, A/M'15) (Apr/May 2019)

- Method study is the systematic recording and critical examination of ways of doing things in order to make improvements we can generalize it as: Method study is the systematic recording and critical examination of production, service and business processes in order to make improvements.
- Method study is also known as methods engineering. The following definition, appears in the 3rd edition of the Industrial Engineering Handbook
- The technique that subjects each operation of a given piece of work to close analysis to eliminate every unnecessary element or operation and to approach the quickest and best method of performing each necessary element or operation. It includes the improvement and standardization of methods, equipment, and working conditions: operator training; the determination of standard time; and occasionally devising and administering various incentive plans.
- This definition, however, tends to define methods engineering rather narrowly. It states that methods engineering is limited to operations or pieces of work, but recently the trend has been to address broader areas, such as production processes, the factory in total, or large scale work systems that involve a lot of people and extensive equipment.The basic approach suggested for the method study consists of eight steps.

SELECT : Job or process to be studied
RECORD : All the details concerning job using various recording techniques
EXAMINE : Recorded facts critically by asking question like who, what, when why
DEVELOP : Most economical method

EVALUATE : The amount of work involved and set standar time to do that job
DEFINE : New method and standard time
INSTALL : The new method as a standard practice
MAINTAIN : New agreed standard practice by proper control procedures

1. SELECT
The process to be studied to selected and its boundaries are to be defined

2. RECORD
The process is to be recorded in specified charts and diagrams.
Process charts
Flow charts
Flow diagram
String diagram

A variety of techniques for analysis and charting have for a long time been established as IE techniques. Among the methods of analysis, process analysis, operation analysis, motion study, time study, work sampling, and flow analysis are widely used. Similarly, among the charting techniques, process charts, pitch diagrams, multiple activity charts, process charts, and machine sequential charts are used. From among these various techniques, the appropriate one will be chosen ,based on the object being analyzed

3. EXAMINE

A process or method has activities.The activities are categorized into action activities and idle (inventory) activities.Action categories are subdivided into i) MAKE READY activities, (ii) Do operations iii) PUT AWAY activities
Each activity is subjected to a series of questions:

A Purpose

- What is done?
- Why is it done?
- What else might be done?
- What should be done?

B. Place

- Where is it done?
- Why is it done there?
- Where else might it be done?
- Where should it be done?

C. Sequence

- When is it done?
- Why is done then?
- When it might be done?
- When should it be done?

D. Person

- Who does it?
- Why does that person do it?
- Who else might do it?
- Who should do it?

E. Means

- How is it done?
- Why is it done that way?
- How else might it be done?
- How should it be done?

These questions in the above sequence must be asked every time a method study is undertaken. They are the basis of successful method study.

4. DEVELOP

The shortcomings of the present process are brought out by the systematic questioning process that is combined with a knowledge relevant to the process being examined. Industrial may have the knowledge required or may not have the adequate knowledge. They need to have a knowledge library to support their effort as well as access to the experts during the study period. Alternatives to the current activities which have the shortcomings are to be generated during this stage.

5. EVALUATE

Alternatives are to be evaluated at this stage to find their contribution to the efficiency of the process as well as effectiveness.

6. DEFINE

The new method or process suggested has to be put down standard process sheets that are issued to the shop or department.

7. INSTALL

Industrial engineers of methods study persons have to train the operators and their supervisors in the new method and participate in installing the method.

8. MAINTAIN

Industrial engineers have to conduct a periodic review of methods to observe modifications brought into the installed methods by operators and supervisors and if they are beneficial, they have to be made part of standard operating procedure (SOP). If they are not beneficial, supervisors are to be informed of the same to bring the method back to SOP.

6. Explain the different techniques of work measurement (N/D'14) (Apr/May 2019) (Nov/Dec 2018) (Apr/May 2018)

Work Measurement Techniques

1. Time Study Involves timing a sample of a worker's performance and using it to set a standard.
2. Predetermined Time Standards Divide manual work or task into small basic elements that have established times, and then add the time factors for each element to estimate time for a particular task.
3. Work Sampling Determines the proportion of time a worker spends on activities.

Steps to perform Time Study

1. Define the task or objective to be studied
2. Decide how many times to measure the task. Time study is a sampling process. It is important to decide the number of cycles or samples needed and the required level of confidence in the estimated time standards to set standard time

3. Divide the task into precise elements
4. Time and record each element time a worker would take to complete the task element. Rate the performance of worker. Let the experienced analyst record the time.
5. Complete the average cycle time for each task element as given below: [Sum of the times recorded to perform each element] Average Cycle Time Number of cycles observed =
6. Determine the performance rating and normal time for each task element as given below: Normal time= [Average observed time] x [Performance rating factor]

Work Sampling

- Estimates the percentage of time that worker spends on various activities.
- Developed by L. Tippet in 1930s.
- Used to analyze the jobs that have non-repetitive elements.
- Also used to determine ratio delay which is the percentage of time a worker is delayed or idle.
- Work sampling involves random observations to record the activity that the worker is performing.
- Work sampling helps in determining how employees allocate their time. So, the study can be utilized to set staffing levels, reassign duties, estimate various costs and set delay allowances.
- Easier approach and less expensive than time study.

Steps of work sampling procedure

1. Take a Preliminary sample to obtain estimates of the parameter values.
2. Compute the sample size required.
3. Prepare a schedule for random observations at appropriate times.
4. Observe and record employee activities
5. Record the performance indicator like number of units produced or any other services rendered during the study.

6. Compute the normal time and standard time per service.

7. Explain the following i) Memo motion study ii) Work sampling iii) Micromotion study (A/M'15) (Nov/Dec 2018) (Apr/May 2017)

(i) Memo motion: MEMOMOTION STUDY:

Memo motion study developed by marvin mundel, is a special type of micro motion study in which the activities are filmed at a much slower speed say that of 60 or 100 frames per minute

Memo motion is also a motion study technique that gives more detail than visual motion study and less than micro motion study

Procedure

(i) Study the operations to be filmed
(ii) Obtain the film
(iii) Analyze the film
(iv) Construct the suitable chart depending upon the type or nature of activities. for example , for plotting group activities , multiple activity chart is drawn
(v) Improve the method by using the principles of motion economy

(ii) Work sampling: Work sampling is a statistically based technique utilized for analyzing work performance and machine utilisation by direct observation, but without a stop watch. So work sampling another useful techniques of work measurement .

Definition :Work Sampling is defined as a method of finding the percentage occurrence of a certain activity by statistical sampling and random observations.

(iii) Micromotion Study:

The micromotion study is used to a make a detailed motion study employing either videotapes or motion pictures operating at a constant and known speed. Here each space occupied by a single picture known as frame , is projected independently, and then collectively with successive frames. In short when picture camera is utilized for study then the procedure is known as micromotion study

The micromotion study is based on the idea of dividing human activity into divisions of movements or groups of movements (known as therbligs) according to the purpose for which they are made.

Procedure

- Filming the operation to be studied
- Analyzing the films, and
- Recording/presenting the data

8. Explain the steps involved in work study (N/D'16)

In order to survive in today's competitive market, an industry must be aware of the latest developments brought by continuous application of new technology and methods used in production. Also it must continuously strive for improvements in the efficiency of its production and must consistently aim at producing better quality goods at lower prices than its competitors. The performance of an industry can be improved by adopting the following two approaches:

1. By improving the process of manufacture by adopting new technology, by developing better machine and equipments
2. By improving the operation of existing facilities, both plant and human Resources .

The first approach , called new technology developing is a long term approach which deals with extensive important and involves huge capital investment in R& D. The second approach, called work study, aims at achieving higher efficiency and effectiveness of existing facilities through systematic analysis (usuallyin a relatively short time and with very little or no extra capital expenditure).

In this chapter, we discuss the concept, objectives, procedure, tools, techniques and application of work study.

Work study is the study of human work in all aspects in order to increase the effectiveness with which the work is done.

Efficiency means doing things right and effectiveness refers doing the right things. Work study may be defined as a discipline which analysis and evaluates all aspects of a work system in order to enhance effectiveness and

functional efficiency. Defination : The definition of work study as given in the british standard(B.s) Glossary is as follows:

Work study is a generic term for those techniques ,particularly method study and work measurement, which are used in the examination of human work in all its contexts, and which lea systematically to the investigation of all factors which affect the efficiency and economy of the situation being recived , in order to effect improvement".

In simple terms, work study is a term used to embrace the techniques of method study and work measurement which are employed to ensure the best possible use of human and other resources (material,money,machinery) in carrying out a particular activity.

Work study aims at achieving higher productivity by fining the most efficient use of the available resources to create a prescribed output.

Techniques / Elements of Work Study

Work study embraces two different techniques viz., method study and work measurements.

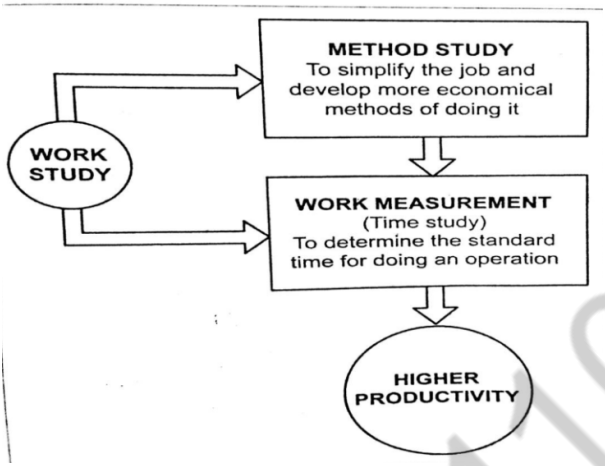
Work Study = Method Study + Work Measurement

Definitions: The definition of method study and work measurement from the B.S. glossary are follows:

∑ "Method Study is the systematic recoding and critical examination of existing and proposed ways of doing work, as a means of developing and applying easier and more effective methods and reducing costs." "Work measurement is the application of techniques designed to establish the time for a qualified worker to carry out a specified job at a defined level of performance."

In short, once the method study develops an improved method, work measurement is used to find the time allowed to complete the job by that procedure.

The relationship between work study techniques leading to higher productivity.



9. A time study was conducted on a job consisiting of four elements. Stop watch readings in hundredth of a minute are given below using a cumulative time method along with rating factors.

Element	Stop watch readings					Rating
	1	2	3	4	5	
A	15	78	143	208	271	85
B	32	95	162	225	287	110
C	40	101	173	230	296	95
D	70	134	199	266	328	90

Calculate the standard time if allowanceis 12%

Solution: The given stop watch readings are cumulative. The individual timings for elements for elements are computed by subtracting proceeding reading from successive figure as shown in table below:

Element	Individual elemental timings (min/100)					Average time (min)	Rating (%)	Normal time (min)
	1	2	3	4	5			
A	15	8	9	9	5	0.092	85	0.0782
B	17	17	19	17	16	0.172	110	0.1892
C	8	6	11	5	9	0.078	95	0.0741
D	30	33	26	36	32	0.314	90	0.2826
							Total = 0.6241	

32-15=17; 78-70 =8; *(46/5)× $\frac{1}{100}$ =0.092

Normal time = 0.6241 min

Allowance = $\frac{12}{100}$ × 0.6241 = 0.0749 min

Standard time = 0.6241 + 0.0749

=0.699 min Ans

Objectives of work study

The work study is mainly carried out of fulfill the following objectives:

(i) To find the most economical way of doing the work.

(ii) To simplify and standardize the methods, materials, tools and equipment.

(iii) To determine the time required by a qualified worker to perform the work at a normal pace.

(iv) To plan the training programmers for the workers for the new methods.

Purpose of work study

Work study leads to the following benefits/advantages in industries:

(i) It is direct means of raising productivity.

(ii) It helps to increase the productive efficiency of an operative unit without much capital expenditure.

(iii) It helps to eliminate/reduce waste (waste of capital, material, labour, supervisory effort) and to make better use of resources.

(iv) It helps for establishing standards of performance on which effective production planning and control depends.

(v) It provides a scientific basis for work improvement through work simplification.

(vi) It provides a better workspace layout and work environment.

(vii) It provides a better quality of product to the consumer at a reasonable cost.

(viii) It provides a concept of fair days work to the workers, thus they can protect them selves from the overload.

(ix) It provides a basis for negotiation between trade union leaders and the management

10. Briefly discuss the steps in work sampling study (N/D'16)(Nov/Dec2018)

Work sampling is a statistically based technique utilized for analyzing work performance and machine utilization by direct observation, but without a stop watch. So work sampling is another useful technique of work measurement

Definition: work sampling is defined as a method of finding the percentage occurrence of a certain activity by statistical sampling and random observations

Principle of work sampling

Work sampling is a work measurement technique in which a large number of instantaneous observation are made at random intervals over a specified period of time of a group of workers machines and process . each observation records the state of the system observed ,the percentage of observations recorded for a particular activity or delay over the specified period is measure (estimate) of the percentage of time during which that activity or delay occurs. This estimate resembles closely to the actual situation if the specified time interval is taken to be very long

The fundamental principle underlying work sampling is that the number of observation of the occurrences of an activity or event actually occurs. Thus the work sampling method consist of taking a number of intermittent , randomly spaced , instantaneous activity being studied , and determining the percent of time devoted to each activity of the operation

Work sampling procedure

Three phases

Phase 1: preparing for work sampling

(i) Decide and state the main objective of the study

(ii) Obtain the approval of the supervisor of the department in which work sampling is to be performed

(iii) Establish quantitative measure of activity

(iv) Train the personal
(v) Make a detail for taking observation

Phase 2: performing work sampling

(i) Describe and classify the elements to be studied in detail
(ii) Design the observation form
(iii) Determine the number of days or shifts required for the study
(iv) Develop properly randomized times of observations
(v) Observe activity and record data
(vi) Summarise the data at the end of each day

Phase 3: evaluate and present results of work sampling

(i) Evaluate the validity and reliability of data
(ii) Present and analyse data
(iii) Plan for future studies

Uses of work sampling

(i) To help in determination of time standards and delay allowance
(ii) To help in the measurement of overall performances
(iii) To study the time utilization by supervisors and establishing goals for supervision
(iv) To aid in job evaluation
(v) To assist in engineering economy studies
(vi) To aid in manpower planning
(vii) For appraisal of safety performance
(viii) For appraisal of organization efficiency

Advantages of work sampling

1. Work sampling studies of several operators and machines may be conducted simultaneously
2. Many operations or activities which are impractical or costly to measure by time study can be measured by work sampling
3. Only one analyst can perform work sampling study of many

activities

4. Observations may be made over a period of days or weeks thus decreasing the change of day to day or week to week variations
5. It usually requires lesser man-hours and costs less to make a work sampling study instead of making a continuous time study
6. Any interruption during study will not affect the results

Limitations of work sampling

1. It is not economical for the study of jobs of short duration
2. It does not provide as complete a breakdown of elements as time study
3. The statistical approach of work sampling study is difficult to be understood by worker when compared to time study
4. Workman may change their normal pattern of working on seeing the observer , making the sampling study of very little value
5. It does not provide a record of the technique used and in case there is achange in any element a new study has to be conducted

6 . It does not assit in improving work method

7. Observation neither random onr sufficient in number may provide wrong results 10.

11. Briefly explain PMTS. (Nov/Dec 2018)

2.15. PREDETERMINED MOTION TIME STANDARDS (PMTS)

2.15.1. What is it?

- ✓ *A predetermined motion time system consists of a set of time data which has been developed from many observations of a worker's performance.*
- ✓ *It has a systematic procedure which analyses and subdivides any operation of human task into motions, body motions, or elements of human performance and assigns to each the appropriate time value.*
- ✓ Predetermined times are the tabulated values of normal times required to perform individual movements such as moving an arm from one position to another, *etc.* The total times needed to perform the operation is the sum of the times needed for basic motions.

✓ By arranging the basic motions and aggregating associated times, an existing task can be analysed or a proposed operation can be timed without actually performing it.

2.15.2. Types of PMTS

Amongst various available PMTS, the following three systems are common in use.

1. Methods time analysis (MTA),
2. Work force system (WFS), and
3. Method time measurement (MTM).

1. Methods time analysis (MTA): ✓ It is the relationship between the time element and the motion.

✓ A.B. Segur was one of the first to establish this relationship. He developed a table of improvement principles involving many of his motions such as hold, graph, preposition, position, avoidable delay and balanced delay.

✓ It is a very important tool for work simplifications.

2. Work force system (WFS): ✓ It is a system which determines the work force time for manual tasks by the predetermined data.

✓ A detailed analysis of each of the tasks is made based upon the identification of major variables of work and use of work factor as a unit of measure.

✓ There are four variables of work factor: body member, distance, weight or resistance, and manual control.

✓ This system is applicable to highly repetitive system.

3. Method time measurement (MTM): ✓ The objective of MTM is the establishment of tangible, understandable and acceptable data for the scientific measurement of human effort.

✓ MTM is defined as a procedure which analyses any manual operation or method into the basic motions required to perform it and assigns to each motion a predetermined time standard which is

determined by the nature of the motion and the conditions under which it is made.

2.15.3. Purposes of PMTS

1. PMTS is very useful in methods analysis.
2. It helps in modifying and improving work methods before starting the work on the job.
3. It sets time standards for different jobs.
4. It assists in constructing time formulae.
5. It aids the pre-balancing of the manufacturing lines.
6. It provides a basis for wages plans and labour cost estimation.
7. It facilitates training of the workers and supervisors.
8. It is used for timing those short and repetitive motions which cannot be measured by stopwatch.

2.15.4. Advantages of PMTS

1. It eliminates inaccuracies with stop watch time study.
2. It is superior to stop watch time study when applied to short cycle highly repetitive operations.
3. PMTS data is more reliable and accurate as compared to stop watch time study data.
4. The time and cost associated with finding the standard time for a job is considerably reduced.

2.15.5. Limitations of PMTS

1. PMTS can deal only with manual motions of an operation.
2. All categories of motions have been considered while collecting PMTS data.

13. Explain briefly the following techniques of work measurements.

i) Time study
ii) Production study
iii)Work sampling (Apr/May 2017)

Refer Question Bank Page **63**, Question No. **10**
Refer Question Bank Page **56**, Question No. **6**.

14. Explain the basic procedure of method study (Nov/Dec 2017)
Refer Question Bank Page **53**, Question No. **5**

15. What are the basic requirements of work sampling? (Nov/Dec 2017)
Refer Question Bank Page **63**, Question No. **10**.

16. Write the objectives of method study. (Apr/may-2018)
Refer Question Bank Page **53**, Question No. **5**

17. Explain multiple activity chart with a good example. (Apr/may-2018)
Refer Question Bank Page **38**, Question No. 2

18. State and explain in brief about the various steps involved in conducting the work study procedure. (Nov/Dec-2018)
Refer Question Bank Page **38**, Question No. **3**.
Refer Question Bank Page 5**9**, Question No. **8**.

19. State and explain in brief the steps involved in conducting the method study procedure.
Refer Question Bank Page **53**, Question No. **5**

20. List the principles of motion economy as applied to:
(a) The use of human body
(b) Arrangement of workplace
(c) Design of tools and equipment.

Refer Question Bank Page 37, Question No. **1**.

UNIT - 3

PRODUCTION PLANNING AND PROCESS PLANNING

PART - A

1. What are the considerations in selection of an equipment or process? (APRIL/MAY-14)

The following considerations are to be made while selecting a ma- chine:

1. Economic consideration.
2. Production rate and unit cost production.
3. Durability and dependability.
4. Lower process rejection.
5. Functional versatility.
6. Minimum set-up and put away times.

2. Mention the difference between value engineering and value anal- ysis. (APRIL/MAY-14)

Value engineering is the application of a set of techniques to new product at the design stage itself. Thus value engineering is a preven- tive process.

Value analysis is the application of a set of techniques to an exist- ing product with a view to improve its value. Thus value analysis is a remedial process

3. What is value Analysis? (APRIL/MAY-15) (NOV/DEC-16) (Nov/Dec 2017) (Apr/May 2018)

Systematic analysis that identifies and selects the best value alternatives for designs, materials, processes, and systems. It proceeds by repeatedly asking "can the cost of this item or step be reduced or elim- inated, without diminishing the effectiveness, required quality, or cus- tomer satisfaction?" Also called value engineering, its objectives are

(1) to distinguish between the incurred costs (actual use of resources)

and the costs inherent (locked in) in a particular design (and which determine the incurring costs), and (2) to minimize the locked-in costs

4. Define Product Planning. (APRIL/MAY-15) (NOV/DEC-16)

(or)

State the need for product planning. (Apr/May 2017)

The process of coming up with a business idea for a manufactured good, preparing the good for production and then introducing it to the market. Product planning involves managing the product's manufacture and development by selecting marketing and distribution approaches, making modifications, setting and changing prices, and offering promotions.

5. **What is meant by line balancing? (Nov/Dec 2017) (Apr/May 2019)**

A production **line** is said to be in **balance** when every workers task takes the same amount of time. **Line balancing** is a manufacturing-engineering function in which whole collection of production-**line** tasks are divided into equal portions. Well-balanced lines avoid labour idealness and improve productivity.

6. State the types of value. (Apr/May 2018)

(i). Cost value
(ii). Exchange value
(iii). Use value
(iv). Esteem value

7. List the factors affecting production planning. (Nov/Dec 2018)

i. Non-availability of materials
ii. Plant, equipment and machine breakdown
iii. Changes in demand and rush orders.
iv. Absenteeism of workers.
v. Lack of coordination and communication between various functional areas of business.

8. State the main functions of process planning. (Nov/Dec 2018)

a. Specific requirements are established for which machines, tools and other equipment can be designed or selected.

b. The efforts of all engaged in manufacturing the product is coordinated.

c. A guide is furnished to show the best way to use the existing or the providing facilities.

9. **What is meant by machine loading? (Apr/May 2019)**

It is the process of assigning specific jobs to machines, men (or) work centres based on relative priorities and capacity utilization.

10. State the aims of value analysis (APRIL/MAY-12)

Cost Analysis

product and function

Evaluation of alternatives

Secondary Function evaluation

Recommendation

11. Name any four essential information needed to do process planning effectively (APRIL/MAY-12)

i. assembly and component drawing and bill of materials (part list)

ii. machine and equipment details

iii. standard time for each operation and details of set up time for each job

iv. availability of machines, equipment and tools.

12. State the prerequisite information needed for process planning (NOV/DEC-14)

1. Part drawing and assembly drawing; BOM (Bill of materials)
2. Machine and equipment details (specifications, capacity etc.,)
3. Operation time and setup time for each job
4. Availability of machine, equipment and tools

---

13. What is machine capacity? (NOV/DEC-14)

Time available for work in a machine is expressed as machine hours (ex) 100 machine hours per week (5 days of 20 hours (3 shifts each))

14. List the information that can be obtained from the system maintanence concept.

i. Identification of level of maintenance support.

ii. Definition of repair policies.

iii. Definition of effectiveness measure

iv. Establishment of supportability requirements in system / equipment design.

v. Establishment of requirements for logistics supports.

15. List activities of advanced products planning.

i. Product selection and justification.

ii. Product specification and plans

iii. Product acquisition plan

iv. Product use and logistic support plan

v. System proposal

vi. Product evaluation plan

16. What is value analysis? (Apr/May 2017)

Value analysis is a disciplined approach that ensure the necessary function at minimum cost without comprising on quality, reliability, performance and appearance.

17. What is value? List its type.

Value, in general, taking the use value as an objective, is the ratio between the function and the cost

$$\text{Value} = \frac{\text{Function}}{\text{Cost}}$$

Types of economical value: 1. Use value, 2. Esteem value, 3.Cost value, 4.Exchange value.

18. How can you increase the value of a product?

- The value of a product can be increased:

- i) By reducing the cost
- ii) By improving function

19.List any six reasons for products unnecessary costs.

i. Failure to utilize specialized knowledge,

ii. Poor design of component

iii. Lake of ideas and relevant information.

iv. Lake of standardization and exaggerated specification

v. Unavoidable delivery contrails

vi. Belief in the old traditional method

20. List out the various phases of values analysis.

i. Orientation phase

ii. Information phase

iii. Functional analysis

iv. Creative phase

v. Evaluation phase

vi. Development phase

vii. Recommendation phase

viii. Implementation phase

ix. Follow up phase

21. What is meant by process planning?

Process planning can be defined as an act of preparing a detailed process documentation for the manufacturing of a piece part or assembly.

22. List the various information required for process planning.

1. Assembly and component drawing and bill of materials (Part list)
2. Machine and equipment details:
   i) The various possible operation that can be performed.
   ii) The maximum and minimum dimension that can be machined on the machine
   iii) The accuracy of the dimensions that can be obtained.
   iv) Available feeds and speeds on the machines.
3. Standard time for each operation and details of set up time for each job.
4. Availability of machines, equipment and tools.

23. What are the factors affected process planning?

i. Volume of production

ii. Delivery dates parts or product.

iii. Materials specification

iv. Accuracy and process capability of machines

v. Accuracy requirements of part or products.

vi. The skill and expertise of man power.

24. List out the various activities involved in a process planning pro- cess. (OR)

What are the steps in process planning. (Apr/May 2017)

1. Analysis of the finished part requirements as specified in the engineering design.
2. Determining the sequence of operations required
3. Selection the proper equipment to accomplished the required operations.
4. Calculating the specified operation setup times and cycle times on each machine.
5. Documenting the established process plans.
6. Communicating the manufacturing knowledge to the shop floor.

PART - B

1. Discuss in detail various steps in process planning (M/J'12) (Nov/Dec 2017) (Apr/May 2019)

Process planning it is understand that the product design for each product has been developed in the design department .to convert the product design
into a product, a manufacturing plan is required. The activity of developing such a plan is called process planning Process planning consists of preparing set of instructions that describe how to manufacture that product and its

parts The task of process planning consists of determining the manufacture operations required to transform a part from a rough (raw material) to the finished state specified on the engineering drawing Process planning also known as operations planning , is the systematic determination of the engineering process and systems to manufacture a product competitively and economically

Process planning is a detailed specification which list the operations ,tools and facilities

Process planning is usually accomplished in manufacturing department

Process planning defined

An act of preparing a detailed process documentation for the manufacture of a piece part or assembly According to the American society of tool and manufacturing engineers process planning is the systematic determination of the methods by which a product is to be manufactured economically and competitively It consists of devising selecting and specifying processes machine tools and other equipment to transform the raw material into finished product as per the specifications called for by the drawings

Details of a process plan

A detailed plan usually contains the rough, processes, process parameters, and machine and tool selections

Informations required for the process planning : in order to prepare a process plan (also called as rough sheet) one require the following informations

1. assembly and component drawing and bill of materials this detail give the information regarding the general description of part to be manufactured raw material specifications, dimensions and tolerances required the surface finish and treatment required

Machine and equipment details

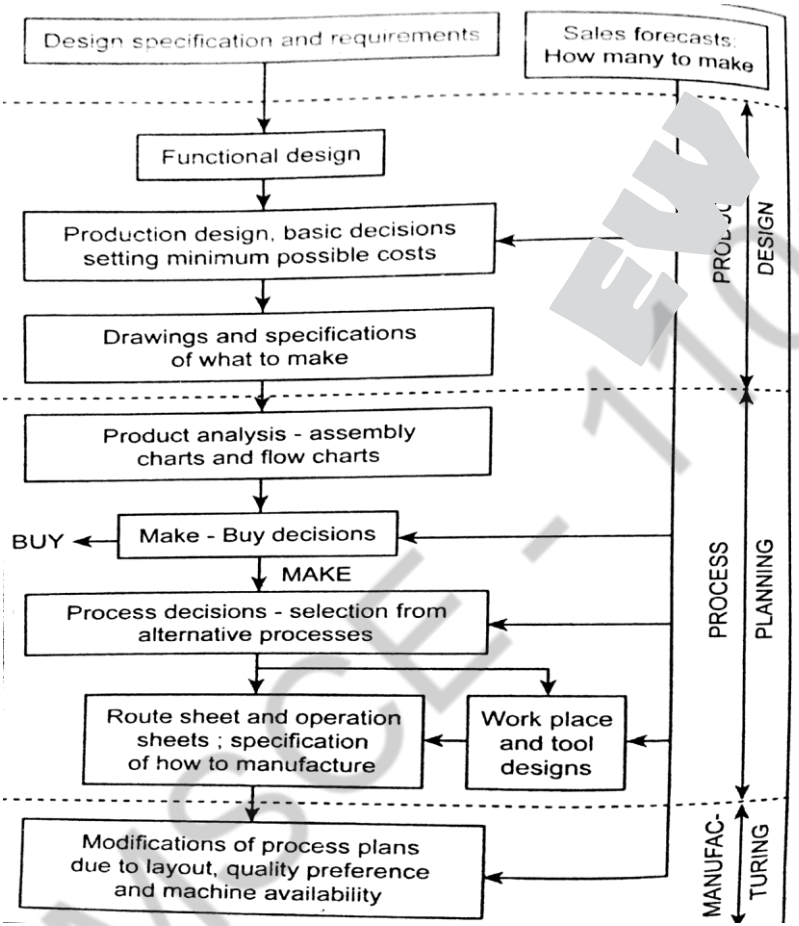
(i) The various possible operations that can be performed

(ii) The maximum and minimum dimensions that can be machined on the machines

(iii) The accuracy of the dimensions that can be obtaioned

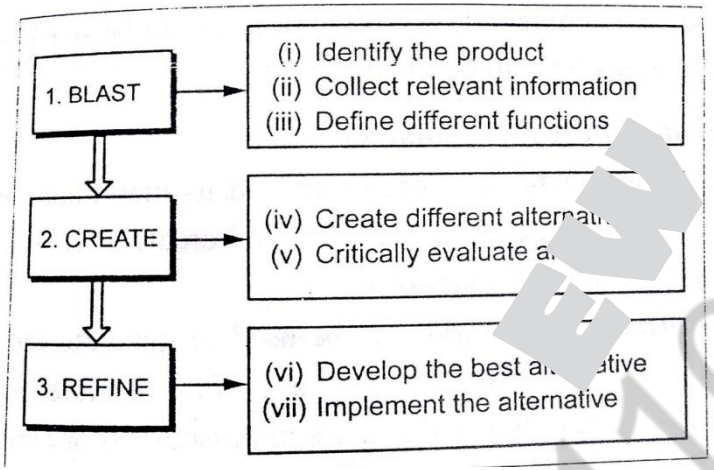
(iv) Available feeds and seeds of the machine

Standard time for each operations and details of setup time for each job
Availability of machines equipment and tools



2. With an example explain the value of engineering procedure? (M/J'12,A/M'14) (Nov/Dec 2017) (Nov/Dec 2018) (Apr/May 2019)

Value analysis (VA) is also known as value engineering (VE) value assurance (VA) and value management (VM)Value analysis is a disciplined approach that ensure the necessary functions at minimum cost without comprising on quality reliability performance and appearance According to the society of American value engineers (SAVE) value analysis is the systematic application of recognized techniques which identify the functions of a product of service establish a monetary value for the function and provide the necessary function reliability at the lowest overall cost.



Step 1. Identify the product

- ✓ First, the product should be identified for study.
- ✓ Value analysis can be applied to a product as a whole or its, subunits.

Step 2. Collect relevant information

- ✓ The next step is concerned with collecting all relevant information regarding the identified product from the point of view of (i) marketing and application, (ii) engineering, (c) manufacturing and procurement, and (d) economics.
- ✓ Some of the information needed to be collected include:
  - (i) Technical specifications with drawings.
  - (ii) Production processes, machine layout and instruction sheet.
  - (iii) Tine study details and manufacturing capacity.
  - (iv) Complete cost data and marketing details.
  - (v) Latest development in related products.

Step 3. Define the functions

- ✓ As we know the functional analysis is the heart of value analysis. Therefore the primary, secondary, and tertiary functions of the identified product/part should be identified and defined.
- ✓ Also the value content of each function should be specified and the high cost areas have to be identified.

Step 4. Create different alternatives

- ✓ Knowing the functions of each part and its manufacturing details the next step is to generate the ideas and create alternative ways of

achieving the defined functions.

- ✓ **Brain storming technique** can be used to generated ideas. Here it is important that all feasible and nonfeasible suggestions (alternatives) are only listed and are not discussed or evaluated.

Step 5. Critically evaluate the alternatives

- ✓ The ideas generated in the previous step are compared, evaluated, and critically assessed for their virtues, validity and feasibility as should be further developed.

Step 6. Develop the best alternative

- ✓ Using the detailed development plans that are made in the previous step, the best alternative plan should be selected.

Step 7. Implement the best alternative

- ✓ Having obtained the best alternative, then it should be converted into a prototype manufacturing model.
- ✓ Then the prototype is finally implement into operation and its results should be recorded.

3. A gear manufacturing has gear shaper and gear hobbers. The gear can be processed on gear shaper as well as gear hobber . The following information is given given . which of the two machine will you choose to do the job if the order quantity is (i) 1000 numbers and the order is likely to repeat for 3 years ? (A/M'14)

	Gear shaper	Gear hobber
Machine time per piece (min)	12	04
Machine cost per hour (rs.)	45	120
Set up time (min)	60	90
Tooling up cost (Rs.)	400	2000

Solution

Total cost = Machining cost + Set up cost + Tooling up cost

$$\frac{\left[(\text{Machining time /pc} \times \text{Batch size}) \times \text{machine cost / hour}\right]}{60} + \frac{\left[\text{Set up time /batch x Machine cost /hour}\right] + \text{Tooling up cost}}{60}$$

Case (i)

For gear shaper:

$$\text{Total cost} = \left\lceil \frac{(12 \times 1000) \times 45}{60} \right\rceil + \left\lceil \frac{60 \times 45}{60} \right\rceil + 400$$

=9000+45+400= Rs. 9445

For gear hobber:

$$\text{Total cost} = \left\lceil \frac{(4 \times 1000) \times 120}{60} \right\rceil + \left\lceil \frac{90 \times 120}{60} \right\rceil + 2000$$

=8000+180+2000=Rs.10180

Since the total cost is lesser in gear shaper, therefore the gear shaper machine will be chosen if the order quantity is 1000 numbers and the order is unlikely to repeat.

Case (ii):

For gear shaper :

$$\text{Total cost} = \left\lceil \left(12 \times 1000 \times \frac{3}{60} \right) \times 45 \right\rceil + \left\lceil \frac{60}{60} \times 45 \right\rceil + 400$$

=27000+45+400=Rs.27, 445

For gear hopper:

$$\text{Total cost} \left\lceil \left(4 \times 1000 \times \frac{3}{60} \right) \times 120 \right\rceil + \left\lceil \frac{90}{60} \times 120 \right\rceil + 2000$$

= 24000+180+2000=Rs.26180

Since the total cost is lesser in gear hobber ,therefore the gear hopper machine will be chosen If the order quantity is 1000 numbers and the order is likely to repeat for 3 years.

4. Discuss the value analysis and value engineering (N/D'14)

Value Engineering (VE);

- It is a systematic method to improve the "value" of goods or products and services by using an examination of function. Value, as defined, is the ratio of function to cost. Value can therefore be increased by either improving the function or reducing the cost. It is a primary tenet of value engineering that basic functions be preserved and not be reduced as a consequence of pursuing value improvements. Value engineering uses rational logic (a unique "how" - "why" questioning technique) and the analysis of function to identify relationships that increase value. It is considered a quantitative method similar to the scientific method, which focuses on hypothesis-conclusion approaches to test relationships, and operations research, which uses model building to identify predictive relationships. Value Analysis (VA);

- It is an orderly and creative method to increase the value of an item. This "item" can be a product, a system, a process, a procedure, a plan, a machine, equipment, tool, a service or a method of working. Value Analysis, also called Functional Analysis was created by L.D. Miles. The value of an item is how well the item does its function divided by the cost of the item (In value analysis value is not just another word for cost): Value of an item = performance of its function / cost An item that does its function better than another, has more value. Between two items that perform their function equally well, the one that costs less is more valuable. The "performance of its function" could include that it is beautiful (where needed). Do not be surprised if as a result of value analysis the cost of an item is less than half of its previous cost.

- Value engineering began at General Electric Co. during World War II. Because of the war, there were shortages of skilled labour, raw materials, and component parts. Lawrence Miles, Jerry Leftow, and Harry Erlicher at G.E. looked for acceptable substitutes. They noticed that these substitutions often reduced costs, improved the product, or both. What started out as an accident of necessity was turned into a systematic process. They called their technique "value analysis". When to use it;

- Use Value Analysis to analyze and understand the detail of specific situations.· Use it to find a focus on key areas for innovation.· Use it in reverse (called Value Engineering) to identify specific· solutions to detail

problems. It is particularly suited to physical and mechanical problems, but can also be used in other areas. Quick X Long Logical X Psychological Individual X Group [Value Analysis & Value Engineering] March 6, 2011 [IE301 Product Design and Innovation] Page 2 The Job Plan;

- Value engineering is often done by systematically following a multi-stage job plan. Larry Miles' original system was a six-step procedure which he called the "value analysis job plan." Others have varied the job plan to fit their constraints. Depending on the application, there may be four, five, six, or more stages. One modern version has the following eight steps:

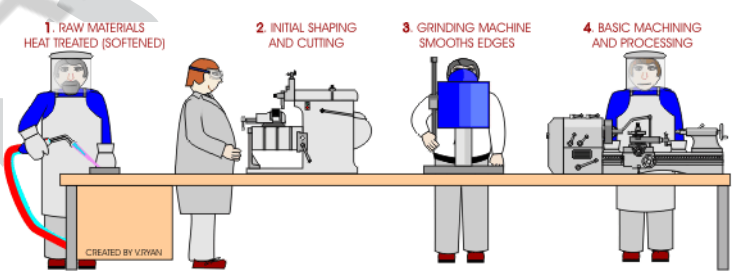
- 1. Preparation 2. Information 3. Analysis 4. Creation 5. Evaluation 6. Development 7. Presentation 8. Follow-up Four basic steps in the job plan are: Information gathering - This asks what the requirements are for the object. Function analysis, an important technique in value engineering, is usually done in this initial stage. It tries to determine what functions or performance characteristics are important. It asks questions like; What does the object do? What must it do? What should it do? What could it do? What must it not do? Alternative generation (creation) - In this stage value engineers ask; What are the various alternative ways of meeting requirements? What else will perform the desired function? Evaluation - In this stage all the alternatives are assessed by evaluating how well they meet the required functions and how great will the cost savingsbe. Presentation - In the final stage, the best alternative will be chosen and presented to the client for final decision.

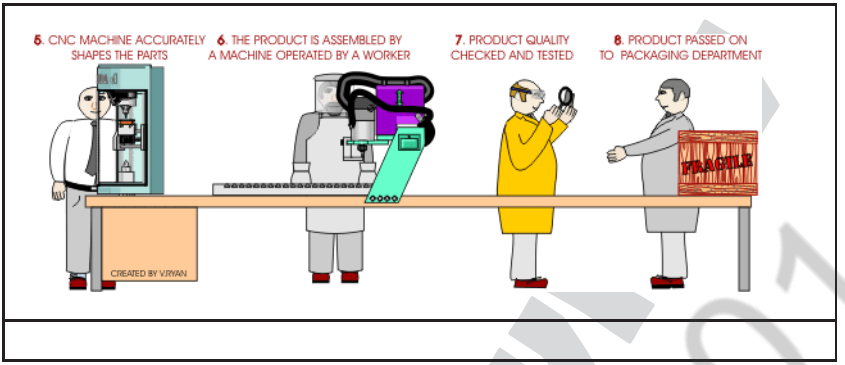
5. Explain how production quantity in batch production is determined.

The way products are manufactured depends on the quantity required. For example, cars are continually manufactured in hundreds of thousands , a prototype is a 'one off' (just one made) and DIY furniture is made in batches of thousands. Batch production is described below.
BATCH
PRODUCTION

SAMPLE PRODUCTS

FURNITURE
ELECTRICAL GOODS
CLOTHING
NEWSPAPERS
BOOKS
SAMPLE PRODUCTS

CHARACTERISTICS
1A production line is set up.
2. Each worker completes one task and passing down the production line to the next worker.
3. The workers are semi skilled or unskilled.
4. The workers must be able to switch from one part of the production line to another.They are called a flexible workforce
5. The production line can be changed quickly, so that different products can be made.
6. Often individual parts of the product are bought from other companies and assembled on the production line.
7. The production lines runs for a certain amount of time and then the product is changed.
The example production line (shown below) is that of an engineering company, manufacturing small steel products such as hinges and locks. They manufacture batches of five hundred at a time. The workers are unskilled and semi skilled. As each task is completed the item being manufactured is passed down the production line to the next worker, until it is complete.




6. Describe the problems of lack of product planning (N/D'14 & A/M'15)

Organizational planning should include long-term and short-term planning. The plan should predict where the organization will be in two or five years, listing specific, measurable goals and results. The plan should also include a specific "to-do" list that keeps everyone informed of the necessary actions and resources, as well as listing who is responsible for the all the tasks. It should also include a reasonable time frame for these tasks to be accomplished. Failure to plan will damage the effectiveness of the organization and can even lead to complete break-down.

Material Resources

Lack of planning is certain to result in shortages or delays of necessary materials. Without an analysis of how often resources need to be replenished, these necessities will not be found where and when needed. The necessary resource might be something as small as staples for the stapler, or as essential as running out of the raw material needed to manufacture the product that is sold. In all cases, a business a cannot flourish if the management of its resources is not being monitored and planned for.

Finances

Cash flow issues are bound to occur if the organization does not plan properly for where and when the finances are needed. Late payments are likely to result in suppliers becoming unreliable or cutting off the supply of their goods or services. Late payments can also result in additional interest payments or other financial penalties that cut into profits. Cash flow problems can go so far as to result in the inability to pay

employees on time. This is bound to have a negative impact on employee loyalty and retention.

Human Resources -- Productivity

Without planning, there will be no mission statement and no vision. Employees are most productive when they understand the bigger picture behind what they are doing, so productivity will decrease. There is also likely to be much wasted time, as some workers will be duplicating the work of others, while some essential tasks will be overlooked. This is all likely to result in the need for crisis management. Workers will spend a great deal of time "putting out fires" caused by the fact that no one is able to anticipate the problems that will regularly occur. In addition, larger projects will take longer than necessary, or may never reach completion, because no one did the planning necessary to break them down into more manageable segments.

Human Resources -- Morale

Employees in organizations suffering from lack of planning are likely to experience low morale. The workers will be aware of their disorganized environment, and will suffer stress and frustration because they will have difficulty executing their assigned tasks. There likely will be a high staff turnover rate, which leads to lowered productivity. Some employees might be laid off because of lowered profits and this will further diminish morale. Other employees might feel unappreciated and over-worked as the organization will be under-staffed. This will exacerbate the downward spiral and the business is likely to fail.

Payroll

A lack of planning may cause you to hire new employees every time you see a need in a department. If you do not balance these needs with the consideration of what you can afford, your payroll expenses can zoom out of control. In short, you must plan for enough growth to justify increased payroll and make sure that plan includes a cost-effectiveness evaluation for each position. This will tell you if new employees' efforts are paying off in increased profitability.

Marketing

Marketing can seem like a vague enterprise. You may feel that you are

aimlessly searching for customers and waiting to see who buys before you target a particular market segment. In fact, you can do research and identify potential target markets. You could also allocate marketing funds for each target group and measure the results of your expenditures. If you fail to make a marketing plan, you may waste a lot of money with the hit-or-miss approach of advertising to the marketplace in general.

Debt

It's easy to imagine that each new project you finance will pay for itself by making enough money to service the debt and leave a profit. In reality, some projects fail. If you continue to finance projects as you think of them without a debt plan, you may over-borrow. Part of your financial planning should include monitoring the percentage of debt you carry in relation to your income. Without such a plan, you could quickly end up owing more than you make.

Product Development

Part of your growth depends on introducing new products or services to the market. It takes time to develop these. You need to do test marketing, try out different features, examine financing needs and look at how a new product fits into your overall offerings. If you don't have a product-development plan, you may waste money pursuing products that have no chance of succeeding, adding more products than you can afford to finance or introducing products that conflict with your brand.

7. Explain the analysis of process capabilities in a multi product system

So far. We have considered the balancing of machine for the production of single product only. That is, we have taken a single product which has undergone several stages for its manufacture. Now we shall discuss the balancing for the production of multiproduct using the various stage in the production sequence for a multiproduct system is better explained with the help of the example problem, given below

Example : Two products A and B are produced in a plant, which have to be processed through five stages. The total operation time at each stage for each product, when employed for one product only is given below.

Stage	Product A (min/unit)	Product B (min/unit)

I	0.3	0.5
II	0.4	0.4
III	0.6	-
IV	0.5	0.375
V	-	0.3

Assume 8 hours /day working.

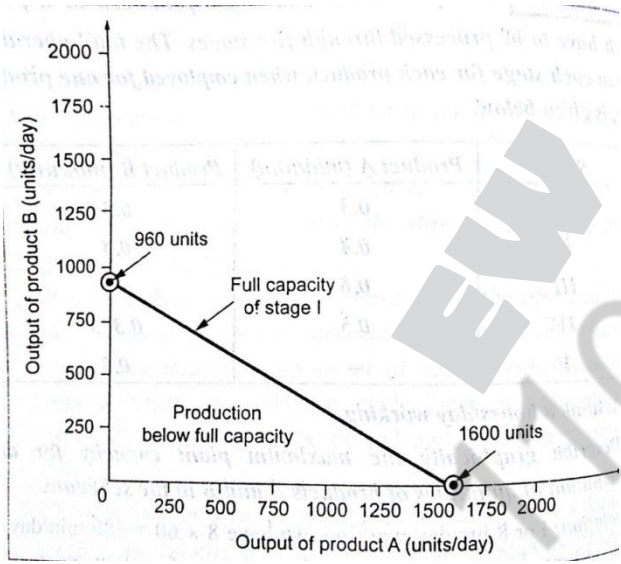
8. Describe graphically the maximm plant capacity for any comblination of quantities of products A and B in the schedule.

Solution: For 8 hrs/ day working, we have 8x 60=480 min/day of working time Using this , the maximum output of each stages can be calculated as below.

Stage	Product A (units/ day)	Product B(units/ day)
I	(480 min/day) /(0.3 min / unit)=1600	480/0.5=960
II	480/0.4=1200	480/0.5 =960
III	480/0.6 =800	-
IV	480/0.5	480/0.375=1280
V	-	480/0.3=1600

Graphical representation of process capacity

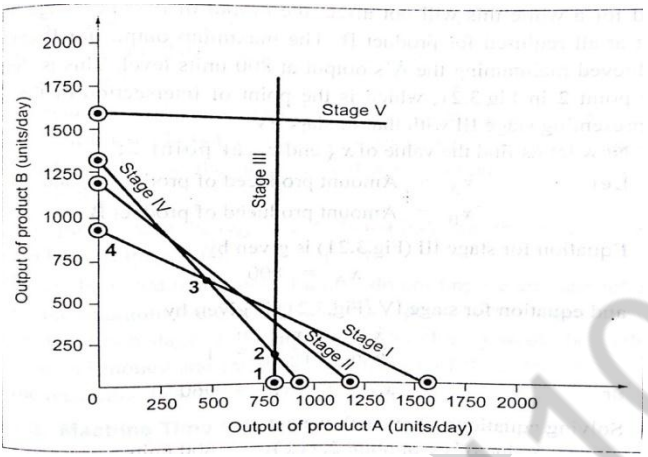
The capacity of stage I can represented graphically, as shown I grapf .in the output of product A is represented on the X- axis the output of product B is represented on the Y-axis.



When only product A is produced ,the maximum output of 1600 units is marked on the X-axis; similarly , when only product B is produced ,the maximum out of 960 units is marked on the Y- axis . Any combination of the two product, if stage I is employed at full capacity , is given by point on the straight line indicated.

Thus the straight line represents the full capacity of stage I. The region above the full capacity line refer to output value that cannot be achieved by stage I .The region /points below the full capacity line refer to production below full stage capacity

In the same fashion process capacities of all the five stages can be drawn graphically , on a single graph, as shown graph



In stage III is represented by a vertical line since stage III is not employed for the manufacture of product B. Similarly stage V is represented by a horizontal line as stage V is not required for product A.

Analysis

The graphical representation shown gives us immediately which processes limit the output.

For example, if we wish to produce only product A, the limiting process is given by stage III, here stage III is the bottleneck as it involves the longest operation time per unit and the maximum output is 800 units/day. But at the same time , all the stages will be idle for atleast some time (in fact stage V will be idle throughout). We can increase our total output by using some of the available machine time for producing product B, and for a while this will not affect the output of A, since stage III is not at all required for product B. The maximum output for B can be achived maintain the A , s outputat 800 units level . This is shown by point 2 ,Which is the point of interaction of the line representing stage III with that of stage III with that of stage IV.

Now let us find the value of x_A and x_B at point 2:

Let x_A = Amount produced of product A, and

x_B = Amount produced of product of B.

Equation for stage III is given by

$$x_A = 800$$

and equation for stage IV is given by

$$\frac{x_A}{960} + \frac{x_B}{1280} = 1$$

Or $$x_A + 0.75\, x_B = 960$$

Solving equations (i) and (ii). We get

Value of x_A at point 2, $(x_A)_2 = 800$ units

And Value of x_B at point 2, $(x_B)_2 = 214$ units

9. Define process planning .Discuss in detail steps for the same. (A/M'15) (Apr/May 2018)

(i) Process planning can be define as "an act of preparing a detailed processing documentation for the manufacture of a piece part or assembly."

(ii) According to the American Society of tool and Manufacturing Engineers, "process planning Is the systematic determination of the methods by which a product is to be manufactured economically and competitively."

(iii) It consists of devising, selecting and specifying processes, machine tools and other equipment to transform the raw material into finished product as per the specifications called for by the drawings.

A detailed process plan usually contains the route, processes, process parameters , and machine and tool selection .

Information required for process planning :

In order to prepare a process plan (also called as route sheet) one require the following informations

1. Assembly and component drawings and bill of materials (part list)

- This detail give the information regarding the general description of part to be manufactured , raw materials specifications dimensions and tolerance required the surface finish and treatment required

2. Machine and equipment details:

(i) The various possible operation that can be performed

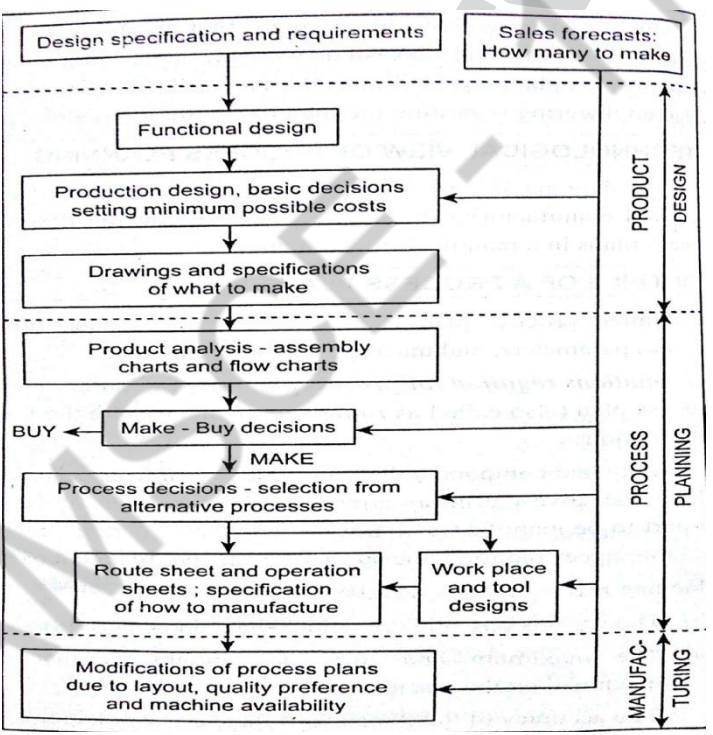
(ii) The maximum and minimum dimensions that can be machined on the machines

(iii) The accuracy of the dimensions that can be obtained

(iv) Available feeds and speeds on the machine

(v) Standard time each operation and details of setup time for each job

(vi) Availability of machines ,equipment and tools



Responsibilities of process planning engineer

The specialists managing the process planning task are called process engineer are given below

1. Interpreting part print analysis, and symbols

2. Gathering the fundamental details of product design, such as

(i) Type of rough stock

(ii) Type of finish ,

(iii) Production volume

(iv) Downtime

(v) Dimensional tolerance

(vi) Production rate

(vii) Scarp losses

(viii) Design changes

4. Selecting proper machining with allied tooling based on:

(i) Required machine capability

(ii) Setup-up time

(iii) Practical lot size

(iv) Quality of parts

(v) Cost of tooling and

(vi) Type of tooling

5.Sequence the operations

6. deciding on the inspection equipment in order to meet the desired quality

7. determining appropriate production tolerances.

8.Determining proper cutting tools and cutting conditions

9. calculating the overall times using work measurement techniques

Factors affecting process planning

Volume of production

The skill and expertise of manpower

Delivery dates for parts or products

Material specifications

Accuracy and process capability of machines

Accuracy requirements of part or products

Process planning activities

1. Analysis of the finished part requirements as a specified in the engineering design
2. Determining the sequence of operations required
3. Selecting the proper equipment to accomplish the required operations.
4. Calculating the specific operation setup times and cycle times on each machine
5. Documentation the established process plan
6. Communication the manufacturing knowledge to the shop floor

Analyze finished part requirements

The first step in the process planning is to analyse the finished part requirements as specified in the engineering design. The engineering drawing or in a CAD model format.

The component drawings should be analysed in detail to identify its features , dimensions and tolerance specifications

The part's requirement defined by its feature, dimensions, and tolerance specifications will determine the corresponding process requirements (such as operations encompassing part shape generation, inspection, testing , hear treatment surface coating packing etc)

Determine operation sequence

The second step in the process planning is to determine the sequence of operations required to transform the features, dimensions and tolerance on the part from rough (initial) to a finished state.

The basic aim of this step is to determine the type of processing operation that has the capability to generate the various types of feature , given the

tolerance requirements

There are two alternative ways of viewing the decision process in determining the sequence of operation .

The first view is to consider the processing evolution of the part from the rough state to the finished final state. In this view like in conventional production shop, material is removed or modified on the rough part in stages in order to transform it to the finished part.

The second view is to consider part evolution from a finished state back to a rough initial state. In this view, in contrast to the first view the operation processing is planned by adding material back onto the part

It should be noted that the tolerance specifications are primary factors in determining the sequence of operations

Select machines

Once the appropriate type of manufacturing process has been determined. The next step in process planning is to select appropriate machines , equipment and tools to accomplish the required operations

There are many factors which influence the selection of machines

(i) Economic considerations : due analysis should be made with respect to the initial cost, maintenance and running cost .an alternative which results in lower total cost should be selected .

(ii) Production rate and unit cost of production

(iii) Durability and dependability

(iv) Lower process rejection

(v) Minimum setup and put away times

(vi) Longer productive life of machines or equipment.

(vii) Functional versatility ability to perform more than one functions

- Machine selecting requires determining how the part would be processed on each of the alternative machines so that the best machine can be selected

- Also at the machine selection phase , the firml has to decide whether to make (manufacturing) purchase the component part
- In this regard break even analysis is the most convenient method for selecting the optimum method of manufacture or machine amongst the competing ones
- Material selection parameters
- The selection of a sound , economic material is an another important aspect of process planning the primary parameters
- Affecting the choice of a material are given

1. **Function** : many of the parameters developed for material selection are related to the functions the product must perform in terms of mechanical ,physical, electrical, and thermal properties of materials
2. **Appearance** : the aesthetic value of the material must be considered while selecting the material
3. **Reliability**: reliability is another important criterion for material selection because of increasing consumer demands for trouble free product
4. **Service life**: the length of service life over which the material maintains its desirable characteristics is avery important consideration in material selection
5. **Environment**: the environment to which the material is exposed during the product life is a very important consideration depending on whether the environment is beneficial or harmful
6. **Compatibility**: this is an important factor influencing material selection especially whenever more than one type of material is used in a product or assembly
7. **Produciblity**: the ease of producibility of an item is an important parameter in the selection of material.
8. **Cost**: the cost of the material is a significant factor contributing to the overall cost

Calculate processing times:

After an appropriate set of machines required is selected ,the next step process planning is to calculate the specific operation setup times and cycle

times on each machine

The dermination of setup times requires knowedge of available tooling and the sequence of steps necessary to prepare the machine for processing the given workpiece

For establishing accurate setup times detailed knowedge or the calculation of part processing time required

The calculation of part processing time requires the determination of the sequence of processing steps on each machine this activity is often called out planning

After the given machining or processing time is calculated the appropriate times for part loading ,part unloading machine indexing and other factors involved in one complete cycle for processing a part must be included to compute the expected machine cycle time

With the calculated machine cycle time ,allowances (for operator personal time , fatigue time and supplemental time) are added to calculate the standard cycle time for processing one piece

With the calculated ownership/use in rupees per unit of time are applied to calculate the expected standard cost for the given operation

10. Explain in detail the various steps in product and process planning (N/D'16) (Apr/May 2017)

PRODUCTS PLANNING PROCESS

The product planning process is one of the most controversial within any company. Everyone wants a hand in new product definition and almost everyone will have contributions that will make a new product successful. With all these interested parties, we need a system to

perform the product planning process steps.

The product planning process often includes the following

1. Marketing and marketing analysis ,
2. Performance of feasibility studies,
3. Advanced product planning.

process planning

It is understand that the product design for each product has been developed in the design department .to convert the product design into a product,

a manufacturing plan is required. The activity of developing such a plan is called process planninProcess planning consists of preparing set of instructions that describe how to manufacture that product and its parts The task of process planning consists of determining the manufacture operations required to transform a part from a rough (raw material) to the finished state specified on the engineering drawing Process planning also known as operations planning , is the systematic determination of the engineering process and systems to manufacture a product competitively and economically

Process planning is a detailed specification which list the operations,tools and facilities

Process planning is usually accomplished in manufacturing department

Process planning defined

An act of preparing a detailed process documentation for the manufacture of a piece part or assembly According to the American society of tool and manufacturing engineers process planning is the systematic determination of the methods by which a product is to be manufactured economically and competitively It consists of devising selecting and specifying processes machine tools and other equipment to transform the raw material into finished product as per the specifications called for by the drawings

Details of a process planA detailed plan usually contains the rough, processes, process parameters, and machine and tool selections

Informations required for the process planning : in order to prepare a process plan (also called as rough sheet) one require the following informations

1.assembly and component drawing and bill of materials this detail give the information regarding the general description of part to be manufactured raw material specifications, dimensions and tolerances required the surface finish and treatment required Machine and equipment details

(i) The various possible operations that can be performed

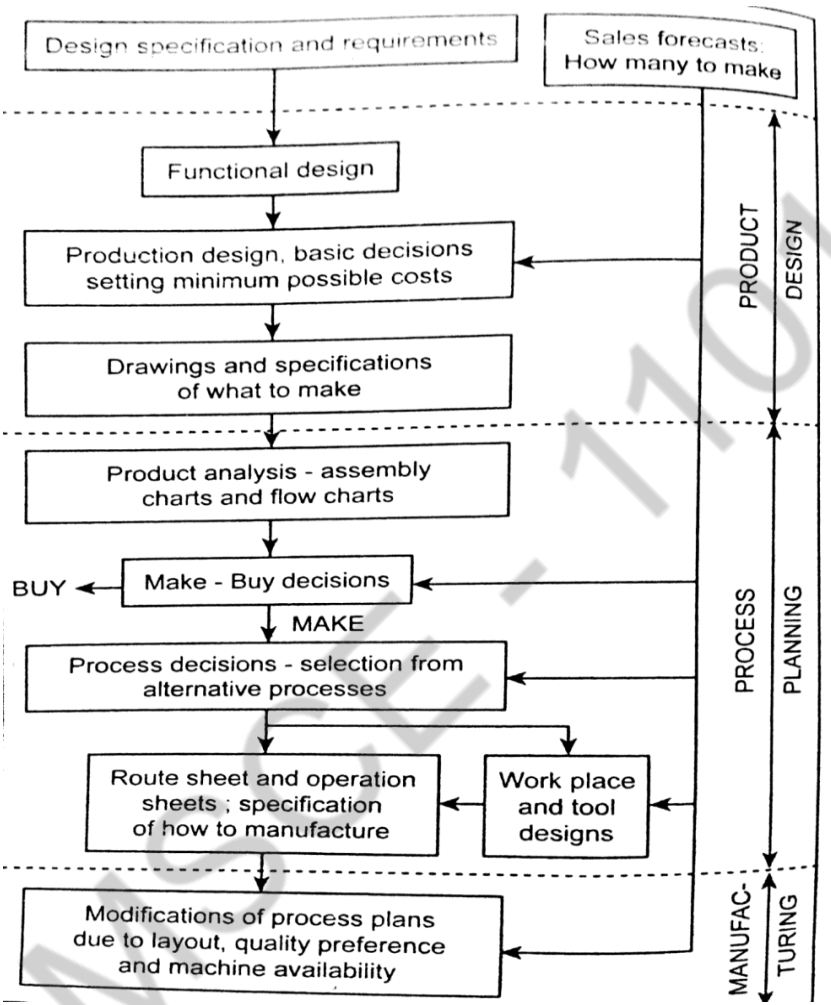
(ii) The maximum and minimum dimensions that can be machined on the machines

(iii) The accuracy of the dimensions that can be obtaioned

(iv) Available feeds and seeds of the machine

Standard time for each operations and details of setup time for each job

Availability of machines equipment and tools



11. Elaborate on the procedures involved in the determination of quantity, machine capacity and balancing in batch production (N/D'16) (Nov/Dec 2018)

QUANTITY DETERMINATION BATCH PRODUCTION

As discussed already, batch production falls between job shop production and mass production . batch production is required when a variety of products are to be made and the volumes are not large enough to demand a separate line for each product

Batch production is necessary

(a) When the demand for a product is limited

(b) When the rate of production is higher than the rate of consumption

In batch production the product is manufactured periodically in a quantity that will be sufficient to satisfy the demand for some time until manufacture of this product is resumed . in the interval between two production periods, the facility (plant and equipment) can be used for the manufacture of a variety of goods in a similar fashion

Thus in batch production a complete production cycle can be organized in such a way that each product in turn is manufactured in quantities corresponding to the total demand for it throughout the cycle time

Characteristics of batch productionn Picture Planning for batch production

During the planning of batch production there are two decisions have to be taken by operations manager

(i) Determination of the batch size (the size of the production lot), and

(ii) Determination of batch production

Machine capacity

So far we have determined the production quantities either by definite orders or through batch- size calculations in case of batch production . also the process planning details are already obtained through the operations/ route sheets. Now let us focus on the next activity of PPC machine loading and scheduling

What is meant by machine loading

Obviously , machines have to be loaded according to their capacity of performing the given task and according to their capacity

Machine loading should be carried out in accordance with routing so that smooth workflow can be ensured

Machine loading should ensure maximum possible utilization of productive facilities and should try to avoid bottle necks in production

In machine loading ,appropriate allowance for setup of machine process adjustments and maintenance overtime have to be made

It is important to avoid both over-loading and under-loading the facilities so as to ensure maximum utilization of resources

Machine loading is nothing but a process to match all the production requirements with the available machine capacity therefore it is essential first to determine the machine capacity

Information required for machine loading

The various information required for machine loading and scheduling which are derived from the operations/route sheet include

(i) Number and identification of work order

(ii)Symbol and /or identification of a part/product

(iii) Number of parts in each lot

(iv) List of operations to be performed

(v) Sequence in which these operations are performed

(vi) Specifications of machines and equipment required

(vii) Necessary toolings jigs, and fixture

(viii) Estimated or processing times of each operations for the whole order or batch

(ix) Information about the dates on which the part should be finished

Machine output vs cycle time

It is understood that machine output is inversely proportional to the cycle time

In other words , lower the cycle time higher the machine output and vice versa

Let T= cycle time in minutes and

Q_{th}= theoretical output per machine

$$Q_{th}=\frac{60}{T} \text{ units/hour}$$

Balancing (machine balancing)

What is mean by machine balancing

Once the cycle times in the production line have been set the production capacity of all work centres must be adjusted to conform to those cycle times. The adjustment can involve (i) increase capacity at bottleneck operations (ii) decreasing capacity at non-bottlenecks or (iii) reconfiguring

tasks at workstations

Balancing refers to the procedure of adjusting the times at work centres to conform as much as possible to the required cycle time

A balanced process is one where the actual cycle times at every stage are equal . strictly speaking , the goal of achieving the process is appropriate only in processes that are placed that is where material that is , where material moves on a conveyor or chain at a constant speed past workstations such is the case of product layouts .In other processes that are similar to job shops and where many products and routings are involved , the goal of a balanced process is inappropriate . seeking to balance a process around one product or routing in such cases makes it more difficult to adapt the operations to accommodate many routings and products

Balanced process

Consider a product that undergoes a sequence of operations through five elements five machines A,B,C,D and D, here we can say that operations are done in five stages In such cases the cycle time will be 1min one unit of product will be produced . since the actual cycle times at every stage are equal therefore this process is known as balanced process . thus we get perfect matching of the stages in the sequence

Effect of balancing on number of machines required

The effect of balancing on number of machines required is better explained with the help of following example problem

12. A product has to undergo 10 stages in the production sequence.

Operation	1	2	3	4	5	6	7	8	9	10
Preparation time (min)	0.2	0.4	0.2	0.1	0.2	0.2	0.2	0.2	2.4	3.0
Machine (min)	0.8	9.6	0.4	0.9	1.3	4.6	2.2	2.6	2.4	3.0

(i) Determine the total operation time cycle time the output of the line and the efficiency of the actual given production sequence

(ii) It is required that the cycle time to be reduced to 5 min Explain how it can be accomplished

(iii) Also determine the output and efficiency of the new cycle

Solution :

(i) To find total operation time , cycle time cycle output and efficiency of the current production line:

Operation	Preparation time (t_1) min	Machine time (t_2) min	Total operation time ($t=t_1+t_2$)min
1	0.2	0.8	1.0
2	0.4	9.6	10.0
3	0.2	0.4	0.6
4	0.1	0.9	1.0
5	0.1	1.3	1.4
6	0.2	4.6	4.8
7	0.2	2.2	2.4

4. Develop

Most economical method

5.measure

The amount of work involved and set standar time to do that job

6.Define

New method and standard time

7.Install

The new method as a standard practice

8.Maintain

New agreed standard practice by proper control procedures

Labell

Operation	Preperation time (t_1) min	Machine time (t_2) min	Total operation time ($t=t_1+t_2$)min
8	0.2	2.6	2.8
9	0.2	2.4	2.6
10	0.2	3	3.6
Total	2.4	27.8	30.2

From the above table the total operation time =30.2 min

The operation time for all the 10 stages are graphically represented in fig

In this unpaced production line, the operation time vary at the various stage, ranging from 0.6 to 10.0 min (refer above)

It may be noted that the cycle time or the pace of production is determine by the slowest operation (bottleneck) in the sequence. In this case obviously, the machine at stage 2, which requires 10.0 minutes is the bottleneck.

We know that,

Cycle time of the current line = operation time of the bottleneck operation

Cycle time **T=10.0 min**

Then cycle output $Q_{th} = \frac{60}{T}$ units per hour

$$Q_{th} = \frac{60}{10.0} = 6 \text{ units per hour}$$

In general, the efficiency of a sequence of stations is determined by

$$\text{Efficiency} = \frac{\text{work content}}{\text{No.of work station} \times \text{requiered cycle time}} \times 100$$

In this case,

$$\text{Efficiency} = \frac{\text{Total operation time}}{\text{No.of mechines} \times \text{cycle time}} \times 100$$

$$\text{Efficiency} = \frac{30.2}{10 \times 10} \times 100 = 30.2\%$$

13. A product is solid at a rate of 400 pieces a day and is manufactured at a rate of 2000 pieces a day. The setup costs of the machines are Rs.5000 and the storage costs are found to be Rs.0.015 per unit per day. Labour charges are Rs.120, materials Rs.80, and overheads Rs.160 per piece. If the interest charges are 13% per cent, find the minimum-cost batch size and the costs of the production run. Assume 300 working days in a year.

Given Data: Demand rate, d=400 pieces/day; production rate, p=2000 pieces/day; set-up cost, S= Rs.5000; storage costs, B=Rs.0.015 per piece per day; labour cost, L=Rs.120; materials cost,

M=Rs.80; overhead,

O=Rs.160; interest charge, i=13%.

To find: (i) Minimum-cost batch size (Q_m), and

(ii) Cost of the production run.

Solution:

a. Minimum-cost batch size (Q_m) :

$$\gamma = \frac{\text{Demand rate}}{\text{Production rate}} = \frac{d}{p}$$

We know that, $$= \frac{400}{2000} = \frac{1}{5} = 0.2$$

The given annual interest rate(i) has to be converted into interest charges per day, taking 300 working days in a year.

i.e., $$i = 13\% = \frac{13}{100} \text{ per year}$$

$$= \frac{13}{100} \times \frac{1}{100} = 4.33 \times 10^{-4} \text{ perbday}$$

We know that,

Constant costs, C=L+M+O

=120+80+160 = Rs.360 per piece

Carrying costs, I =iC

$= 4.33 \times 10^{-4} \times 360$

= Rs.0.156 per piece per day

We know that the minimum-cost batch size,

$$Q_m = \sqrt{\frac{2dS}{1(1+\gamma) + 2B}}$$

$$= \sqrt{\frac{2 \times 400 \times 5000}{0.156(1+0.2) + (2 \times 0.015)}}$$

$$= 4291.42 \text{units} \approx 4292 \text{ units Ans.}$$

14. **State the ten commandants of value analysis. (Apr/May 2018)**

The following are the ten basic commandants of value analysis.

1. Do not use a component or part that does not contribute to the value of the product.
2. Do not use a component or part whose cost is not proportionate to its usefulness.
3. Do not provide any features to the component or the finished product that are not absolutely necessary.
4. Accept the change if the part of required quality can be made out of superior or inferior quality material where the overall cost is less.
5. If a part of required quality can be made by a method or process costing less, use the alternative.
6. Replace a non-standard part with a standard part wherever possible. It will cost less.
7. Use proper tooling and manufacturing methods considering the quantities required.
8. Cost of a component shall be proportional to the material used and the labour, overhead and profit allowed.
9. Where possible, use some other material or part better suited for the purpose.
10. If a dependable supplier can provide a part for less or a better part for the same, then do not make it yourself.

15. **Explain the multiproduct system.**
Refer Question Bank Page 80, Question No. 7

16. **Explain the various phases of value Engineering**
Refer Question Bank Page 71, Question No. 2

17. **Explain the importance of process planning with reference to production control. Discuss the activities involved in process planning**
Refer Question Bank Page 90, Question No. 10

18. **What is meant by machine loading? Also enumerate the various methods to the cycle time to minimum.**

    Refer Question Bank Page 92, Question No. 11

19. **What is meant by product planning ? Explain in detail the various steps involved in the product planning process?**

    Refer Question Bank Page 6, Question No. 1

20. **Explain the factors that affect the selection of machines.**

    Refer Question Bank Page 88, Question No. 9

21. **What do you mean by machine balancing? Also explain the effect of balancing on number of machines required with an illustration**

    Refer Question Bank Page 92, Question No. 11

UNIT - 4
PRODUCTION SCHEDULING

PART - A

1. **What is Gantt chart and how it is constructed? (APRIL/MAY-14)**
Gantt charts are usual (bar chart) aids to depict the sequencing, load on facilities, or progress associate with work effort over a well –defined time period.

2. **With reference to line balancing, define the terms (a) line efficiency and (b) balance delay. (APRIL/MAY-14)**
Line efficiency is the ratio between the time needed and the time allocated in an assembly line.

Balance delay is the percentage of wasted time.

3. **What are Gantt charts? (APRIL/MAY-15)**
It is a chart in which a series of horizontal lines shows the amount of work done or production completed in certain periods of time in relation to the amount planned for those periods.

4. Brief about "Kanban". (APRIL/MAY-15) (Apr/May 2017)

Kanban is the Japanese word for card. Kanbans usually are rectangular paper cards placed in transparent covers. There are two main types of card in use:

1. Withdrawal kanbans Withdrawal kanbans define the quantity that the subsequent process should withdraw from the preceding work center. Each card circulates between two work centers only - the user work center for the part in question and the work center that produces it.

2. Production kanbans Production kanbans define the quantity of the specific part that the producing work center should manufacture in order to replace those, which have been removed.

5. what are the basic inputs for MRP (APRIL/MAY-12)

1. master production schedule,
2. bill of materials file, and
3. inventory record file

6. Distinguish between single machine scheduling and flow shop scheduling (APRIL/MAY-12)

The main difference of the flow shop scheduling from the basic single machine scheduling is that the inserted idle time may be advantageous in flow shop scheduling. Though the current machine is free, if the job from the previous machine is not released to the current machine we cannot start processing on that job. So, the current machine has to be idle for some time. Hence, inserted idle time on some machine would lead to optimality.

7. Write a note on Perpetual loading (NOV/DEC-14)

In perpetual loading, a copy of every order is placed along with the job till the job is completed. During the processing, the status of the job is reported with tickets such as inspection ticket, material requisition ticket, move ticket etc.,

8. hat is product sequencing? (NOV/DEC-14)

It is the systematic way of determine the optimum sequence of job that minimize the total completion time

9. Difference between sequencing and scheduling (NOV/DEC-16)

Sequencing	Scheduling
If no order specified use come first come –first served (FCFS) LCFS(last come first out) DDATE – earliest due date CUSTPR- highest priority SETUP- similar required setup SLACK –smallest SLACK CR smallest critical ratio STP – shortest processing time .LPT- longest processing time	Scheduling: The allocation of resources over time to accomplish specific tasks. Demand scheduling : A type of Scheduling where by customers are assigned to a definite time for order fulfillment. Workforce Scheduling:A type of Scheduling that determines when employees work. Operations Scheduling :A type of Scheduling in which jobs are assigned to workstations or employees are assigned to jobs for specified time periods

10. Cite the meaning of the term line of balance. (NOV/DEC-16)

Balancing refers to the procedure of adjusting the times at work centers to conform as much as possible to that required cycle time.

11. List key functions of the production scheduling and controls.

1. **Release orders** to the system in accordance with the priority plan.

2. **Assign jobs** to specific work centers (including machine loading, or shop loading)

3. Provide **sequencing priorities** to specify the order in which jobs are to be processed.

4. Control the **manufacturing lead time** by **tracking and expediting** jobs if necessary.

5. Monitor the capacity satus of facilities via input/output reports of workload versus capacity.

12. What is do you mean by loading?

Loading, also known as machine loading, may be defined as the assignment of work to a facility (facility may be machine, group of men, entire plan, etc.) without specifying when the work is to be done and in what sequence.

13. What is scheduling? What are its objectives? (Apr/May 2018)

- Scheduling refers to the setting of operation start dates so that jobs will be completed by their due date.
- The objectives of production scheduling are:

(i) to meet due date,
(ii) to minimize lead time,
(iii) to minimize setup time or cost,
(iv) to minimize work-in process inventory, and
(v) to maximize machine or labour utilization.
(vi)

14. What are the data required for production scheduling?

The production scheduling requires accurate information on:

(i) The current status of jobs(e.g., what orders are in process and where);
(ii) what upcoming jobs are available;
(iii) The adequate of material and capacities;
(iv) Equipment and labour utilization; and
(v) Job progress and efficiency.

15. What is master scheduling? (Apr/May 2017) (Apr/May 2019)

The master schedule, also known as master production schedule (MPS), formalizes the production plan and translates it into specific end-item requirements over a short to immediate planning horizon.

16.Differenciate between aggregate planning and master scheduling.

1. **Aggregate planning** is the process of planning the quantity and timing of output over the medium range (often 3 to 18 months) by adjusting the production rate, employment, inventory, and other controllable variables.
2. **Master scheduling** follows aggregate planning and expresses the

overall plan in terms of specific end items to produce and dates to produce them. It uses information from both forecasts and orders on hand, and it is the major driver of all production activities.

17. What is MPS?

MPS is nothing but Master production schedule. MPS formalizes the production plan and translates it into specific end-item requirements over a short immediate planning horizon.

18. What are gantt charts?

Gantt charts are usual (bar chart) aids used to depict the sequencing, load on facilities, or progress associated with work effort over a well defined time period.

19. What is the purpose of (a) Workload chart and (b) Scheduling charts?

1. **A work load chart** is usually to depict workload levels for equipment, workstations, or departments.
2. **A Gantt scheduling chart** is used to track the progress of jobs as they pass through departments in an organizations.

20. What is priority sequencing?

Priority sequencing is a systematic procedure for assigning priorities to scheduling rules, are the rules used in obtaining a job sequence.

21. What are dispatching rules?

Dispatching rules, also known as priority procedure for assigning priorities to waiting jobs thereby determining the sequence in which the jobs will be performed.

22. What is meant by product sequencing?

Priority sequencing is a systematic procedure for assigning priorities to waiting jobs thereby determining the sequence in which the jobs will be performed.

23. List any six priority rules used for job sequencing. (Nov/Dec 2017) (Apr/May 2019)

(i) FCFS (First come, First Served).
(ii) SOT(Shortest operating Time).
(iii) Due date-earliest due date first.

(iv) Start date-due date minus normal lead time.

(v) STR (Slack Time Remaining)

(vi) STR/OR(Slack Time Remaining per Operations).

24. What is the use of objective chart?

The objective chart shows the contrast between expected completion schedule of production and the actual performance.

25. When do you use progress chart?

The progress chart is a bar type chart which shows the actual number of items produced at each operation stage against the quantities that should have been produced as indicated by line of balance(in the LOB chart).

26. What is MRP? (Nov/Dec 2017)

Material requirements planning(MRP) is a computational technique that converts the master schedule for final products into a detailed schedule for the raw materials and part used in the final products.

27. List the various inputs required for MRP. (Nov/Dec 2017)

1. Master production schedule,
2. Bill of materials file, and
3. Inventory record file.

28. What is MPS?

Master production schedule (MPS) is a detailed plan that shows how many end items (i.e., the final product to be sold to the customer) will be available for sale or distribution during specific periods.

29. What are the purpose of the master production schedule?

The MPS is used:

1. To set due dates for the availability of end items.
2. To provide information regarding resources and materials required to support the aggregate plan.
3. As an input to MRP, which will set specific production schedules for parts and components used in end items.

30. State the steps in Johnson's algorithm for solving sequencing problems of n jobs and 3 or 4 machines. (Apr/May 2018)

The method consists of replacing the given problem by an equivalent problem involving n jobs and two machines. These two hypothetical machines are denoted by g and H and their corresponding processing times are given by

$G_i = M1_i + M2_i$ and

$H_i = M2_i + M3_i$

If this new problem with the presented order G-h is solved by Johnson's method, the resulting optimal sequence will also be optimal for the original problem.

31. What are the different techniques of loading and scheduling? (Nov/Dec 2018)

a. Master scheduling
b. Perpetual loading
c. Order scheduling
d. Loading by schedule period

32. Define dispatching. (Nov/Dec 2018)

It is the routine of setting productive activities in motion through the release of orders and instructions in accordance with previously planned times and sequences embodied in route sheets and schedule charts.

PART-B

1. Briefly discuss different measure of performance in a single machine scheduling with in impedance jobs (M/J'12) (Apr/May 2017)

The problem of scheduling of n jobs on one machine is also referred as n/1 scheduling . the theoretical difficultly of scheduling problems increases with more machines rather than with more jobs. The n/1 scheduling illustrated in the following example'

A manufacturing facility has five jobs to be scheduled on a machine .their sequence of arrival ,processing time ,and due-date are given in the table below

Job (in sequence of arrival)	Processing time	Due date(days from now)
A	7	8
B	4	3
C	5	7
D	2	9
E	6	6

SCHEDULE the job using (i) FCFS (ii) SPT, (iii) DDate,(iv) LCFS and (VI) STR rules .also compare the result (using the performance measures) of total completion time ,average completion time and average lateness).

(i) FCFS (first come- first served) rule : in this the job which arrives first is scheduled first, and so on, the FCFS rule results are

Job sequence (i)	**Processing time (days) (p_i)**	**Due date (days hence) (di)**	**Flow time (days) ($F_i=F_i-1+P_i$)**	**Lateness of job Li=fI-di, if Fi>di; Otherwise zero)**
A	7	8	0+7=7	0
B	4	3	7+4=11	8
C	5	7	11+5=16	9
D	2	9	16+2=18	9
E	6	6	18+6=24	18

			76	44

$$\text{Mean flow time} = = \frac{76}{5} = 15.2 \text{ days}$$

$$\text{Average lateness} = = \frac{44}{5} = 8.8 \text{ days}$$

rules (ii) SPT(shortest processing time) or SDT(shortest processing time)

This rule gives top priority to that job which has shortest processing time. The resulting flow times are as below

Job sequence (i)	**Processing time (days) (p_i)**	**Due date (days hence) (di)**	**Flow time (days) ($F_i=F_i-1+P_i$)**	**Lateness of job Li=fI-di, if Fi>di; Otherwise zero)**
A	2	9	0+2=2	0
B	4	3	2+4=6	8
C	5	7	6+5=11	9
E	6	6	11+6=17	9
A	7	8	17+7=24	18
			60	34

$$\text{Mean flow time} = \frac{60}{5} = 12 \text{ days}$$

$$\text{Average lateness} = \frac{34}{5} = 6.8 \text{ days}$$

(ii) DDate (or earliest due-date) rule :

This rules gives top priority to the job having earliest due-date as below

Job sequence (i)	**Processing time (days) (p_i)**	**Due date (days hence) (di)**	**Flow time (days) ($F_i=F_i-1+P_i$)**	**Lateness of job Li=fI-di, if Fi>di; Otherwise zero)**

B	4	3	0+4=4	0
E	6	6	6+4=10	8
C	5	7	10+5=15	9
A	7	8	15+7=22	9
D	2	9	22+2=24	18
			75	42

Mean flow time = = $\frac{75}{5}$ = 15 days

Average lateness = = $\frac{42}{5}$ = 8.4 days

(iv)LCFS(last-come first-serve) rule

This rules gives top priority to that job, which has arrived most recently as below

Job sequence (i)	**Processing time (days) (p_i)**	**Due date (days hence) (di)**	**Flow time (days) ($F_i=F_i-1+P_i$)**	**Lateness of job Li=fI-di, if Fi>di; Otherwise zero)**
E	6	6	0+6=6	0
D	2	9	6+4=8	0
C	5	7	10+5=13	6
B	4	3	15+7=17	14
A	7	8	22+2=24	16
			68	36

Mean flow time = $\frac{68}{5}$ = 13.6 days

$$\text{Average lateness} = \frac{36}{5} = 7.2 \text{ days}$$

(iii) STR (slack time remaining) rule

Job sequence (i)	Processing time (days) (p_i)	Due date (days hence) (di)	Flow time (days) ($F_i=F_i-1+P_i$)	Lateness of job Li=fI-di, if Fi>di; Otherwise zero)
B	4	3	0+4=4	1
E	6	6	6+4=10	4
A	7	8	10+7=17	9
C	5	7	17+5=22	15
D	2	9	22+2=24	15
			77	44

$$\text{Mean flow time} = \frac{77}{5} = 15.4 \text{days}$$

$$\text{Average lateness} = \frac{44}{5} = 8.8 \text{ days}$$

2. Distinguish between single scheduling machine and flow production scheduling.(M/J'12) (Nov/Dec 2018)

SINGLE MACHINE SCHEDULING

- Scheduling is the allocation of start and finish time to each particular order.
- Scheduling can bring productivity in shop floor by providing a calendar for processing a set of jobs.
- It is nothing but scheduling various jobs on a set of resources (machine) such that certain performance measures are optimized.
- The single machine scheduling problem consists of n jobs with the same single operation on each of the jobs.
- While the flow shop scheduling problem consists of n jobs with m operations on each of the jobs. In this problem, all the jobs will have

the same process sequences.

- The job shop scheduling problem contains n jobs with m operations on each on the jobs; but, in this case, the process sequences of the jobs will be different from each other.

Flow production scheduling

1. A set of multiple-operation jobs is available for processing at time zero (Each job require m operations and each operation requires a different machine).

2. Set-up times for the operations are sequence independent, and are included in processing times.

3. Job descriptors are known in advance.

4. m different machines are continuously available.

5. Each individual operation of jobs is processed till its completion without break.

The main difference of the flow shop scheduling from the basic single machine scheduling is that the inserted idle time may be advantageous in flow shop scheduling. Though the current machine is free, if the job from the previous machine is not released to the current machine we cannot start processing on that job. So, the current machine has to be idle for some time. Hence, inserted idle time on some machine would lead to optimality.

3. What are the assumption in flow shop scheduling? (Nov/Dec 2018)

Model's assumptions

- All jobs are available for processing at time zero.
- Each job must be completed if it is started.
- Each job has m operations.
- Processing times are independent of the schedule.
- Jobs can wait the next machine to become idle.
- Machines may be idle.

- Setup times are known and they are not included in processing times.
- No machine may process more than one operation at the same time.
- Machines are not available in all the scheduling period and must be stopped after each time interval for PM activity.
- Each machine interval time (unit time between two PM actions on each machine) is determined efore by some techniques.

Number of unit time PM takes on each machine determined before.
Assumptions numbers (1) to (8) are obtained from [6].

4. An assembly line is to be designed to operate 7.5 hours per day and supply a steady demand of 300 units per day. The following table shows the tasks and their performance times. (i) draw the precedence diagram, (ii) Cycle time (iii) assign tasks to work stations stating your logical rules , and (iv) what is the efficiency of your line balance? (A/M'14)

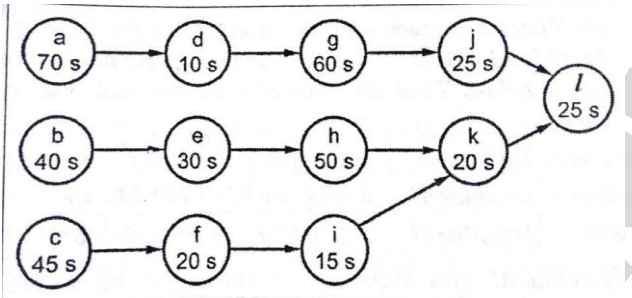
Task	a	b	c	d	e	f	g	H	i	j	k	l
Preceding tasks	-	-	-	a	b	c	d	E	f	g	H,i	J,k
Performance time(sec)	70	40	45	10	30	20	60	50	15	25	20	25

Given data : working time =7.5 hours per day ; demand =300 Units per day.

Solutions:

(i) Precedence diagram:

Using the given data , the precedence diagram can be drawn as below



(ii) Cycle time (CT):

CT= Operating time per day

Desired out per day

= 7.5 x 60 x 60 = 90 s or 1.5 min

= 300

(iii) Assigning tasks to workstations:

Workstation	Assign task	Idle time (in seconds)
1	a,d	20 10
2	c,f,i	45 25 10
3	g,j	30 5
4	b,h	50 0
5	e,k,l	60 40 15
		$\sum$=40

(iv) Efficiency of line balance:

Percentage of idle time (balance decay) for the line

$$= \frac{\text{Idle time per cycle}}{\text{No.of workstations x Cycle time}} \times 100$$

$$= \frac{40}{5 \times 90} \times 100 = 8.9\%$$

Efficiency of the line = 100 – Percentage at idle time

= 1- 8.9 = 91.1%

There are seven jobs which are to be processes first on Machine I and then on Machine II .process time in hours is given below. Find the optimal sequence and total elapsed time

Task	a	b	c	d	e	f	g
Machine I	6	24	30	12	20	22	18
MachineII	16	20	20	13	24	2	6

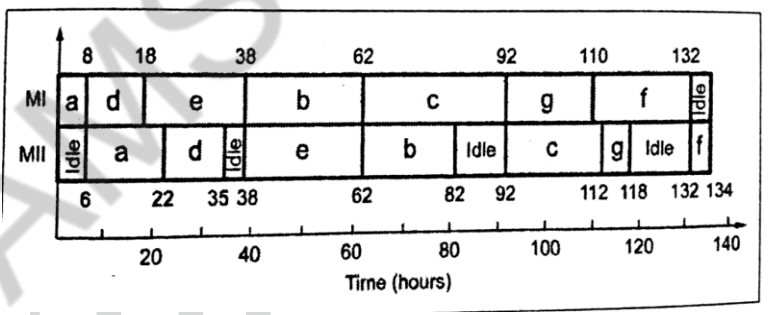
Solution : This sequencing problem can be solved using Johnson's rule given in Section 4.6.3 in our text.

The sequence of jobs can be obtained as below.

						f
a						f
a					g	f
a	d				g	f
a	d		b	c	g	f
a	d	e	b	c	g	f
Machine 1					Machine 2	

Optimal Sequence of job is a d e b c g f

The final schedule for the above job sequence can be drawn as shown below.



From the above figure ,we can write

Total elapsed time =132 hours

Idle time for MI = 2 hours

Idle time for MII =6+3+10+14=33 hours

5. Describe Gantt charts. What are their uses? (N/D'14) (Apr/May 2018)

Gantt charts

Gantt Charts are simple bar graphs that can be used to schedule any of operation. These charts are named after its originator Henry L.Gantt. Gantt charts are usual (bar chart) aids used to depict the sequencing, load on facilities, or progress associated with work ffort over a well-defined time period.

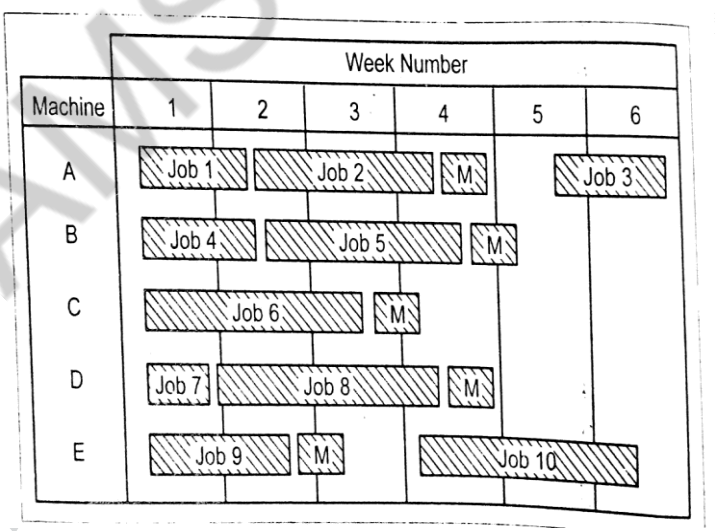
Two basis types of gantt charts are :

- Workload charts, and
- Scheduling charts.

Gantt workload charts

A workload chart is usually used to depict workload levels for equipment, workstations, or departments. In these charts, the vertical axis usually lists different facilities used to manufacture or process job orders. The horizontal axis usally represents time.

A typical Gantt workload chart. As we can see from series of machine is listed on the vertical axis and jobs to which they need to be assigned are listed in rows.



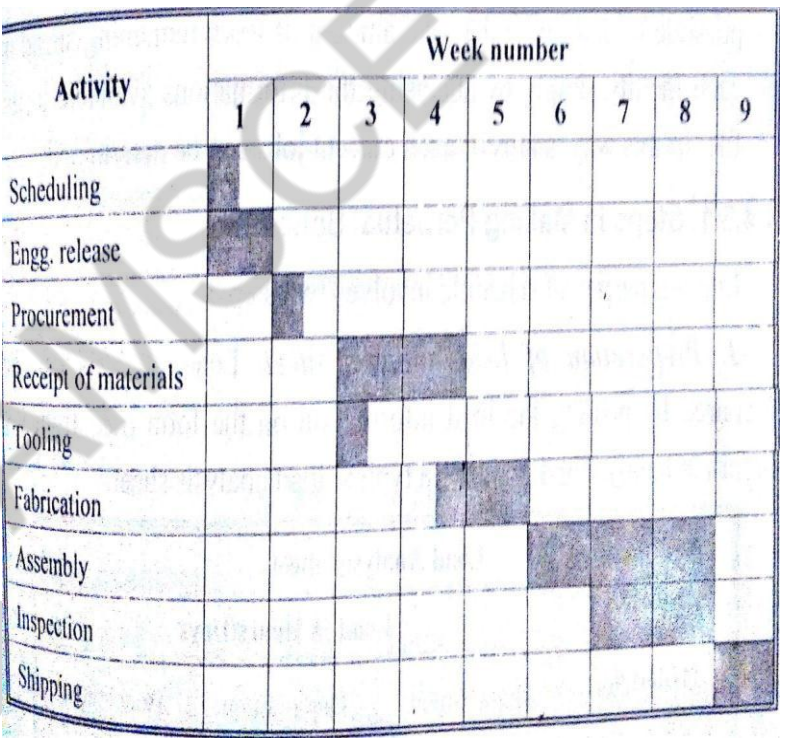
This chart clearly depicts the timing requirements for each job.

This visual allocation of jobs provides managers with a quick and easy way of determining the total workload assigned to each machine .The space between jobs is idle time.

Gantt chart can dynamically adapt scheduling requirement changes as they occur in the operations management system. For example, we can see that most of the machines assignable time in the first two weeks is completely scheduled. After the second week, machine are idle for periods of time. These idle can be filled with other unplanned jobs while managers and workers plan their schedules around the known job requirements.

Gantt scheduling chart

A gantt scheduling chart is used to track the progress of jobs as they pass through departments in an organization. They vertical axis of these charts usually lists the department in the sequence that job flow through them and the horizontial axis represents time. A typical Gantt scheduling chart is shown



As we can see from , a job cannot be started in the next department until it is finished in the previous department.

Thus this chart makes it quite easy to see the time required for and the current status of each job.

Industrial engineers should always try to minimize the unasigned periods to make the best use of existing capacity and improve efficiency in general

6. **Discuss the following i) Flow Production Schedule ii) Periodic Batch control iii) Kanban (Nov/Dec 2018)**

i) Flow production scheduling

A set of multiple-operation jobs is available for processing at time zero (Each job require m operations and each operation requires a different machine).

2. Set-up times for the operations are sequence independent, and are included in processing times.

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The main difference of the flow shop scheduling from the basic single machine scheduling is that the inserted idle time may be advantageous in flow shop scheduling. Though the current machine is free, if the job from the previous machine is not released to the current machine we cannot start processing on that job. So, the current machine has to be idle for some time. Hence, inserted idle time on some machine would lead to optimality

ii) Periodic batch control

The Period Batch Control (PBC) system, a production planning system that has strongly been advocated for application within cellular manufacturing. It is said to be a simple and effective instrument in obtaining the benefits of group technology.

Period Batch Control is a cyclical planning system that co-ordinates the various stages of transformation that are required in order to fulfil the demand of the customers. Effective coordination of the supply chain should make it possible to avoid or reduce decoupling stocks or other types of inefficiencies between successive transformation processes.

PBC differs from other planning systems in the way it accomplishes this co-ordination, and more specifically, in the three principles it applies in configuring the planning system:

1. **Single cycle ordering** refers to the frequency of releasing work orders:

Each part has the same ordering frequency as its parent product

2. **Single phase** refers to the release moment of work orders:

Work orders are released to the production system at the same moment (defined as the start of a period)

3. **Single offset time** refers to the lead time of work orders (per stage):

All work orders have identical lead times

iii) Kanban

Scheduling activities are highly dependent upon the types of production system and the volume of output delivered by the system

The characteristic of scheduling system are summarized and presented

Type of production system	Job shop	Batch production	Flow(continuous) production
Key characteristics	• General – purpose equipment • Unique sequence for each job	• Mixture of equipment • Similar sequence for each batch	• Specialized equipment • Same sequence of operations
Design concerns	• Worker-machines balance	• Line and worker-machine balance	• Line balancing • Charge over

Type of production system	**Job shop**	**Batch production**	**Flow(continuous) production**

Operational concerns	• Job sequencing • Work-center loading • Workflow and work in process	• Material and equipment problems • Setup costs and run lengths • Inventory accumulation (run out times)	• Material shortages • Equipment breakdowns • Quality problem • Product mix volume

7. What is perpetual loading? Describe. (A/M'15) (Nov/Dec 2018)

In this method, a copy of every order is placed in an open file which moves with the job going to different facilities. The copy of the order remains in the file until the job is completed . During the processing, the progress is reported with the help of tickets such as inspection ticket, material requisition ticket, rework ticket, move ticket,etc.

In this file the work order specifies both the facilities used to do each operation and the estimated time for the operation. Thus it is possible to determine the total amount of work remaining a head of each facility simply by analyzing the information available in the file.In this way status of each current jobs can be determined

Making perpetual schedule involves two steps:

1.Preparation of load sheet . Load analysis can be prepared by posting the load information on the form from the orders in hand .

Order No.	Load in Hours/Days		
	Department A	Department B	Department C
AB 12	35	20	26
CJ 48	20	25	20
ML 52	20	30	10
CK 44	18	35	-

Advantages

(i) It is very simple and understandable.

(ii) It can be maintained by even clerical staff, who are trained to analyse the work order file.

(iii) It requires less overall cost.

(iv) These charts can be used for various type of work.

Disadvantage

The complete information is available in gross, and thus it can sometimes mislead. The reason is that this chart indicates that a particular department has a four week a head load, but it does not indicate when the work will occur. It may be very likely that a particular department is idle currently because the load show in the chart ,may occur after several weeks.

8. Discuss periodic batch control.

The Period Batch Control (PBC) system, a production planning system that has strongly been advocated for application within cellular manufacturing. It is said to be a simple and effective instrument in obtaining the benefits of group technology.

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Work orders are released to the production system at the same moment (defined as the start of a period)

6. **Single offset time** refers to the lead time of work orders (per stage):

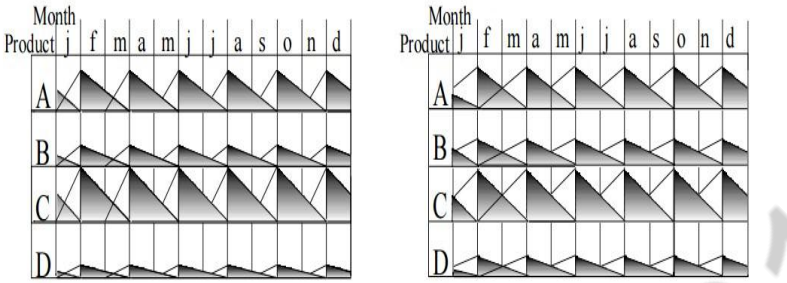
All work orders have identical lead times

The combination of principles 2 and 3 leads to work orders in the production system having all both identical release dates and identical due dates. The time available for completion of a work order, the offset time, is equal to the period length P or a multiple of P. The length of P is therefore an important design parameter of the PBC system.

We may still face the situation that the cycle length of products vary, even if we apply both principle 2 and 3. We define the unicycle PBC system (a term introduced by New, 1977) as a PBC system that uses the same cycle and same phase for all products and parts. Figure 3.1a shows such a system. All products A, B, C, and D use different order sizes. If an order is produced, the inventory curve starts to increase. If no production occurs, inventory decreases. A cycle is depicted as a shaded area, i.e. it is the time between two deliveries. All products do also use the same phase, as they start producing at the same moment in time.

In a unicycle PBC system it is still possible, although not very useful, to apply a cycle length for release of work orders to the system that differs from the offset time. This may be the case if the offset time is either greater or smaller than the cycle time. Illustrates the situation of an offset time of one month and a cycle time of two months. The offset time is for each product only one month, as work orders are finished and the inventory curve starts decreasing after this month. Alternative with cycle times equal to the offset time. We will examine the latter system in detail and define it as follows:

The basic unicycle PBC system is a unicycle PBC system with a cycle time equal to the offset time. A unicycle PBC system uses the same cycle and same phase for al products and parts.



a: Single cycle, single phase, offset time<cycle time b: Single cycle, single phase, offset time=cycle time

Unicycle (a) and Basic Unicycle (b) PBC system

In order to obtain the required amount of an end product, often several transformation processes are involved in sequence. Subsets of work orders for these processes may be combined into a stage, which means that these work orders will be produced during the same period of time (when). A reason for such a subset may be that these orders are performed within one cell (where), or that input material is too costly. PBC releases work orders per stage, so a network of work orders has to be completed involving several periods of time.

We define N as the number of successive stages that are co-ordinated using PBC.

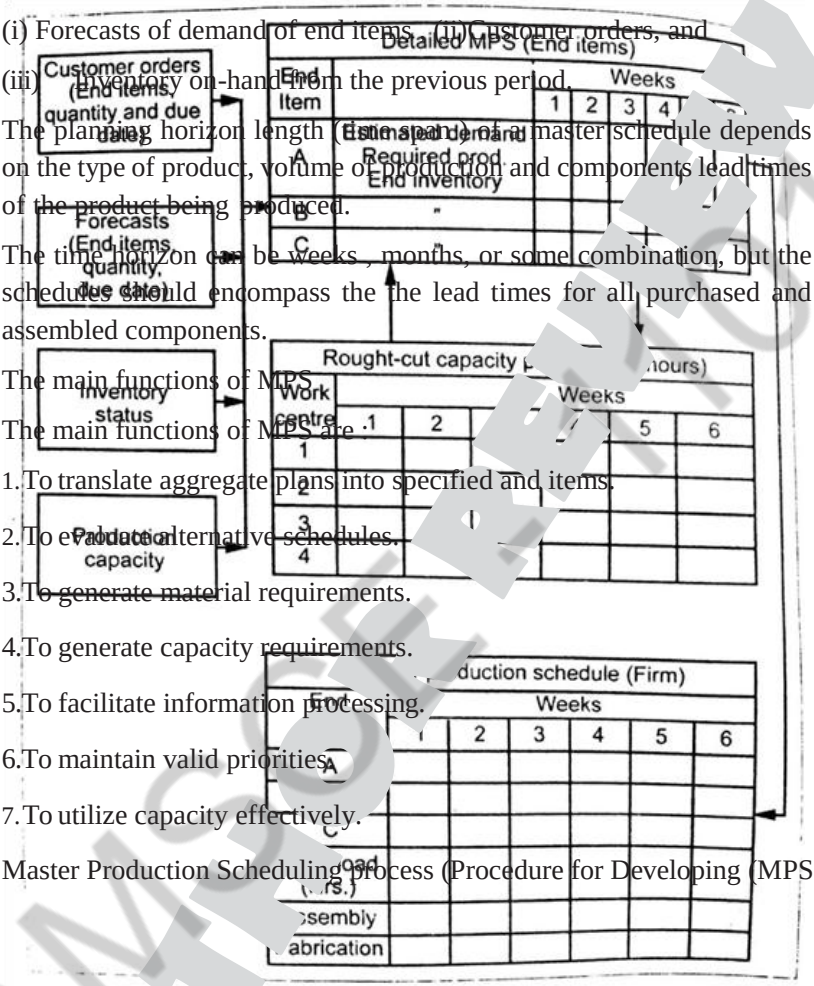
In a PBC system, the total throughput time T is determined by the product of the period length P and the number of stages N that have to be visited. If all products require processing according to this sequence of stages, they all have identical throughput time T=P·N. The basic scheme of a PBC system with four stages.

9. Discuss in detail the method of obtaining the master production scheduling for a system with examples suitable assumption can be made? (N/D'16) (Nov/Dec 2017) (Nov/Dec 2018)

Ans The master schedule, also known as master production schedule (MPS), formalizes the production plan and translates it into specific end –item requirements over a short to immediate planning horizon.

Then the end items are exploded into specific material and capacity requirements by the material requirement planning (MRP) and capacity requirements planning (CRP) systems.

Then the MPS essentially drives the entire production and inventory system. The major inputs to the master production schedule are:



(i) Forecasts of demand of end items, (ii) Customer orders, and

(iii) Inventory on-hand from the previous period.

The planning horizon length (time span) of a master schedule depends on the type of product, volume of production and components lead times of the product being produced.

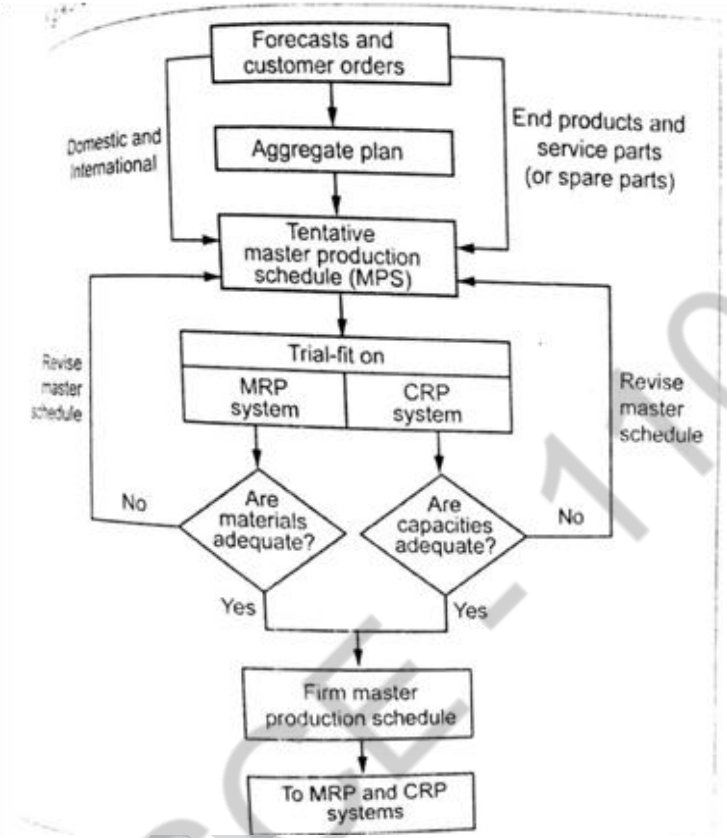
The time horizon can be weeks , months, or some combination, but the schedules should encompass the the lead times for all purchased and assembled components.

The main functions of MPS

The main functions of MPS are :

1. To translate aggregate plans into specified and items.
2. To evaluate alternative schedules.
3. To generate material requirements.
4. To generate capacity requirements.
5. To facilitate information processing.
6. To maintain valid priorities.
7. To utilize capacity effectively.

Master Production Scheduling process (Procedure for Developing (MPS)



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In these charts, the vertical axis usually lists different facilities used to

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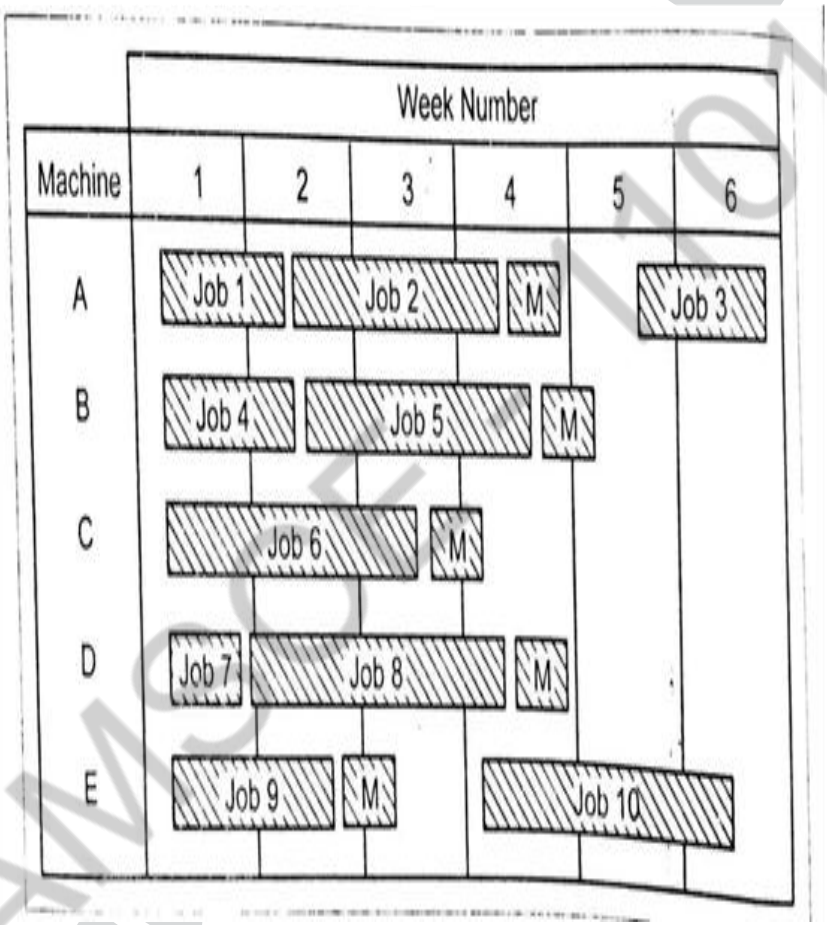

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are idle for periods of time. These idle can be filled with other unplanned jobs while managers and workers plan their schedules around the known job requirements.

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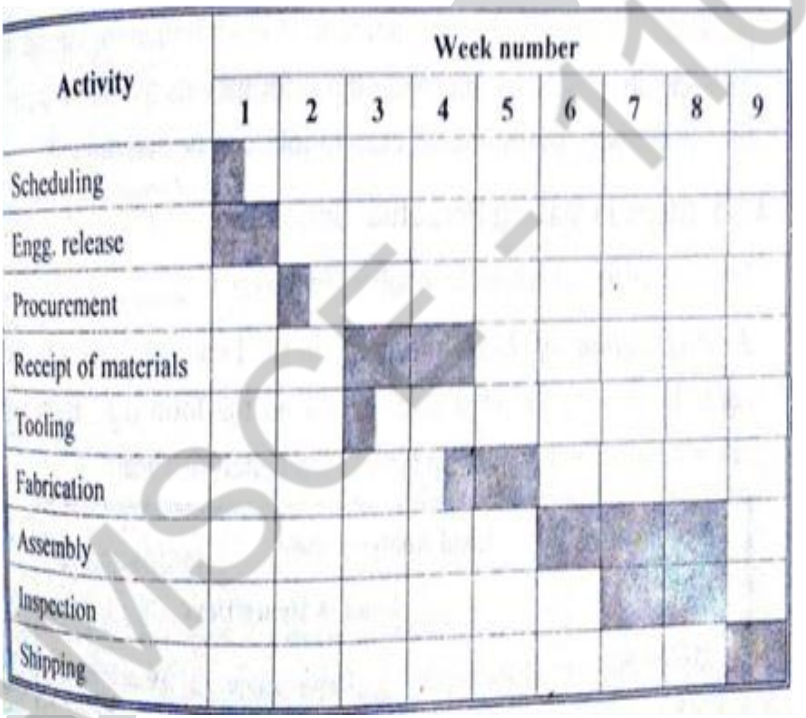


As we can see from , a job cannot be started in the next department until it is finished in the previous department.

Thus this chart makes it quite easy to see the time required for and the current status of each job.

10. Industrial engineers should always try to minimize the unasigned periods to make the best use of existing capacity and improve efficiency in general. Explain in detail the various components of MRP and their functions and objectives.

(N/D'16) (Apr/May 2017) (Nov/Dec 2017)

Material requirement planning (MRP)is a computational technique that converts the master schedule for final product into a detailed schedule for the raw materials and parts used in the final products.

The detailed schedule identifies the quantities of each raw materials and part item it also indicates when each item must be ordered and delivered so as to meet the master schedule for the final product.

In summary, MRP is a computers system for managing dependent- damand* inventory scheduling replenishment orders and meeting demand for end items as given in the master production schedule.

BASIC CHARACTERISTICS OF MRP

Two basic characteristics of MRP are:

1. MRP drives demand for computers subassemblies materials form demand for and production schedules of parent items.

2. MRP offsets replenishment orders (purchase orders or production schedulers) relative to the date when replenishment is needed.

INFORMATION NEEDED FOR MRP

The following information are needed for MRP (i) Demand fo

all product.

(ii) Lead times for all finished goods. Components parts and raw materials.

(iii) Lot sizing policies for all parts.

(iv) Opening inventory levels.

(v) Safety stock requirements.

(vi) Any orders previously placed but which haven't arrived yet.

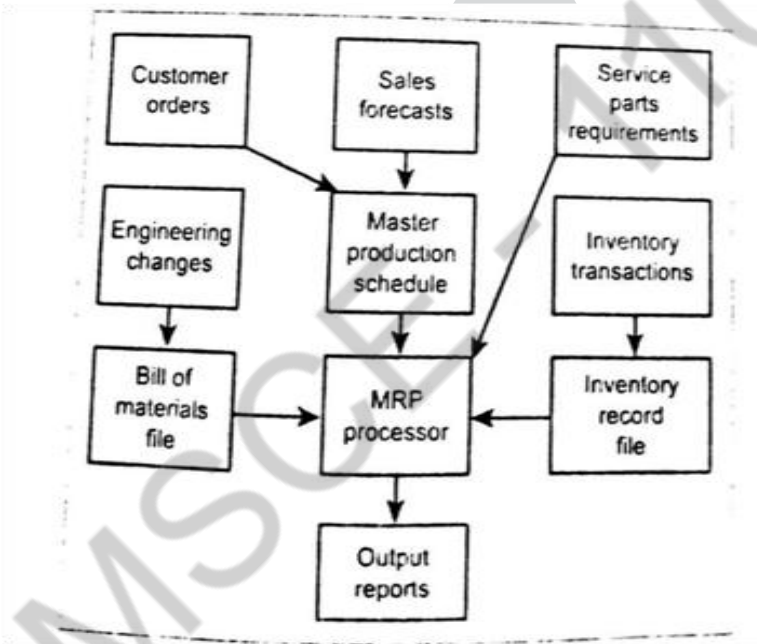
INPUTS TO MRP

The three important inputs to MRP are:

1. Master production schedule.
2. Bill of materials file, and
3. Inventory record file .

Depicts the structure of a MRP system, showing flow of data into the MRP

processor and conversion into useful output reports.



1. Masters production schedule (MPS)

What is MPS?

Master production schedule (MPS) is a detailed plan the sates how many end items the final products to be sold to the customer will be available for sale or distribution during specific periods.

PURPOSE OF THE MASTER PRODUCTION SCHEDULE:

The MPS in used

i) To set due dates for the availability of end items.

(ii) To provide information regarding resources and materials required to support the aggregate plan.

(iii) As an input to MRP, which will set specific production schedules for parts and components used in end items.

Inputs to MRP:

The MRP inputs are:

1. Market requirements,
2. Productions plan form aggregate planning,
3. Resources available.

MRP OUTPUT

The output of MRP is the list of end items available every period that is feasible with respect to demand and capacity.

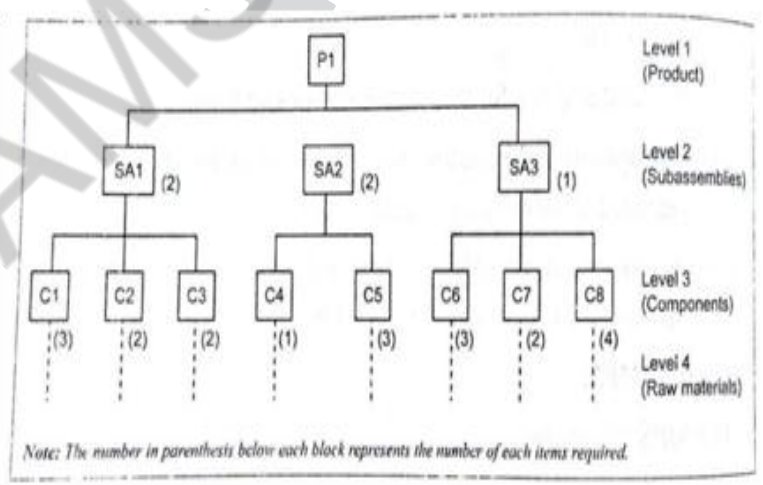
2. Bill of materials file

What is bill of materials file?

The bill of materials (BOM) designates what items and how many of each are used to make up a specified final product.

The bill of materials file is used to compute the raw material and component requirements for end products listed in the master schedule.

It provides information on the product structure by listing the component parts and subassemblies that make up each product.



PRODUCT STRUCTURE:

The structure of an assembled product, in the form of a pyramid, can be depicted as shown in fig

It can be seen from fig that the product P1 is the parent of subassemblies SA1,SA2 and SA3. Similarly SA1 is the parent of components C_1, C_2 and C_3 and so on.

INVENTORY RECORD FILE

All the data related to the inventory are recorded in the inventory record file. The inventory record file contains following three segments:

1. Item master data segment:

It provides the item identification by part number and other data, such as lead time, cost and quantity.

2. Inventory status data:

It provides a time-phased record of inventory status.

3. Subsidiary data segment :

It provides subsidiary data such as purchase orders, scrap or rejects and engineering changes.

The below Fig represents: Depicts the typical inventory record file showing the different types of data contained in the inventory record file.

<table>
<tr><td rowspan="5">ITEM MASTER DATA SEGMENT</td><td>PART NO</td><td>DESCRIPTIONS</td><td>LEAD TIME</td><td>STD.COST</td><td>SAFETY STOCK</td></tr>
<tr><td>ORDER QUANTITY</td><td>SETUP</td><td>CYCLE</td><td>LAST YEAR'S USAGE</td><td>CLASS</td></tr>
<tr><td colspan="2">SCRAP ALLOWANCES</td><td>CUTTING DATA</td><td colspan="2">POINTERS</td><td>ETC</td></tr>
<tr><td rowspan="6">INVENTORY STATUS SEGMENT</td><td colspan="2">ALLOCATED</td><td>CONTROL BALANCE</td><td colspan="2">PERIOD 1 2 3 4 5 6 7 8</td><td>TOTAL</td></tr>
<tr><td>GROSS REQUIREMENTS</td><td colspan="3"></td><td colspan="2"></td></tr>
<tr><td>SCHEDULED RECEIPTS</td><td colspan="3"></td><td colspan="2"></td></tr>
<tr><td>ON HAND</td><td colspan="3"></td><td colspan="2"></td></tr>
<tr><td>PLANNED ORDER RELEASES</td><td colspan="3"></td><td colspan="2"></td></tr>
<tr><td rowspan="2">SUBSIDIARY DATA SEGMENT</td><td>ORDER DETAILS</td><td colspan="5"></td></tr>
<tr><td>PENDING ACTION COUNTERS</td><td colspan="5"></td></tr>
</table>

RECORD OF AN INVENORY ITEM WORKING OF MRP

As discussed so far, the MPS provides a period–by-period list of final products required. The BOM defines what materials and components are needed for each product. Then the inventory record file contains information on the current and future inventory status of each component. By using these three inputs, the MRP processor computes the number of each component and raw material required for the final product. To better understand how MRP works, one can refer the following example.

Procedure steps

1.Since there is no on-hand inventory therefore gross and net requirements are same for products P1and P2 correspondingly

2. the delivery requirements for products P1 and P2 must be offset by the 1-week assembly lead time , for both products P1and P2 in the planned order release row

3. now let us move to subassemblies. For component C4 can be exploded. For C4 the manufacturing using the product structures SA2 and SA3 can be calculated (ex for SA2:50=100nfor SA3:70 and soon) now the rows of net requirements

As discussed in the step 4 the component C4 ccan be exploded for C4 the manufacturing lead time is 2 weeks so offset the net requirements value by two weeks to obtain the planned order release

In the similar way the raw material M4 can be exploded

MRP outputs reports

1. Order release notice to place orders that have been planned by the

MRP system

2. Report of planned order release in future periods

3. Rescheduling notices to indicate the changes in due dates for open orders

4. Cancellation notices to indicate the cancellation of open orders because of changes in the master schedule

5. Reports on inventory status

Secondary outputs include

Performance reports of various types to indicate costs item usage Exception reports to show deviations from schedule orders that are overdue scarp and

soon

Inventory forecasts to indicate the projected inventory levels in future periods

11. **A scheduler has four jobs that can be done on any of four machines with respective times (minutes) as shown in table below.Determine the allocation of jobs to machines that will result in minimum time.**

Job	Machine			
	1	2	3	4
A	5	6	8	7
B	10	12	11	7
C	10	8	13	6
D	8	7	4	3

Solution: The step by step procedure of obtaining optimum assignment is given below.

Step 1. Row subtraction

	1	2	3	4
A	0	1	3	2
B	3	5	4	0
C	4	2	7	9
D	5	4	1	0

step 2. Column substraction

	1	2	3	4
A	0	0	2	2
B	3	4	3	0
C	4	1	6	0
D	5	3	6	0

step 3. Cover all zeros

	1	2	3	4
A	0	0	2	2
B	3	4	3	0
C	4	1	6	0
D	5	3	0	0

step 4. Modify matrix

	1	2	3	4
A	0	0	2	3
B	2	3	2	0
C	3	0	5	0
D	5	3	0	1

step 5. Cover all zeros

	1	2	3	4
A	0	0	2	3
B	2	3	2	0
C	3	0	5	0
D	5	3	0	

Optimum assignments:

Job A to machine 1 at 5 min.

Job B to machine 4 at 7 min.

Job C to machine 2 at 8 min.

Job D to machine 3 at 4 min.

Total minimal flow time =5+7+8+4=24min.

12. What is progressing? Explain its function. Also write short notes about 'Recording progress' (Nov/Dec-2018)

4.11. EXPEDITING (OR PROGRESSING)

4.11.1. What is it?

- ✓ ***Expediting,*** *also known as* ***follow-up or progressing,*** *is a control function that keeps track of the 'progress' of work in accordance with planned schedule.*
- ✓ *While dispatching initiates the execution of production plans, expediting maintains the production flow according to plan till the job is completed.*
- ✓ This follow-up is to be done at every stage in production cycle, *i.e.*, follow-up of materials, follow-up of work-in-process, and follow-up of assembly.

4.11.2. Functions of Expediting

The various activities/functions/duties of expediting include:

(*i*) Status reporting;

(*ii*) attending to bottlenecks or hold-ups in production and removing the same;

(*iii*) controlling variations or deviations from planned performance levels;

(*iv*) following up and monitoring progress at work through all stages of production;

(*v*) co-ordinating with purchase, stores, tool room and maintenance departments; and

(*vi*) modifying the production plans and replan if necessary.

4.11.4. Recording Progress

As discussed above, though there are many recording tools available, the most widely used progress recording methods are:

1. Gantt charts. ✓ Gantt charts are used to provide an immediate comparison between schedule and reality.

- ✓ This is achieved simply by marking on the schedule the actual progress of the work.
- ✓ The uses and types of Gantt charts are already presented in Section 4.4.2.

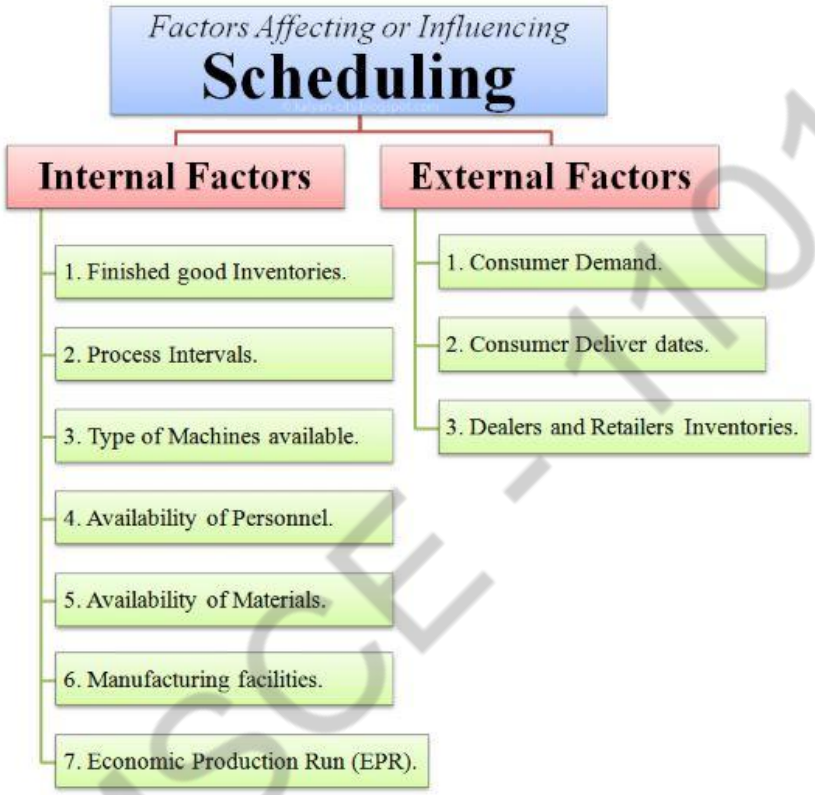
2. Visual charts. ✓ Visual charts are nothing but variations of the Gantt chart, for example, a visual control chart using a pinboard.

- ✓ These charts present a current picture of the situation but leave no record of past events.
- ✓ Visual charts often make use of coloured bars, strings, moveable rulers, meters with numbers, *etc.*

3. Cumulative and weekly charts

- ✓ The cumulative chart shows how much we have managed to produce so far. The weekly output charts depict the weekly fluctuations in production.
- ✓ The objective chart, line-of-balance chart, and progress chart are already presented in Section 4.8.4.

13. Discuss in detail about the various factors that affect scheduling. (Apr/May 2019)



The factors that affect scheduling are grouped into two categories viz;

Internal factors : Affect an entity (e.g. a company) from within.
External factors : Influence an entity (e.g. an organisation) from outside.

Factors affecting scheduling internally are:

- ✓ Stock of finished goods kept by company.
- ✓ Process intervals of each product.
- ✓ Type of machines available.
- ✓ Availability of personnel.
- ✓ Availability of materials.
- ✓ Manufacturing facilities available in the company.

- ✓ Economic production runs (EPR) or optimum lot size.

Factors that affect scheduling externally are:

- ✓ Consumer demand.
- ✓ Consumer delivery dates.
- ✓ Inventories (stock of goods) with dealers and retailers.

Now let's discuss internal and external factors influencing scheduling.

Internal Factors Affecting Scheduling

Followings are the internal factors affecting scheduling:

1. **Finished goods inventories :**
   Scheduling depends on how much stock of finished goods is kept by the company. Most companies keep, one month's supply of each product, as stock. If the company's product is fast moving or slow moving, then scheduling will have to be changed.
2. **Process intervals :**
   It depends on the process intervals of each product. Process interval is the time required to produce a product. Different products have different process intervals. For example, the process interval of a car is more than that of a soap. Scheduling will be different for each process interval.
3. **Type of machines available :**
   It also affected by the type of machines available. If the company has old and outdated machines, the schedule must keep provisions for the breakdown of machines. Modern and computerized machines makes scheduling very easy.
4. **Availability of personnel :**
   Scheduling also depends on the availability of personnel. If the company has untrained and inexperienced employees, then they will take more time to produce a product. So, the schedule must keep provisions for this. A faster schedule will be required for trained and experienced employees.
5. **Availability of materials :**
   It is also affected by the availability of materials. If a regular supply of materials is available, then the company can do normal-scheduling. However, if the supply of materials is irregular, the schedule must be made flexible. That is, when the supply is good then the schedule will be fast and vice versa.
6. **Manufacturing facilities :**
   Scheduling depends on the manufacturing facilities available in the

company. This includes space for new machines, employees, etc. It also includes the availability and supply of electricity and water, which may be required for production. If all the required infrastructure is available, then the production schedule can be fast and vice versa.

7. Economic production run (EPR) :

It also depends on the economic production runs. Economic production runs (EPR) means the optimum lot size. That is, how many items must be produced in one lot in order to minimize the cost of production. If the company produces more or less than the optimum lot size, then the cost of production will increase. There are many formulas for calculating optimum lot size. Scheduling must be done only after calculating the optimum lot size.

External Factors Affecting Scheduling

The external factors affecting scheduling are as follows:

1. Consumer demand :

Scheduling also depends on the consumer demand. Consumer demand can be found out by sales forecast. So, the production schedule is prepared according to the sales forecast. However, it has to be adjusted (changed) when the actual demand is different from the sales forecast.

2. Consumer delivery dates :

The production schedule also depends on the consumer delivery dates. The consumer is the most important person in a business. So, this factor must be given more importance than other factors. The production schedule must be made in such a way that it will guarantee timely delivery to the consumers. In case of seasonal goods, production must be spread out throughout the year; so, there will not be too much pressure in demand season.

1. Dealers and retailers inventories :

It also depends on the stock of goods (inventories) with dealers and retailers. The production manager must find out how much stocks is held by dealers and retailers. He must also know why they are keeping this stock. Are they keeping this stock to meet current demand? If yes, then normal-scheduling can be done. However, if they are keeping stock in anticipation of future demand, the scheduling will have to be slowed down because there will be fewer orders in the future.

14. The table below gives the data on current inventory, production lot sizes, standards hours per unit and the forecast of demand for all items required for a product. Determine the sequence of production (i.e., production) using the aggregate run-out (AROT) method. The available production capacity is 320 hours. Also anal- yse the effect of capacity on the schedule.

Item	Standard hours Per unit	Lot size	Forecast demand /week	Current inventory	Machine hour per order
A	0.20	200	70	200	40
B	0.40	300	100	240	120
C	0.30	200	80	260	60
D	0.40	400	120	160	160
					380

Solution:

Step 1. Calculate AROT as shown in the table below:

Table :AROT determination

Item	Standard hours per unit	Forecast demand per unit	Machine hours for the forecast demand	Current inventory	Machine hours inventory
A	0.20	70	$70 \times 0.2 = 14$	200	$0.20 \times 200 = 40$
B	0.40	100	$100 \times 0.4 = 40$	240	$0.40 \times 240 = 96$
C	0.30	80	$80 \times 0.3 = 24$	260	$0.30 \times 260 = 78$
D	0.40	120	$120 \times 0.4 = 48$	160	$0.40 \times 160 = 64$
Total =126 hrs.					Total =278 hrs.

$$\text{AROT} = \frac{278 + 320}{126} = 4.746$$

Step 2. Calculation of schedule requirements is shown below in the table.

Gross requirements=Forecast demand per week AROT

Net requirements = Gross requirements-Current inventory

Table: Schedule requirements

Item	Standard hours per unit	Forecast demand per week	AROT	Gross inventory	Current Net inventory	requirements
A	0.20	70	4.746	4.746× 70 = 332	200	332-200=132
B	0.40	100	4.746	4.746×100 = 474	240	474-240=234
C	0.30	80	4.746	4.746×80 = 380	260	380-260=120
D	0.40	120	4.746	4.746×120 = 570	160	570-160=410

Step:3 Calculations of capacity requirements is shown in the table below:

Table:Calculations of capacity requirements

Scheduled sequence	Standard hours/unit	Lot size required	Machine hours required	Remaining capacity
A	0.20	132	0.2×132=26.40	320-26.4=293.60
B	0.40	234	0.40×234=93.60	293.60-93.60=200
C	0.30	120	0.3×120 = 36.00	200-36=164
D	0.40	410	0.4×410=164.0	164.0-164.0=nill

15. Sequence the following jobs to minimize the processing times on the two machines. Also compute the idle times of the machines.

Job:	1	2	3	4	5	6
Machine 1:	5	9	4	7	8	6
Machine 2:	7	4	8	3	9	5

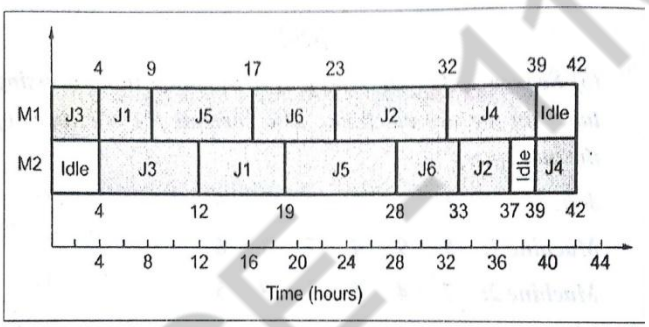
Solution: This sequencing problem can be solved using Johnson's rule, given in section 4.6.3 in our text. The sequence of jobs can be obtained as below

					J4
				J2	J4
J3				J2	J4
J3	J1			J2	J4
J3	J1		J6	J2	J4
J3	J1	J5	J6	J2	J4

Machine 1 **Machine 2**

Optimal sequence of job is .

The final schedule for the above job sequence can be drawn as shown below.



From the above figure, we can write

Total elapsed time = 42 time units

Idle time for M1 = 3 time units

Idle time for M2 = 4+2 = 6 time units.

16. Explain the various charts used in LOB (Apr/May 2018)

4.8.4. Various Charts Used in LOB

In fact, the application of LOB technique requires the following four charts:

1. Operation programme chart/or assembly chart,
2. Objective chart,
3. Progress chart, and
4. Line of balance chart.

1. Operation programme chart

- ✓ ***Operation programme chart,*** also known as ***program plan*** or ***production lead time chart*** or ***assembly chart,*** *is a chart that shows the lead time for each operation stage/processing step.*
- ✓ It shows the operations and time requirements in completing one unit of the end product.
- ✓ This network like event-oriented charts indicate:
  - Latest start time of any operation.
  - Date by which it must be completed.
  - Amount of lead time by which each event must precede to final completion.
- ✓ ***Illustration:*** Fig.4.12 illustrates a typical operation programme chart for an assembly consisting of two items A and B.

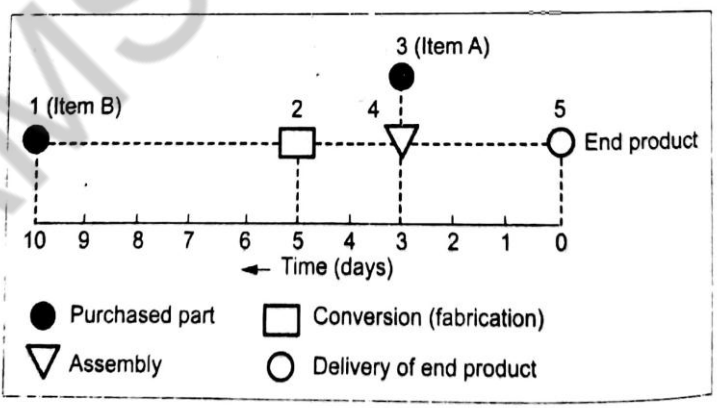


Fig. 4.12. Operation programme chart

From Fig.4.12, the following points may be noted:

- The delivery lead time for the end item is zero.

- The time scale indicates the lead time[†] and it runs from right to left.
- The purchased part A must be combined with the item B in operation stage (*i.e.*, processing step 4), three days before the completion of end item.
- Prior to combination, item B has to undergo a conversion operation (*i.e.*, processing step 2), which has to be completed five days before the completion of end item.
- The purchased part item B must be available 10 days prior to the delivery date for the end item.

2. Objective Chart

✓ *The objective chart shows the contrast between expected completion schedule of production and the actual performance.*

✓ The objective chart shows:

(*i*) the difference between the scheduled and actual deliveries. and

(*ii*) the time lag between the scheduled and actual deliveries.

Illustration: Table 4.3 gives the planned schedule of end items to be shipped in various weeks.

Table 4.3.

Week No.	Number of items to be shipped	Cumulative deliveries
1	5	5
2	10	15
3	10	25
4	10	35
5	5	50

[†] The meaning of lead time, here, is the length of time prior to the completion of the final operation/processing step by which intermediate operations must be completed.

For the above delivery schedule, the objective chart may be developed as shown in Fig.4.13.

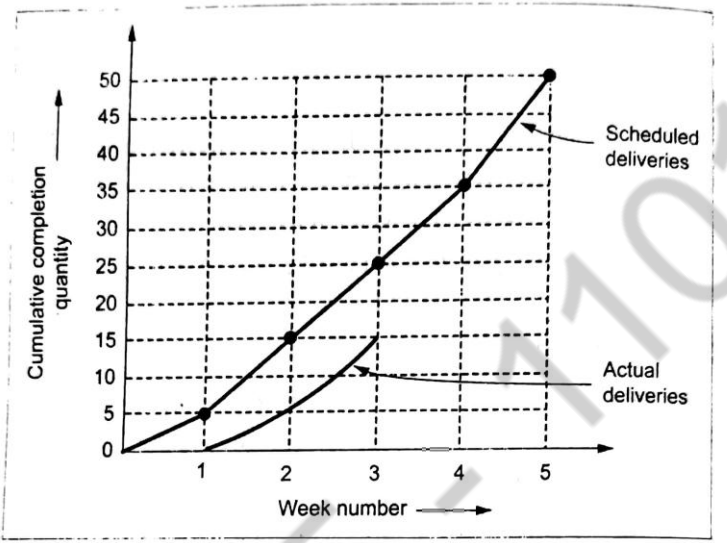


Fig. 4.13. Objective chart

From Fig.4.13, the following points may be noted:

- The schedule of actual deliveries is drawn on the same objective chart as the contract schedule.
- In the chart, the vertical distance between the lines shows the difference between the scheduled and actual deliveries; the horizontal distance shows the time lag between the scheduled and actual deliveries; and the relative slopes of the two lines show whether they are tending to separate or to converge.

3. Line-of-Balance Chart

✓ *The line-of-balance chart shows the quantity of item that should have been completed at each operation stage in a particular time at which, progress will be reviewed so as to meet the delivery schedule for the finished product and to meet the completion schedule quantities cumulatively.*

Illustration: Let us develop a LOB chart on the 2nd week for the product having the operation program shown in Fig.4.12 and the delivery schedule shown in Table 4.3.

The LOB chart can be constructed graphically for the given problem as shown in Fig.4.14(*b*).

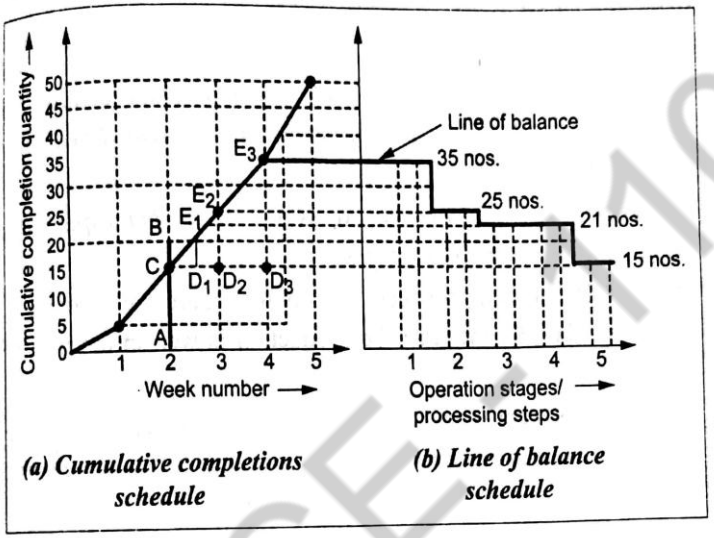


Fig. 4.14.

Construction procedure

Step 1. First draw the cumulative completion schedule graph, as shown in Fig.4.14(*a*).

Step 2. Draw a vertical line AB on the cumulative completion schedule graph at the week at which the review is to take place (in this case, 2nd week).

Step 3. Draw the line of balance schedule on the right hand side of the cumulative completion schedule graph [Fig.4.14(*b*)]. Show by means of vertical bars, the 5 operation stages on the LOB schedule and indicate the quantities of the item that should have been passed through the operation stages (*i.e.*, processing steps 1 to 5), by means of height of the vertical bars for each operation stage.

Step 4. For each of the other operation stages (*i.e.*, processing steps 1 to 4). find out how many have been completed at the end of week no.2.

Step 5. Draw the line-of-balance (a stair-case step like line) by joining the tops of the vertical bars for each operation chart.

4. Progress Chart

- ✓ *The progress chart is a bar type chart which shows the actual number of items produced at each operation stage against the quantities that should have been produced as indicated by line of balance (in the LOB chart).*
- ✓ *This chart clearly indicates the excess or shortage in the quantities of the item at the operation stages.*
- ✓ If the LOB line is higher than the progress chart, the schedule is taken as delayed, otherwise the production is well in advance of plan.
- ✓ Thus management can take corrective action based on the information from LOB chart for those components that lagging and causing production to fall behind of schedule.

Illustration: Fig.4.15 illustrates the programme progress chart for the review week (week no.2, as a continuation of previous illustration).

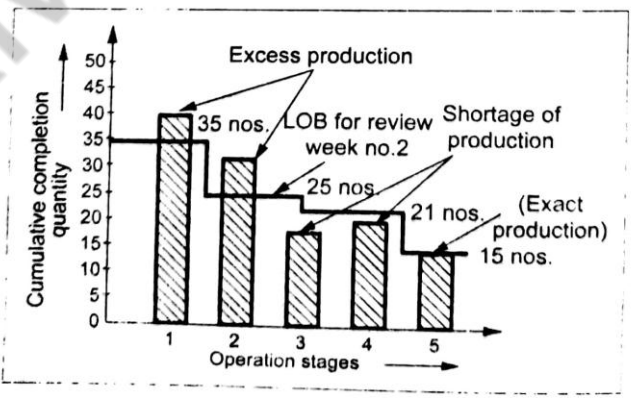


Fig. 4.15. Programme progress chart

17. Discuss the concepts, inputs, characteristics, working, outputs and benefits of MRP.

Refer Question Bank page 125, Question No.10

18. Explain the procedure for developing master production schedule

Refer Question Bank page 117, Question No.7

19. Explain the procedure by which scheduling 2 jobs in m machines can be done with suitable example.

Refer Question Bank page 130, question No.11

20. What is Gantt charts? Explain its types and mention the significance for each

Refer Question Bank page 113, question No.5

21. What is perpetual scheduling? Explain the steps in making perpetual schedule.

Refer Question Bank page 120, question No.9

UNIT –V

1. List the different types of inventories a manufacturing organization keeps. (Apr/May 2017)

A. Classification base on material flow:

1. Raw materials inventories.
2. Brought out parts inventories.
3. Work-in-process inventories.
4. Finished goods inventories.
5. MRO inventories.

B. Classification based on nature of use:

1. Anticipation inventories.
2. Fluctuation inventories.
3. Lot size inventories.
4. Transportation inventories.

2. What is meant by EOQ & JIT (Apr/May 2017)

EOQ is the acronym for **economic order quantity**. The **economic order quantity** is the optimum quantity of goods to be purchased at one time in order to minimize the annual total costs of ordering and carrying or holding items in inventory. **EOQ** is also referred to as the optimum lot size.

Just-in-time (**JIT**) manufacturing, also known as **just-in-time** production or the Toyota Production System (TPS), is a methodology aimed primarily at reducing flow times within production system as well as response times from suppliers and to customers.

3. Mention basic elements of Just-In-Time manufacturing.

A. Technology management

1. Structured flow manufacturing
2. Small lot production

3. Setup reduction

4. Fitness for use

B. People management.

5. Total employee involvement

6. Control through visibility

7. Housekeeping

8. Total quality focus.

C. System management

9. Level load and balanced flow

10. Preventive maintenance

11. Supplier partnerships

12. Pull Systems

4. List the advantages of two bin systems.

Benefits of two bin system1. No Repacking in the Line2. Materials fed directly to point of use3. No Paper / Plastic / Card board waste in Shop Floor4. Operator focuses on Process5. Visual Trigger for Material Feeder6. No communication gaps. 100% Material Available, ready to use.

5. **What is MRP-II?**

Manufacturing resource planning (MRP II) is defined as a method for the effective planning of all resources of a manufacturing company. Ideally, it addresses operational planning in units, financial planning, and has a simulation capability to answer "what-if" questions and extension of closed-loop MRP.

optimality.

6. distinguish between P and Q systems of inventory

S. No.	Feature	Fixed-order quantity (Q) model	Fixed-time period (P) model
1.	Order quantity	Order quantity is constant for all orders	Order quantity varies each time order is placed

S. No.	Feature	Fixed-order quantity (Q) model	Fixed-time period (P) model
2.	When to place order	Order is placed when inventory position drops to the reorder level R	Order is placed when the review period T arrives
3.	Size of inventory	Less than P model	Larger than Q model
4.	Record keeping	Records must be updated every time a withdrawal or addition is made	Counting takes place only at the review period

7. **what is ERP? (Nov/Dec 2017)**

Enterprise resource planning (ERP) is a new system concept in which every enterprise function is integrated in a seamless flow of information. This system integrates all facets of business including sales and order entry, engineering , manufacturing, finance and accounting ,distribution , order planning and execution and the supply chain flows

8. **Brief about two bin system.**

Inventory of any item is placed in bins. When an order is placed, bin 2 is depleted. When replenishment order level is received, the bin 1 is filled with reorder point level and the remainder is placed in bin 2.

9. What are the objectives of inventory control? (Apr/May 2019)

i) To ensure continuous supply of materials so that production should not suffer at any line.
ii) To maintain the over all investment in inventory at the lowest level, consistent with operating requirements.
iii) To minimize holding, replacement and shortage cost of inventories and maximize the efficiency in production and distribution
iv) To keep inactive, waste, surplus and obsolete items at the minimum level.

10.What is Manufacturing resource planning? (Apr/May 2019)

Manufacturing resource planning (MRP II) is defined as a method for the effective planning of all resources of a manufacturing company. Ideally, it addresses operational planning in units, financial planning, and has a simulation capability to answer "what-if" questions and extension of closed-loop MRP.

11. **what is ABC analysis**

The ABC classification system is a widely used method of categorizing inventories according to quantity and value. ABC analysis is based on the pareto principle that a few high usage value items constitute a major part of the capital invested in inventories whereas bulk of inventory items having low usage value constitute insignificant part of the capital.

12. **List out the various elements of JIT systems.**

1. Technology management,
2. People management,
3. Systems management

13, **Compare excess stock and stock out situations. (Apr/May 2018)**

Excess stock refers to storing of more raw materials, WIP and finished good than actually needed.

When the stock of an item is depleted and then is a demand for it, then the shortage cost will occur. In simple terms, shortage cost is the cost associated with stock –out

14. **State the advantages of ABC analysis. (Apr/May 2018)**

This approach helps the manager to exercise selective control and focus his attention only on a few items.

15. **What is order cycle? (Nov/Dec 2018)**

The time period between two successive orders is called order cycle.

16 . What are the functions of production planning and control?

a. Material function, b. Machines and equipment, c. Methods, d. Routing, e. Estimating f. Loading and scheduling, g. Dispatching, h. Expediting, i. Inspection.

17. Define – Durability

Durability refers to the length of the active life of the product under given working condition.

18. Define – Dependability

Dependability refers to the reliability with which the product serves its intended function.

19. Define –Standardization

Standardization is a process of defining and applying the conditions necessary to ensure that given range of requirements can normally be met with a minimum of variety and in a reproducible and economic manner on the basis of the best current techniques.

20. What are the objectives of Standardization?

i) Interchangeability of parts, components, etc. ii) Keeping the variety minimum. iii) Helps to achieve a better control due to reduced variety.

PART-B

1. **Derive the economic order quantity (EOQ) formula for purchase model without shortages. (Apr/May 2012)**

(OR)

How will you determine minimum cost batch size? (Apr/May 2018)

The total cost (TC) of stocking inventory is the sum of the cost of purchase , plus the cost of ordering ,plus the cost of carrying.

Let tc = Total annual cost,

D =Annual demand in units/year,

C=Cost per unit,

Q= Order quantity,

EQQ = Economic order quantity,

S=Setup cost or ordering cost per order(cost of placing an order),

H= Annual holding (or carrying) cost per unit of average inventory (in Rs/unit /unit time),

H=iC, when holding cost is given in terms of percentage of the cost of the time,

i-Percentage carrying cost, and

N=Number of orders per annum.

$$\text{Total annual ordering cost} = \left\{\quad\right\}\left\{\text{Annual ordering cost}\right\} + \text{Annual carrying cost} + \text{Annual purchase cost}$$

where Annual ordering cost

$$= \text{Annual demand} \times \frac{\text{Oerdering cost/order}}{\text{Ordering quanity}}$$

$$= \frac{D \quad S}{Q}$$

Annual carrying cost

$$= \text{Average inventory} \times \text{Inventory carrying cost}$$

$$= \frac{Q}{2} H$$

and Annual purchase cost

$$= \text{Annual demand} \times \text{Cost per unit}$$

$$= D.C$$

$$TC = \frac{D}{Q} S + \frac{Q}{2} H + D.C$$

To determine EQQ , Differentiate the above equation with respect to the order quantity Q .

The total cost is minimum at the EOQ where the slope of the curve is zero.

$$\frac{d(TC)}{dQ} = \left[\frac{}{} \right] -\frac{D.S}{Q^2} + H + 0 = 0$$

$$\boxed{Q_{opt} = EOQ = \sqrt{\frac{2\,D \cdot S}{H}}}$$

1. If the inventory carrying cost is expressed as a % of annual average inventory investment, then

$$EOQ = \sqrt{\frac{2D \cdot S}{iC}}$$

2. Optimal number of orders per year $= \frac{\text{Annual demand}}{\text{Economic order quanity}} = \frac{D}{EOQ}$

3. Optimal time interval between two orders $= \frac{\text{Number of working days in a year}}{\text{Optimal number of orders per year}}$

4. Minimum total year inventory cost $= \sqrt{2\,D \cdot S \cdot H}$

5. Determination of level of safety stock:

$$\text{Safety stock} = (\text{Maximum lead time} - \text{Normal lead time}) \times \text{Consumption rate}$$

2. Explain the two aspects of computer integrated manufacturing such as organizational part and operational part. (Apr/May 2012)

With the advances both in computer software and hardware certain manufacturing decisions presently are taken with help of computer in efficient manner. With suitable top management is generally able to get information of shop floor

Some of the common manufacturing subsystem that complete a PPC systems include

1.product-structure processor
2.materail requirement
3.product costing system
4. inventory management system
5. master production scheduling system
6. capacity planning system
7. shop floor and control monitoring system

1. Product-structure process

This subsystem includes data of an end product and its subsequent breakdowns, known as bill of material .a program reads the bill of materials files and interacts with the main production planning system as per the logic created in the system.Any change of specification of component or assembly can be incorporated in this model through an updating programming

Material requirement system

This subsystem performs periodical calculation for entire material plan updating of data can be incorporated from the inventory status file This module also schedules timing of planned order releases and generate reports of inventory status, receipt of purchased items lead time details

Distinguish between MRPI and MRPII

MRP-I	MRPII
Material requirements planning (MRP) is a computational technique that converts the maste schedule for final products into a detailed schedule for the raw materials and part used in the final products 1. master production schedule 2. bill of materials file , and 3. inventory record file	MRP-II as a computer based system for planning scheduling, and controlling the materials resources and supporting activities needed to meet the master production schedule In fact, MRPII consists of virtually all of the functions in the PPC system plus additional business functions that are related to production

3 A manufacturer has to supply his customers 3600 units of his product carrying per year. Shortages are not permitted. inventory carrying cost amounts RS.12 per unit per annum. The set up cost per run is RS.80 find (i) economic orders quantity, (ii) optimum number of orders per annum, (iii) average annual inventory cost, (iv) optimum period of supply per optimum order. (Apr/May

2014)

Given data: D=3600 units/years; H=i C =Rs.1.2 per unit per annum S=Rs= Rs.80.

(i) Economic order quantity (EOQ):

$$EOQ = \sqrt{\frac{2DS}{H}} \quad \sqrt{2 \times 3600 \times \frac{80}{1.2}}$$

$$= 692.82 \qquad \approx 693\ units$$

(ii) Optimal number of orders per year (N):

$$N = D/EOQ = 3600/693 = 5.19 \quad \approx 6$$

(iii) Average annual inventory cost:

$$= \sqrt{2.D.S.H}$$

$$= \sqrt{2 \times 3600 \times 80 \times 1.2}$$

= Rs.831.38

(iv) Optimal period of supply per optimum order:

$$EOQ/D = \frac{693}{3600} \times 12$$

=2.31 months= 69 days

4. Explain briefly the procedure for ABC analysis and list its merits and demerits (Apr/May 2014) (Apr/May 2017) (Nov/Dec 2017) (Nov/Dec 2018) (Apr/May 2019)

ABC analysis:

The ABC classification system is a widely used method of categorized inventories according to quantity and value

ABC analysis is based on the pareto principle that a few high usage value items constitute a major part of the capital invested in inventories whereas bulk of inventory items having low usage value constitute insignificant part of the capital.

In ABC analysis, the items are categorized into three groups A,B and C on the basis of their usage value ,

Category of items	Consumption value	Percentage of Items	Percentage of usage value
Class A	high	10 to 20%	70 to 80%
Class B	Medium	20 to 30%	15 to 20%
Class C	low	60 to 70%	5 to 10%

A typical ABC classification is depicted in fig 5.7 . the two points P and Q where the curve changes its shape , provides three segments A,B and C. from points P and Q and the tabulated data, the usage value classification points A,B and C may be fixed and generalized over the entire population of the stock items .

Procedure for the ABC analysis

Following steps may be used to make ABC analysis

Step1. Identify all the items being used, list them and estimate their annual consumption in units. It may be done for each category of item like raw materials, components spares etc

Step2. Collect cost data of individual items.

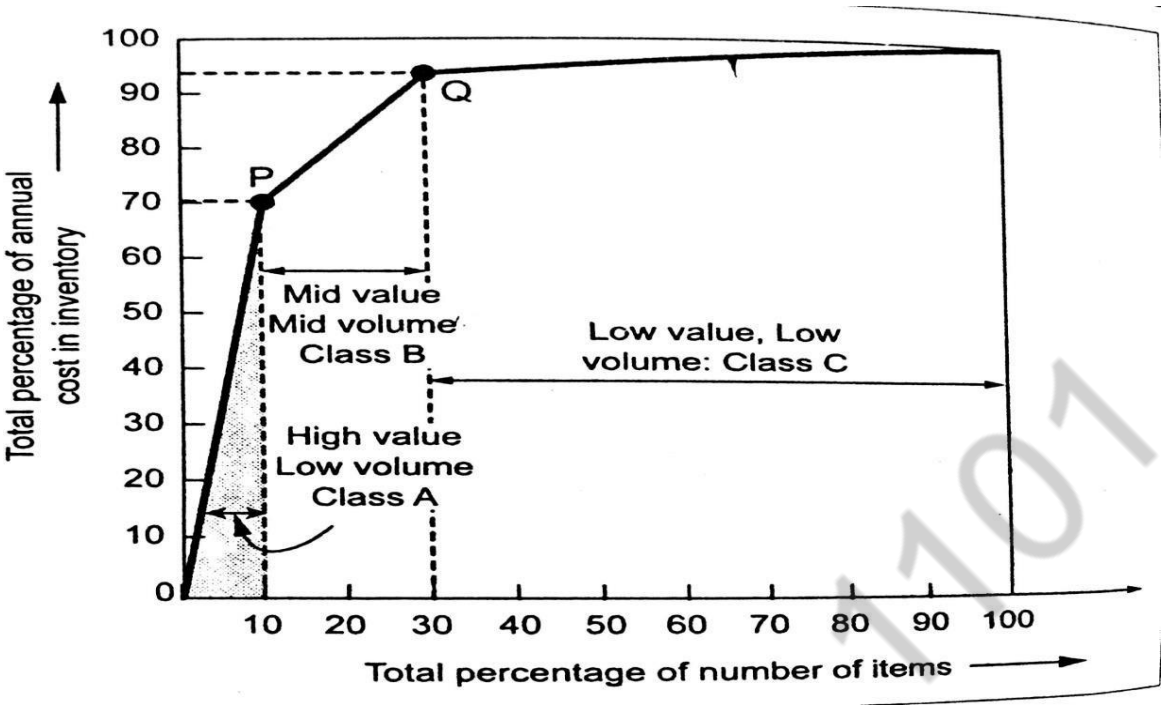
Step3 Find out annual usage/consumption in rupees for each item. It may be done by multiplying annual usage in units by unit price of the item .

Step4 Starting from highest annual usage value, arrange the items in descending order of annual consumption in value .

Step5 Calculate cumulative annual usage and express it in percentage of total annual usage . also express number of items into cumulative item percentages

Step6 Plot cumulative usage percentage against cumulative item percentage and segregate into A,B and C and category. It will be seen that for certain length the curve has a steep rise after that it flattens off. The two tangential lines where the curve changes its direction will determine the range of" A" B and 'C' category of items.

Characteristics of ABC systems.



Sl. No.	Factors	A-type inventory	B-type inventory	C-type inventory
1.	Quantity (% of items)	10 – 20%	20 – 30%	60 – 70%
2.	Value (% of Rs. value)	70 – 80%	15 – 20%	5 – 10%
3.	Degree of control	Tight	Moderate	Low
4.	Types of records	Complete and accurate	Complete and accurate	Simplified
5.	Safety stock	Low	Moderate	Large
6.	Ordering procedure	Careful, accurate; frequent reviews	Normal ordering; some expediting	Order periodically; 1- to 2-year supply
7.	Ordering frequency	Frequent	Moderate	Low
8.	Value analysis	Rigorous	Moderate	Minimum
9.	Forecasting and material planning	Accurate	Moderate	Rough
10.	Supervisor	Top management	Middle management	User department

Advantages of ABC analysis

This approach helps the material manager to exercise selective control and focus his attention only on a few items when he is confronted with many store items .

Industrial experience reveal that implementing ABC analysis results in reduced clerical

costs, saves time and effort ,results in better planning and control , and increased inventory Turn over

Limitations of ABC analysis

ABC analysis in order to be fully effective , should be carried out with standardisations and codification .

The result of ABC analysis have to be reviewed periodically and updated .

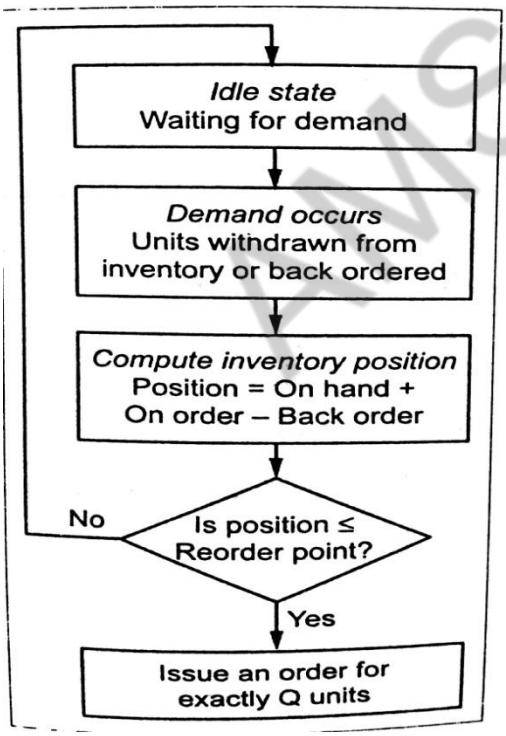
5. Explain ordering procedure (Nov/Dec 2014) (Nov/Dec 2017)

There are two types of inventory systems they are :

1. Fixed-order quantity models (Q models), and
2. Fixed time period answers to the questions (i) how much to order? And (ii) when to order ?

Fixed-order quantity models (Q models)

This model is also known as the economic order quantity (e00) model, Q model, re-order point inventory system , and perpetual inventory system.

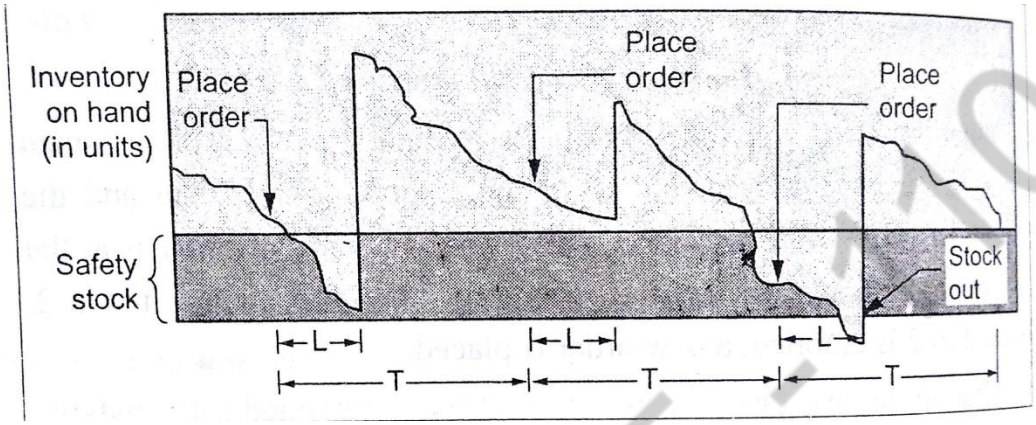


Fixed time period

The fixed –time period models are also reffered to as the periodic system ,periodic review system , fixed-order interval system, and p model

In a fixed period system revie of inventories are made and an order is anvariably placed in that period

In other words, p model has a fixed ordering interval, but the size of the order quantity may vary with the fluctuation in demand.



6. Determine the optimum order quantity of an inventory item with the following data. (Nov/Dec 2014)

Annual demand = 2800 units unit cost = Rs. 5 ordering cost = Rs.36/ order, carrying cost = 20% of unit cost

Order quantity	<500	500<=Q<1250	>=1250
Discount % on unit cost	Nil	4%	8%

Given data D =2800 units ; c= Rs 5/unit; S= Rs.36/order; i=20%

Order quantity	< 500	500≤ q< 1250	≥1250
Discount % on unit cost	Nil	4%	8%
Unit cost after discount	Rs.5	Rs.4.80(=5x	Rs.4. (=5x0.92)60

		0.96)	

Solution : the optimum order quantity Q_3* based on highest discount or lowest unit cost, c_3= Rs.4.60 is given by

$$Q_3^* = \sqrt{\frac{2\,D\,S}{i\,C_3}} = \sqrt{\frac{2 \times 2800 \times 36}{0.2 \times 4.60}} = 488 \text{ units}$$

Since $Q_3^* < b_1$ (= 500), therefore calculate Q_1^* based on C_1 = Rs.5 as below.

$$Q_1^* = \sqrt{\frac{2 \times 2800 \times 36}{0.2 \times 5}} = 449 \text{ units}$$

Also Q_1* < b_1 (=500), calculating and comparing total costs TC (b_1),TC (b_3) as follows:

$$TC = \frac{D}{Q} \times S + \frac{Q}{2} \times H + D \times C$$

$$TC\,(Q_1^* = 449) = \left[\frac{2800}{449} \times 36\right] + \left[\frac{449}{2} \times (0.2 \times 5)\right] + [2800 \times 5]$$

$$= \text{Rs.}14{,}449$$

$$TC\,(b_1 = 500) = \left[\frac{2800}{500} \times 36\right] + \left[\frac{500}{2} \times (0.2 \times 4.8)\right] + [2800 \times 4.8]$$

$$= \text{Rs.}13{,}881.60$$

$$TC\,(b_2 = 1250) = \left[\frac{2800}{1250} \times 36\right] + \left[\frac{1250}{2} \times (0.2 \times 4.6)\right] + [2800 \times 4.6]$$

$$= \text{Rs.}13{,}535.64$$

Since $TC\,(b_2) < TC\,(b_1) < T_1\,(Q_1^*)$, therefore the optimal order quantity is

$$EOQ = Q^* = b_2 = \mathbf{1250 \text{ units}}$$

7. Discuss any two elements of JIT systems. (Nov/Dec 2014)

JIT Objectives

- Give the customer the products they want, when and where they want them at the minimum cost

What does this mean?

I. Respond only to actual demand

What do we need to do this

- Rapid transmission of demand so that we know demand as soon as possible

- Fast, flexible production system so that we can respond quickly to changes in demand

II. Minimize Costs

- Minimize waste

- Increase quality

PUSH Versus PULL PRODUCTION SYSTEMS

push system: total demand is forecast, and the producer allocates ("pushes") items to users based on the expected needs of all users. Finished goods accumulate in inventory. - **Produce for Forecast**

pull system: each user requests ("pulls") items from the producer only as they are required. Units are only produced if there is demand for them. - **Produce For Demand**

- production is pulled through the supply chain in response to actual demand

- first seen in Just-In-Time systems in Japan

- current pull systems - JIT, Quick Response, Efficient Consumer Response, Continuous Replacement

Led by Toyota Motor Corporation, Just-In-Time Production systems were developed in Japan during the 1970's. The focus was on lowering production costs at a time when raw material prices were skyrocketing.

Primary goal - lower costs associated with meeting customer demand

Cost reduction by elimination of waste in manufacturing operations:

1. Excessive production resources.
2. Overproduction
3. Excessive inventory
4. Unnecessary capital investment

Secondary goal - Quality Improvement

1. Quality control
2. Quality assurance - each process supplies only good units
3. Respect for humanity

Examples of Waste

- Watching a machine run
- Waiting for parts
- Counting parts
- Overproduction
- Moving parts over long distances
- Storing inventory
- Looking for tools
- Machine breakdown
- Rework

These goals achieved using four key concepts

- JIT

- Autonomation - autonomous defects control supports JIT by preventing defects from disrupting production.
- Flexible workforce
- Creative thinking

JIT systems gradually reduce the amount of inventory in systems to reduce costs associated with carrying and handling inventory but also to reveal production problems in the system. Once problems are revealed they can be analyzed and the process or product improved to eliminate the inefficiencies.

KEY ELEMENTS OF JUST-IN-TIME SYSTEMS

- material flow system
- small lot sizes
- short setup times
- uniform Master Production Schedule
- standardization of components and work methods
- consistent, high quality
- close supplier ties
- flexible work force
- product focus
- preventative maintenance
- continuous improvement

Basic Elements of JIT

1. Flexible resources
2. Cellular layouts
3. Pull production system

4. Kanban production control
5. Small-lot production
6. Quick setups
7. Uniform production
8. Quality at the source
9. Total productive maintenance
10. Supplier networks

Flexible Resources

- Multifunctional workers
- General purpose machines
- Study operators & improve operations

Standard Operating Routine

Cellular Layouts

- Group dissimilar machines in manufacturing cell to produce family of parts
- Work flows in one direction through cell
- Cycle time adjusted by changing worker paths
- Cells operated byworker teams who are cross-trained

- Frequently light systems are used to indicate potential problems. A worker experiencing difficulty can turn on warning lights and others will assist.

KANBAN SYSTEMS ("SEQUENTIAL JUST-IN-TIME") (Apr/May 2019)

Kanban system:

- a pull system where the production or movement of the next batch of material is not started until the user signals a need for it
- the user comes to the producer to withdraw materials in the quantity needed at the time needed
- the producer produces only the exact quantity withdrawn by the user

Kanban is based on "visibility" and control of production - a unit is produced only if one has been called for by downstream (closer to the customer) operation. The signal can be made in any one of a number of ways.

- cards, authorizing workers to move or make an item
- containers, indicating need to start making an item
- flags, indicating need to start making an item
- squares painted on the floor, indicating need to start making an item
- computer screens authorizing production and displaying production directions

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Small-Lot Production

- Requires less space & capital investment
- Moves processes closer together
- Makes quality problems easier to detect
- Makes processes more dependent on each other

Inventory Hides Problems - Lower Levels Of Inventory To Expose Problems

Continuous Improvement - JIT systems gradually reduce the amount of inventory in the system

- reduce costs associated with carrying and handling
- expose production problems so that they can be addressed
- reduce the number of kanbans until the problem is exposed
- temporarily return inventory to former level
- correct the problem and start removing kanbans again

Reducing Setup Time

- Preset desired settings
- Use quick fasteners
- Use locator pins
- Prevent misalignments
- Eliminate tools
- Make movements easier

Uniform Production

Results from smoothing production requirements

Kanban systems can handle +/- 10% demand changes

Smooths demand across planning horizon

Mixed-model assembly steadies component production

Trends In Supplier Policies

1. Locate near to the customer
2. Use small, side loaded trucks and ship mixed loads

3. Consider establishing small warehouses near to the customer or consolidating warehouses with other suppliers

4. Use standardized containers and make deliveries according to a precise delivery schedule

5. Become a certified supplier and accept payment at regular intervals rather than upon delivery

Benefits Of JIT

1. Reduced inventory
2. Improved quality
3. Lower costs
4. Reduced space requirements
5. Shorter lead time
6. Increased productivity
7. Greater flexibility
8. Better relations with suppliers
9. Simplified scheduling and control activities
10. Increased capacity
11. Better use of human resources
12. More product variety

JIT Implementation

Use JIT to finely tune an operating system

Somewhat different in USA than Japan

JIT is still evolving

JIT isn't for everyone

JIT works best in growing company where improvements don't result in lost jobs - just different ones.

8. **Perform ABC analysis on the items given below and classify them based on ABC analysis (Nov/Dec 2014)**

Item	101	102	103	104	105	106	107	108	109	110
Annual consumption in units	200	100	2000	400	6000	1200	120	2000	1000	80
Unit cost in Rs.	40	360	0.20	20	0.04	0.8	100	0.70	1	400

Solution (i) The average value of item can be calculated by multiplying the annual consumption and corresponding price and rank the items in the descending order of the usage values.

Item	Annual consumption unit	Price/unit (Rs.)	Annual usage (Rs.)	Rank
(1)	(2)	(3)	(4)	(5)
101	200	40	8000	4
102	100	360	36000	1
103	2000	0.20	400	9
104	400	20	8000	5
105	6000	0.04	240	10
106	1200	0.8	960	8
107	120	100	12000	3
108	2000	0.70	1400	6
109	1000	1	1000	7
110	80	400	32000	2

(*ii*) Now cumulative annual usage and cumulative percentages are calculated, as shown in Table below.

Order of ranking	Item	Annual usage (in Rs.)	Cumulative annual wage	Cumulative usage percentage	% of item	Class
1	102	36000	36000	36	20% [(2/10) × 100]	A
2	110	32000	68000	68		
3	107	12000	80000	80	30% [(3/10) × 100]	B
4	101	8000	88000	88		
5	104	8000	96000	96		
6	108	1400	97400	97.4	50% [(5/12) × 100]	C
7	109	1000	98400	98.4		
8	106	960	99360	99.36		
9	103	400	99760	99.36		
10	105	240	100000	100		

(*iii*) The classification results are presented below.

Class	Item	% of annual value	% of items in class
A	102; 110	68	20
B	107; 101; 104	28	30
C	108; 109; 106; 103; 105	4	50

9. Discuss the effect of Demand on Inventories? (Apr/May 2015)

In orer to realize the dynamics and significane of inventory management, one has to understand the effect of demand fluctuations on the desirable level of stocks. This can be understood with the following illustraction.

Illustraction :

Let a manufacturing firm produces a product in four stages as below:

Stage 1 :Producing components from raw materials.

Stage 2: Producing minor assemblies from components

Stage3:Producing major assemblies from components and minor assemblies

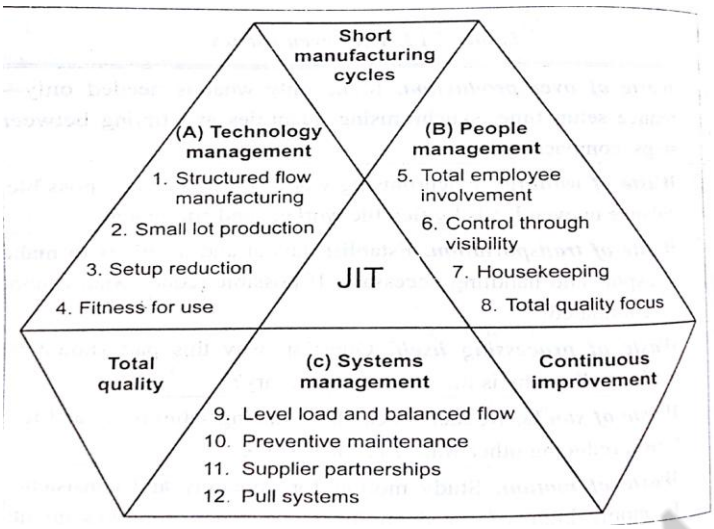
Stage 4: Assambling the final product.

Obviously, in this production system, the stores at all stages should hold inventory/stock of items, as well as stocks raw materials. Also safety stock at all stage should be held.

Stage	Demand per period	Policy I (20% safety stock)		Policy II (50% safety stock)	
		Safety stock	Total stock available at the end of 1st period	Safety stock	Total stock available at the end of 1st period
5. Finished products	1000	200	1200	500	1500
4. Major assemblies	1000	200	1200	500	1500
3. Minor assemblies	1000	200	1200	500	1500
2. Components	1000	200	1200	500	1500
1. Raw materials	1000	200	1200	500	1500

Say the demand for the final product is 1000 units per period Then the output at each stage should also be 1000 units per period and raw materials should also be ordered for 1000 units per period. Let us consider two policies: policy I calls for a safety stock of 20 % of the output per period, and policy II calls for safety stock of 50% of the output per unit.

10. Describe the elements of just in time system (Apr/May 2015) (Apr/May 2019)



1. Technology management
2. People management and
3. Systems management

Technology management

it calls attention to the production environment and emphasizes for a responsive manufacturing system

Structured flow manufacturing

the production facilities are arranged so that process flow is as streamlined as possible

in flow manufacturing the machines and work cells are organized and grouped to maximize the parts production rate and minimize the transportation and queue time for parts

Small-lot production

reduction lot sizes to the smallest quantity possible is supported by structured production and short setup times

the goal is a lot size of 1 or the smallest customer order

setup reduction setup time is the total time from the completion of the last piece of the previous production run to the first good part on the new production job

reduction in setup time increases capacity and production capability while reducing inventory

Fitness for use

fitness for use means that the product satisfied the customers requirements precisely

People management

it is critical for the continuous improvement objective in JIT this elements creates an environment in which all employees from the top management to lower level workers, have the responsibility and authority to suggest and implement improvements to the production systems

Total employee involvement

the continuous improvement –kaizen—recognizes that all employee are valuable resources for the solution of problems

JIT is built on the premise that everyone works on continue improvement corrective teams

Control through visibility

Control through visibility Uses simple visible means to communicate goals and identify problems

For example progress charts for work-center goals , control charts for tracking critical process variables and flashing lights to indicate a machine problem that needs immediate action

House keeping

House keeping focuses on the work centre or workstation with an emphasis on cleanliness ,simplification, discipline and organization to eliminate wasted time, motion and resources

Total quality focus

Total quality focus addresses broad quality issues from suppliers to customers at every element of the production chain

The emphasis is on the quality of the process at every function and work centre in the enterprise because the quality of the product is determined by the quality of the process

System management

It addresses the effective distribution and application of the limited enterprise resources

Level load and balanced flow

These two elements focus on effective utilization of manufacturing resources

The level load deals with scheduling products in roughly equal quanties for a given period such as a week or month

The balanced flow works toward a continuous flow of products through manufacturing

Preventive maintenance

Preventive maintenance works to eliminate equipment failure as a source of process defects by maintaining machines at the highest level of operations performance

Supplier partnerships

Supplier partnerships are key elements because a healthy supplier and user relationship is critical to a JIT operation

Long term vendor partnerships cut cost for all members of the partnership through shared quality goals and design cooperation frequent products delivers and a total cost perspective

Pull system

Pull system is synonymous with JIT manufacturing because it describes how JIT manufacturing works

In pull system parts are produced only when the next workstation in the structured flow production system indicates that parts are required

11. Explain is ERP? Briefly explain? (Apr/May 2015) (Nov/Dec 2016) (Nov/Dec 2018) (Apr/May 2019)

Enterprise resource planning (ERP) is a new system concept in which every enterprise function is integrated in a seamless flow of information. This system integrates all facets of business including sales and order entry, engineering , manufacturing, finance and accounting ,distribution , order planning and execution and the supply chain flows

Evolution of ERP system

Table explain how ERP system has evolved from inventory control sytem.

Year	System evolved	Features
1960's	Inventory control	Customised software packages to handle inventory based on traditional inventory theory.
1970's	MRP: Material requirement planning	Master scheduling giving a detailed break-up of end items required. This list enabled computation of a time table for procuring components or preparing sub-assemblies.
1980's	MRP II	MRP was extended to shop-floor and distribution management.
1990's	ERP: Enterprise resource planning	MRP II was extended to other areas like engineering, finance, human resources and projects management.

Features of ERP system

Some of the main features of ERP are as below:

1.ERP is a software architecture that integrates all the functions of the enterprise.

2. ERP system requires a seanless flow of information.

3.The seamless information flow in ERP is achived through:

(i) common database:

(ii) instant sharing of information which is common and simulation ;and

(i) One time entyr being sufficient for the entire enterprise to get up-date.

4.ERP is an extremely powerful, user –friendly ' graphic –user interface'(GUI) technology.

5.ERP is supported by client server architecture for communication at different levels of the system .

Enterprise Modeling for ERP

An ERP system is aimed at modeling and integrating the enterprise. Therefore enterprise modeling is the key pre –requisite before the selection /implementation of an ERP system

Enterprise modeling is a diagrammatic representation of the business as a main system indicating the sequence and interconnection of all the subsystem that the system comprises.

Enterprise modeling encompasses through understanding and detailed mapping of the firm's business function and decision making process both independently and interactively

Information Requirements of an ERP System

Table provides a list of some of the information need of ERP systems

1. Sales, customer and order demand-related information.
2. Manufacturing resource data.
3. Inventory status data.
4. Manufacturing process information.
5. Internal control and security access tables for client/server.
6. Cost collection: standard-actual-activity costs.

7. Performance measurement extracts.
8. Customer information.
9. Customer satisfaction information.
10. Stockholder and treasury information.
11. Vendor and supply chain detailed data.
12. Employee HR data.

Implementation of ERP

The various steps involved in ERP implementation is presented in table

Step 1: Identify the needs of ERP implementation package
(*i*) Need for quick flow of information.
(*ii*) Effective management information system for quick decision making.
(*iii*) Elimination of manual records handling.
(*iv*) High level of integration between functions.
Step 2: Evaluate the existing business situation
(*i*) Through understanding of existing process.
(*ii*) Procedures and methods for performing processes.
(*iii*) Evaluation criteria for assessment.
(*iv*) Present records, documents and manuals.
Step 3: Make decision regarding desired situation through benchmarking
Step 4: Reengineer business processes to achieve the desired results
(*i*) Reduce cycle time.
(*ii*) Reduce number of decision points.
(*iii*) Streamline the information flow.

Step 5: Evaluate various available ERP packages	
The various ERP packages can be evaluated based on:	
(*i*) Local/global presence	(*ii*) Target market
(*iii*) Modularity	(*iv*) Cost of implementation
(*v*) Investment in R&D	(*vi*) Price
(*vii*) Ease of implementation	(*viii*) Post-implementation support
Step 6: Choose the suitable best ERP package.	
Step 7: Install necessary hardware and networks.	
Step 8: Finalise the ERP consultant.	
Step 9: Implement ERP in phased manner.	

Modules of a ERP software

Table presents the important modules of a ERP software and their elements.

1. ***Finance module***

- ✓ The finance module extracts financial transactions from the sales and manufacturing areas and post them to the general ledger.
- ✓ The main elements of finance module include:
  - ■ General ledger
  - ■ Accounts receivable
  - ■ Fixed assets
  - ■ Budget
  - ■ Accounts payable
  - ■ Cash management
  - ■ Financial department
  - ■ Cost allocation

2. ***Manufacturing module***

- ✓ This module is designed to control all the operations related to manufacture.
- ✓ The business objectives of this module include:
  - ■ Engineering data management
  - ■ Bill of materials
  - ■ Master production schedule
  - ■ Capacity requirement planning
  - ■ Item control
  - ■ Routing
  - ■ Master requirement planning
  - ■ Repetitive manufacturing

- Shop floor control
- Project budget
- Project control
- Hours accounting
- Project configuration and classification
- Quality management

3. ***Distribution module***

✓ This module deals with inventory control, location control, distribution requirements planning and replenishment control.

✓ The main objectives of this module include:

- Item control
- Purchase control
- Sales and marketing information
- Replenishment order control
- Lot control
- Distribution requirements planning
- Cost accounting
- Sales control
- Electronic data interchange
- Inventory control
- Location control

4. ***Service module***

✓ This module deals with repair and warranty related activities.

✓ The main objectives of this module include:

- Installation control
- Service order control
- Contract control
- Service analysis control

5. ***Transportation module***

✓ The main objectives of this module include:

- Employee control
- Fleet management
- Hours and expense control
- Packing control
- Address control
- Fuel control
- Transport control
- Warehouse control

6. ***Process module***

✓ This module helps the firm to keep track of the manufacture of products.

7. ***Project module***

✓ The main objectives of this module include:

- Estimating
- Budget
- Requirement
- Monitoring
- Definition
- Planning
- Progress
- Invoicing

8. *Tools module*

✓ The main objectives of this module include:

- Software installation
- Application configuration
- User management
- Device management
- Job management
- Database management
- Audit management
- Text management
- Menu management
- SQL queries
- Application development and customisation
- Documentation

9. *Other modules*

✓ The other modules of ERP packages are:

- Materials management
- Supply chain management
- Quality management
- Human resource management
- Plant maintenance
- Treasury

ERP Package in india

Some of the widely used ERP packages in india include:

1. SAP	2.JD Edwards
3.Mfg/Pro	4. BPCS
5.Marshal	6.Oracle Financials
7.BaaN	8. MAMIS

12. Discuss in detail the fundamentals of MRP II (Nov/Dec 2016)

An expansion of the material requirements planning system to include other portions of the productive system was natural and to be expected. ? Manufacturing resource planning (MRP II) represents the natural evolution of closed-loop MRP (materials requirements planning).

MRP II is an integrated information system that synchronize all aspects of

the business.

MRP II system coordinates sales , purchasing, manufacturing, finance and engineering by adopting a focal production plan and by sing one unified database to plan and update the activities in all the system

MRP II is defined as a computer –based system for planning scheduling and controlling the material resources and supporting schedule(MPS).

In fact , MRP II consists of virtually all of the functions in the PPC system plus additional business functions that are related to production.

MRP II

Important MRP II system functions include :

1. Management planning – business strategy,aggregate production planning , master production scheduling rough-cut capacity planning, and budget planning.

Customer services –sales forecasting order entry , sales analysis , and finished good

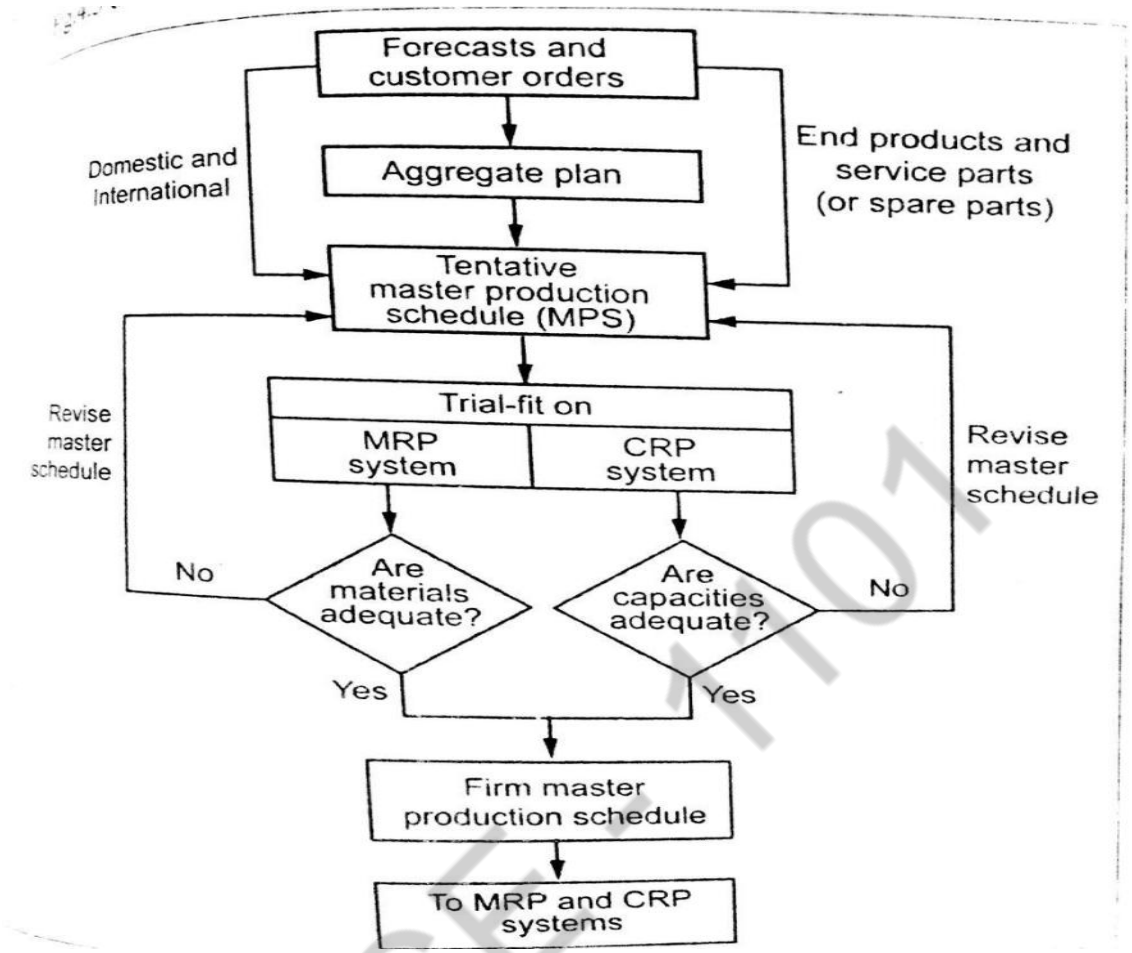
inventory.

2. Operation planning –Purchase order and work order release .
3. Operations execution – purchasing , product scheduling and control , work-in process inventory control, shop floor control and labour hour tracking.
4. Financial functional –cost accounting,accounts receivable accounts payable, general ledger, and payroll.

Thus MRP II system integrates and coordinates all of the major functions of the business to produce the right product at the right times

Structure of MRP II

Atypical structure/frame work of MRP II is illustrated in fig



A shown in ,MRP II includes linking of financial and marketing functions to manufacturing function. It is composed of a wide range of integrated functions which together plan and control all the resources of a manufacturing firm. However ,the implementation of MRP II depends largely on an effective management – information system, including timely and accurate status reporting.

13. **Explain the purpose of maintaining inventory in any production unit. (Apr/May 2017)**

Purpose of Inventory Management

INVENTORY MANAGEMENT must tie together the following objectives, to ensure that there is continuity between functions :

- Company's Strategic Goals
- Sales Forecasting

- Sales & Operations Planning
- Production & Materials Requirement Planning.

Inventory Management must be designed to meet the dictates of market place and support the company's Strategic Plan. The many changes in the market demand , new opportunities due to worldwide marketing , global sourcing of materials and new manufacturing technology means many companies need to change their Inventory Management approach and change the process for Inventory Control .

Inventory Management system provides information to efficiently manage the flow of materials , effectively utilize people and equipment , coordinate internal activities and communicate with customers . Inventory Management does not make decisions or manage operations, they provide the information to managers who make more accurate and timely decisions to manage their operations.

INVENTORY is defined as the blocked Working Capital of an organization in the form of materials . As this is the blocked Working Capital of organization, ideally it should be zero. But we are maintaining Inventory . This Inventory is maintained to take care of fluctuations in demand and lead time. In some cases it is maintained to take care of increasing price tendency of commodities or rebate in bulk buying.

Traditional Supply Chain solutions such as Materials Requirement Planning Inventory Control , typically focuses on implementing more rapid and efficient systems to reduce the cost of communicating information between and across the Inventory links in the SCM.COM focuses in optimizing the total investment of materials cost and workload for every Inventory item throughout the chain from procurement of raw materials to finished goods Inventory . Optimization means providing a balance of supply to meet the demand at a minimum total cost , Inventory level and workload to meet customers service goal for each items in the link of Inventory Chain .

It is strategic in the sense that top management sets goals . These include deployment strategies (Push versus Pull) , control policies , the determination of the optimal levels of order quantities and reorder points and setting safety stock levels . These levels are critical , since they are primary determinants of customer service levels.

Keeping in view all concerns, the latest concept of Vendor Managed Inventory is used to optimize the Inventory. We are entering into Vendor

Managed Inventory , Annual Rate Contracts with manufacturers or their authorized dealers , who maintain Inventory on our behalf and supply the items as and when required .

VMI reduces stock-outs and optimize inventory in supply chain . Some features of VMI include :

- Shortening of Supply Chain
- Centralized Forecasting
- Frequent communication of inventory, stock-outs and planned promotions
- Trucks are filled in a prioritized order , e.g. items that are expected to stock out have top priority then items that are furthest below targeted stock levels then advance shipments of promotional items

Despite the many changes that companies go through, the basic principles of Inventory Management and Inventory Control remain the same. Some of the new approaches and techniques are wrapped in new terminology, but the underlying principles for accomplishing good Inventory Management and Inventory activities have not changed.

The Inventory Management system and the Inventory Control Process provides information to efficiently manage the flow of materials, effectively utilize people and equipment, coordinate internal activities, and communicate with customers. Inventory Management and the activities of Inventory Control do not make decisions or manage operations; they provide the information to Managers who make more accurate and timely decisions to manage their operations.

The basic building blocks for the Inventory Management system and Inventory Control activities are:

- Sales Forecasting or Demand Management
- Sales and Operations Planning
- Production Planning
- Material Requirements Planning
- Inventory Reduction

The emphases on each area will vary depending on the company and how it operates, and what requirements are placed on it due to market demands. Each of the areas above will need to be addressed in some form or another to have a successful program of Inventory Management and Inventory Control.

Inventory is usually a distributor's largest asset. But many distributors aren't satisfied with the contribution inventory makes towards the overall success of their business:

- The wrong quantities of the wrong items are often found on warehouse shelves. Even though there may be a lot of surplus inventory and dead stock in their warehouse(s), backorders and customer lost sales are common. The material a distributor has committed to stock isn't available when customers request it.
- Computer inventory records are not accurate. Inventory balance information in the distributor's expensive computer system does not accurately reflect what is available for sale in the warehouse.
- The return on investment is not satisfactory. The company's profits, considering its substantial investment in inventory, is far less than what could be earned if the money were invested elsewhere.

14. Explain the costs associated with inventory. (Apr/May 2018) (Apr/May 2019)

The major costs associated with procuring and holding inventories are:

1. Ordering costs,
2. Carrying (or holding) costs,
3. Shortage (or stock out) costs, and
4. Purchase costs.

1. Ordering costs

- ✓ *Ordering costs are the costs associated with the placement of an order for the acquisition of inventories.*
- ✓ These costs refer to the managerial and clerical costs to prepare the purchase or production order.
- ✓ These costs are also known by the names ***procurement costs, replenishment costs,*** and ***acquisition costs.***
- ✓ These costs include:
  - (*i*) Costs of staff of purchase department,
  - (*ii*) Costs of stationery consumed for ordering, postage, telephone bills, *etc.*, required in ordering, and

(iii) Depreciation costs and expenses for maintaining equipment required for ordering, receiving and inspecting incoming items.

(iv) Inspection costs of incoming materials.

Note ✓ If a firm is producing its own inventory rather than taking it from an outside supplier, then the cost of set-up for making one batch of product is termed as set-up cost.

✓ Thus set up cost is used when inventory is made within the firm; and in case of buy situation, the ordering cost is used.

2. Holding or inventory carrying costs

✓ *Inventory carrying costs are the costs associated with holding a given level of inventory on hand.*

✓ This cost vary in direct proportion to the amount of holding and period of holding the stock in stores. This cost will not be occurred if inventory is not carried.

✓ The holding costs include:

(i) Costs for storage facilities.

(ii) Handling costs.

(iii) Depreciation, taxes, and insurance.

(iv) Costs on record keeping.

(v) Losses due to pilferage, spoilage, deterioration, and obsolescence.

(vi) Opportunity cost of capital.

3. Shortage (or Stock out) costs

✓ *When the stock of an item is depleted and there is a demand for it, then the shortage cost will occur.* In simple terms, shortage cost is the cost associated with stock-out.

✓ The shortage costs include:

(i) Back order costs.

(ii) Loss of future sales.

(*iii*) Loss of customer goodwill.

(*iv*) Loss of profit contribution by lost sales revenue.

(*iv*) Extra cost associated with urgent, small quantity ordering costs.

4. Purchase (or production) costs

- ✓ *Purchase (or production) costs are the costs incurred to purchase/or produce the item.*
- ✓ These costs include the price paid, or the labour, material, and overhead charges necessary to produce the item.

15. Discuss the recent trends in PPC. (Apr/may 2018)

Refer Unit-V Q.No:2,9,10 & 11

16. What do you understand by inventory control? List out its objectives.

(Nov/Dec 2018)

5.2. INVENTORY CONTROL

5.2.1. What is Inventory Control?

✓ ***Definition:*** *Inventory control may be defined as the scientific method of determining what to order, when to order and how much to order and how much to stock so that costs associated with buying and storing are optimal without interrupting production and sales.*

✓ ***Inventory decisions:*** There are two basic decisions to be made for every item in the inventory. They are:

(i) ***How much*** of an item to order when the inventory of that item is to be replenished? (*i.e.*, order quantity), and

(ii) ***When to*** replenish the inventory of that item? (*i.e.*, order level).

The use of inventory models answer the above two questions, which is presented in Section 5.6.

5.2.2. Functions of Inventory Control

The various functions of inventory control include:

1. ***Effective running of the stores.*** It includes problems of layout, utilisation of storage space, storing media (shelves, bins, *etc.*), receiving, and issuing procedures.
2. ***Technological responsibility for the stage of merchandise.*** It consists of methods of storing, maintenance procedures, studies of deterioration and obsolescence.
3. ***Stock control system.*** Its functions include stock taking, stock level records, ordering policies, and procedures for stock replenishment.

5.2.3. Objective of Inventory Control

The main objectives of inventory control are:

(*i*) To ensure continuous supply of materials so that production should not suffer at any time.

(*ii*) To maintain the overall investment in inventory at the lowest level, consistent with operating requirements.

17. **What is meant by two bin inventory control system? (Apr/May 2019)**

A two-bin system is a type of fixed-order system in which inventory is carried in two bins. A replenishment quantity is ordered when the first bin is empty. During the replenishment lead time, material is used from the second bin. A two-bin system is mostly used in assembly environments. The advantage of a two-bin system is a minimal chance of a stock-out and the ease to handle. Inventory control method (used usually for small or low value items) in which when the first bin is used up, an order is made out for replenishment. The second bin contains enough quantity of the item to last until the ordered quantity arrives.

18. **Stating the assumptions in the EOQ model, derive systematically the expression for economic lot size providing explanations wherever appropriate (Nov/Dec 2016)**

Refer Question Bank Page 10, Question No. 1

19. **Why do firms carry inventories? (Apr/May 2018)**

Refer Question Bank Page 41, Question No. 13

20. **Explain the methodology adopted in a ERP software.**

Refer Question Bank Page 33, Question No. 11

21. **Discuss the various basic elements of JIT that must be addressed for successful JIT implementation.**

Refer Question Bank Page 29, Question No. 10