UNIT-I

⇒ Definition of Production Planning And Control :- (PPC)

It is defined as the direction and coordination of the firm's material and physical facilities towards the attainment of prespecified production goals in the most efficient available way.

(or)

It is defined as the direction and coordination of the firm's materials and physical facilities towards the attainment of pre-specified production goals in the most efficient available way.

⇒ objectives of production planning and control :-

* To ensure and economical production process.
* To effectively utilize plant to maximize productivity.
* To maximize efficiency by proper coordination in production process.
* To ensure proper delivery of goods.
* To place the right man for the right job, at right time for right wages.
* To minimize labour turnover.
* To reduce the waiting time.
* Ensuring smooth flow of materials by eliminating bottlenecks if any in production.
* coordinates different resources of production system in the most effective and economic manner and to coordinate among differ-ent departments.
* utilization of Inventory in the optimal way.
* To ensure flexibility in production system to accomodate changes and uncertainty.
* It is used to establish targets and checking it by composing on some performance measures.
* Decides the nature and magnitude of different input factors

to produce the output.

* Scheduling production activities to meet delivery schedule.
* optimizes the use of resources for minimum overall production cost.

⇒ Functions / Elements / Parameters of production planning and control

- → materials
- → Methods
- → Machines and equipment
- → Routing
- → Estimating
- → Loading and scheduling
- → Dispatching
- → Expediting
- → Inspection
- → Evaluating

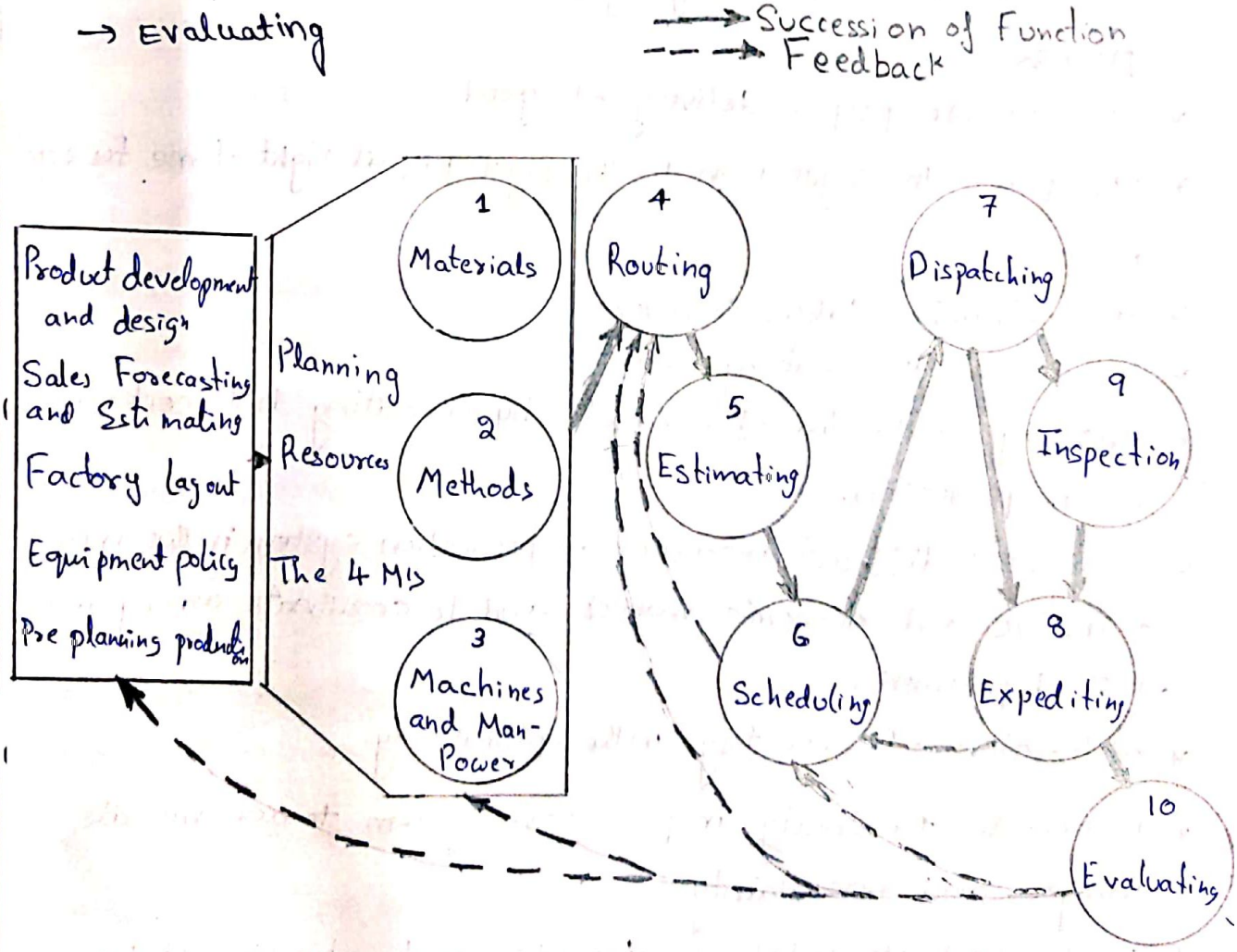


Fig - Ten Functions of PPC cycle.

① Materials:- Raw materials, as well as standard finished parts and semi finished products must be available when required, to ensure that each production operation will start on time.

② Methods:- The purpose of this function is to analyze possible methods of manufacture and try to define the best method compatible with a given set of circumstances and facilities.

③ Machines and equipment:- Methods of manufacture have to be related to available production facilities, coupled with a detailed study of equipment replacement policy, maintenance policy, procedure and shedules are also functions connected with managerial responsibility for equipment since the whole problem of breakdowns and reserves can be seriously reflected in halts in production.

④ Routing:- It prescribes the flow of work in the plant and is related to considerations of layout, of temporary storage locations for raw materials and components of material handling systems.

⑤ Estimating:- this function involves the extensive use of operation analysis in conjunction with methods and routing as well as work measurement in order to set up performance standards.

⑥ Loading and scheduling:- It determines the utilization of equipment and manpower and hence the efficiency of the plant. scheduling must ensure that operations are properly dovetailed that semi finished components arrive at their next station in time, that assembly work is not delayed.

⑦ Dispatching:- This function is concerned with the execution of the planning functions. Dispatching is the routine of setting productive activities in motion, through release of orders and instructions. It authorizes the start of production operations by releasing materials, components, tools, fixtures etc and ensure that material material movement is carried out according to the planned routing.

sheets and to schedules.

8. Expediting :- Also known as follow up or progress as it is logical step after dispatching it maintains the production plans and guide them to successful completion.

9. Inspection :- It improves the production methods and indicates the cost implications of quality at the design stage.

10. Evaluating :- It provides a feedback mechanism on a longer term basis so that past experience can be evaluated with the view to improve utilization of methods and facilities.

⇒ Types of production systems :-

- Job/unit production
- Intermittent/Batch production
- continuous/Mass production

① Job production :-

* It involves production as per customer's specifications.
* This ensures the simultaneous production of large number of batches/orders.
* Each batch comprises of a small lot of identical products and is different from other batches.
* It requires comparatively smaller investment in Machines and equipment.
* It is flexible and can be adapted to changes in product design and order size without much inconvenience.
* This system is most suitable where heterogeneous products are produced against specific orders.
* In this system products are made to satisfy a specific order.

* However that order may be produced - only once or at irregular time intervals as and when new order arrives or at regular time intervals to satisfy a continuous demand.

Characteristics of Job production:-

→ machines and Methods employed should be general purpose as product changes are quite frequent.

→ Man power should be skilled enough to deal with changing work conditions.

→ schedules are actually non-existent in this system as no definite data is available on the product. In process inventory will usually be high as accurate plans and schedules do not exist.

→ product cost is normally high because of high material and labour costs.

→ Grouping of machines is done on functional basis (i.e as lathe section, milling section etc..) this system is very flexible as management has to manufacture varying product types. Material handling systems are also flexible to meet changing product requirements.

② Batch prodction:-

* This is concerned with the production of different types of products in small quantities usually termed as batches.

* A batch contains the similar products but in small quantity.

* This is used to meet a specific order or to meet a continuous demand.

* Batch can be manufactured either - only once or repeatedly at irregular time intervals as and when demand arise or repeat-edly at regular time intervals to satisfy a continuous demand.

* under this system the goods may be produced partly for inventory and partly for customer's orders.
* for example, components are made for inventory but they are combined differently for different customers.
* E.g. automobile plants, printing presses, electrical goods plant are examples of this type of manufacturing.

Characteristics of Batch production :-

→ As final product is some what standard and manufactured in batches, economy of scale can be availed to some extent.
→ Machines are grouped on functional basis similar to the jobshop manufacturing.
→ Semi-automatic, special purpose automatic machines are generally used to take advantage of the similarity among the products.
→ Labour should be skilled enough to work upon different product batches.
→ In process inventory is usually high owing to the type of layout and material handling policies adopted.
→ Semi-automatic material handling systems are most appropriate in conjunction with the semi-automatic machines.

③ continuous/mass production :-

* It is used when we need to produce standardized products with a standard.
* This ensures continuous production of output.
* It is also termed as mass flow production (or) assembly line production.
* this system results in less work in process inventory and high product quality but involves high capital investment in machinery and equipment.

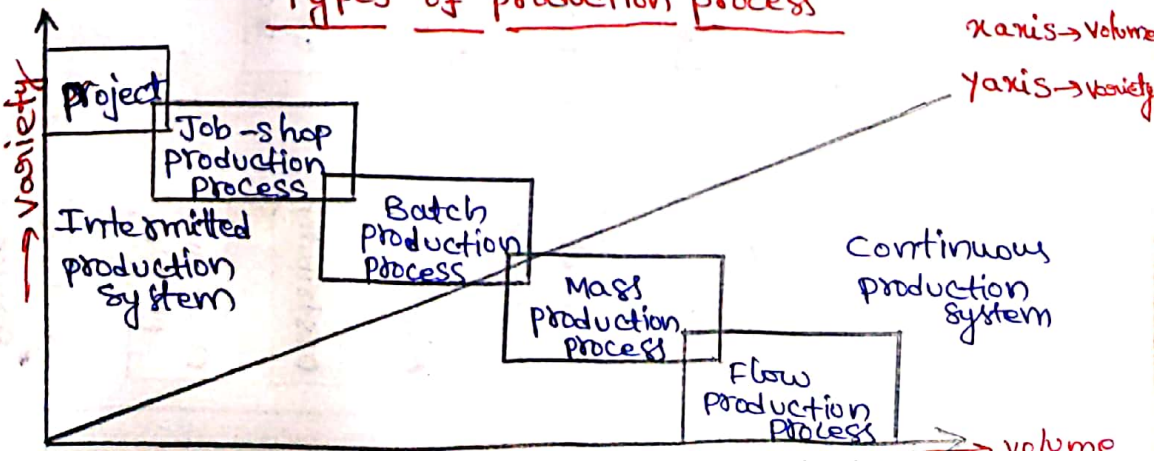
* This ensures very high rate of production as we need not to intervene once the production has begun.
* The system is appropriate in plants where large volume of small variety of output is produced.

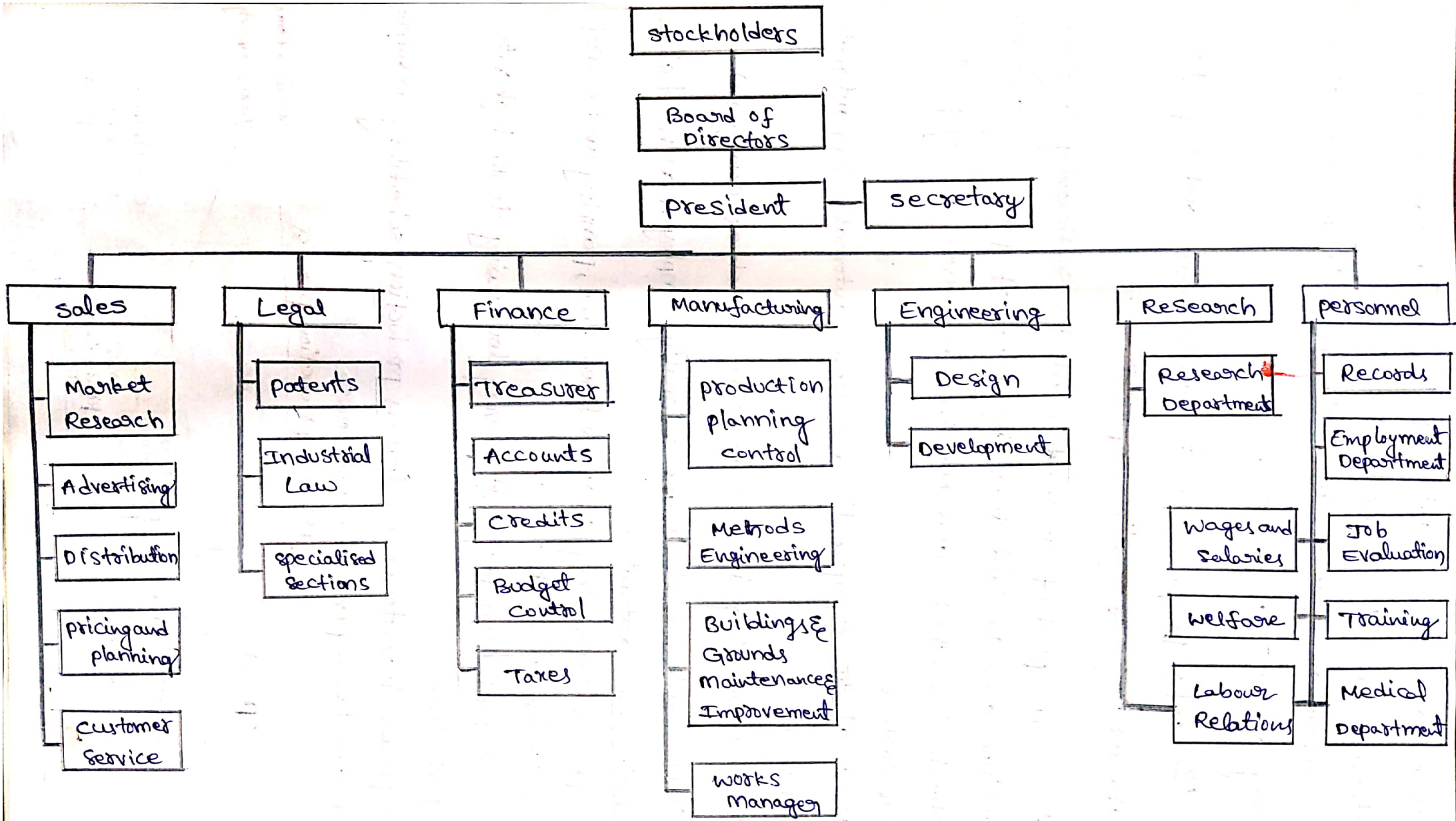
Ex:- oil refineries, cement manufacturing and sugar factory.

characteristics of continuous production:-

→ As same product is manufactured for sufficiently long time, machines can be laid down in order of processing sequence.
→ Standard methods and machines are used during part manufacture.
→ Most of the equipment's are semi automatic (or) automatic in nature
→ Material handling is also automatic (such as conveyors)
→ Semi-skilled workers are normally employed as most of the facilities are automatic.
→ As product flows along a pre-defined line, planning and control of the system is much easier.
→ Cost of production per unit is very low owing to the high rate of production.
→ In process inventories are low as production scheduling is simple and can be implemented with ease.

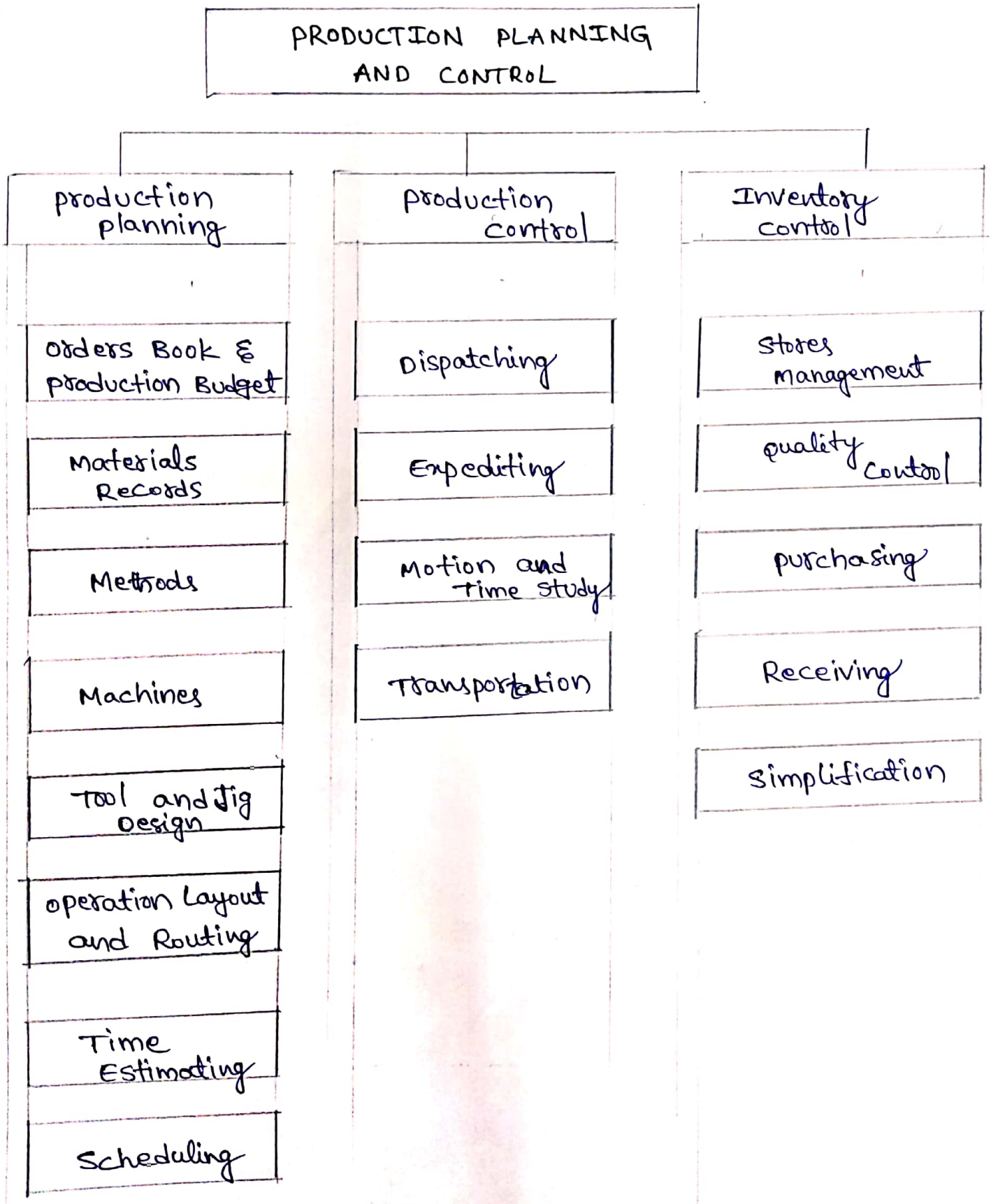
Types of production process





A TYPICAL ORGANIZATION CHART FOR A MANUFACTURING FIRM

* A CONVENTIONAL ORGANIZATION CHART OF THE PRODUCTION PLANNING AND CONTROL DEPARTMENT :-



UNIT-2

FORECASTING

Definition:-

Forecasting is an essential activity to be carried out prior to planning, with the aim to estimate the Future work, may it be regarding sales (or) production (or) any other aspect of business activity.

⇒ Forecasting may also be defined as a technique of translating past experience into prediction of things to come.

Importance of Forecasting:-

* Forecasting is the estimation of type, quantity and quality of future work

  Ex:- sales, demand.

* Based on forecast, we plan for production, material procurement, inventory level, man power, plant capacity etc..
* It plays a crucial role in the development of plans for the future.
* It is a prediction or estimation of a future situation under given conditions.
* the general use of forecasting is to be found in monitoring the continuous progress of plans based on forecasts.
* The forecast provides a warning system of the critical factors to be monitored regularly because they might drastically affect the performance of the plan.

② Types of forecasting :-

* Based on the time period forecasting may be divided into two types

① ⇒ short term forecasting

② ⇒ long term forecasting

① Short term forecasting :-

→ The forecasting, which covers a period of three months, six months (or) one year is generally called as "short term forecasting".

→ The period for which forecasting is done depends upon the nature of business.

→ forecasting is done only for a period when the demand fluctuates from one month to another.

Uses (or) advantages (or) objectives :-

* Formulation of suitable production policy
* Regulate supply of raw material
* Best utilization of machines
* Regular availability of labour.
* price policy formulation
* Forecasting of short term financial requirements
* Setting the sales target.

(2) Long term Forecasting :-

* The forecasting which covers a period of 5 to 10 years and in some cases even 20 years.
* However, beyond 10 years, the future is assumed to be uncertain.
* Many Industries like ship building, petroleum refinery and generation of electricity a long term forecasting is needed as the total Initial Investment Cost of equip-ment is quite high.

Uses (or) advantages (or) objectives :-

* Deciding plant capacity
* Manpower planning
* Estimating cash inflows
* Determining dividend policy
* planning of long-run production
* Long run financial requirements
* Budgetary control over expenditure.

principles of forecasting :-

→ At any point in time, there is only one best estimate forecast for a project that reflects the current under-standing of substance uncertainty and best development and commercial assumptions.

→ This forecast should always be accompained by an uncertainty range.

→ The forecast uncertainty range should always have remaining reserves of an objective function.

→ The forecast and uncertainty range should be based on defined projects, with incremental forecasts for subsequent projects.

with these principles forecasting is part of asset management throughout the year.

Factors Affecting forecasting :-

① General business conditions :- while making sales forecast, the marketer should take into consideration the general conditions of the economy, growth of population, distribution of wealth and income etc -- during the future method.

② conditions with in Industry :- while making sales forecast, the changes going on all the time in the total demand of the product and technological developments should be taken into consideration.

③ conditions with in the company :- Internal changes with in the company in the coming future also affect future sales.

Such changes may be in price structure, distribution ③ channel, sales promotion measures, product or other marketing policies of the company.

④ Factors affecting Export trades:- If the company is engaged in the export trade, the marketing managers must consider various factors in forecasting the export sales.

⑤ political stability:- If the nation is practically stable, the business flourishes. Things outside the business remain static and stable. Generalisations come true and so the forecasts.

⑥ Government Restrictions:- Today governments all over the world are interfering more and more in business activities through various restrictions and control.

⑦ Fiscal and Monetary policy:- The frequency of changes in the fiscal and monetary policy do affect the forecasting.

⑧ price level and trend:- Frequent and wild changes in price levels do adversely affect the forecasting.

⑨ Technological research and development..

Advantages of forecasting:-

→ Helps in effective planning

→ Helps in removing the weakness of organisation structure

→ Helps in better co-ordination

→ Achieves co-operation in the enterprises

→ provides a basis for effective control

→ provides importance at the national level.

Limitations of forecasting:-

→ Forecasting is based on postulations and assumptions and hence it is subject to some guess work and possibility of error.

→ Forecasting is usually based on past data but future may not be a copy of the past.

→ changes in consumer's need, taste, fashion, style etc -- may cause inaccuracy in forecast.

→ They may be lack of history in case of a new product.

→ Development of new products and materials, methods may introduce error in the sales forecast of a particular product

→ there may be lack of efficient and experienced sales force.

→ Lack of sales history, in case of a new product, makes the forecast difficult.

→ short term forecasting is more accurate than long term forecasting and hence its usefulness is limited to short term purposes.

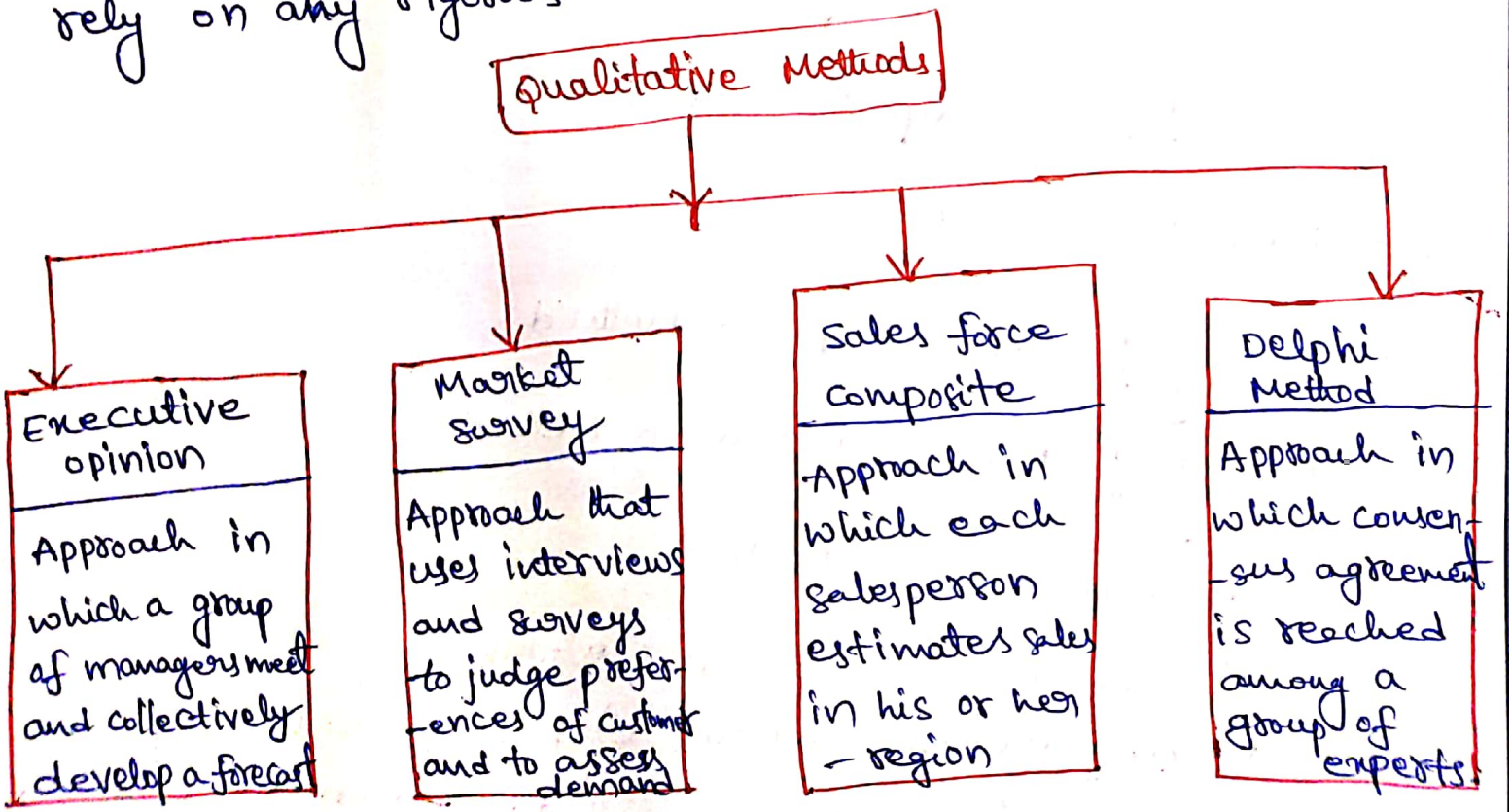
→ Forecasts are not full proof and condition proof and if there are changes in the general economy of the country.

Forecasting Techniques:-

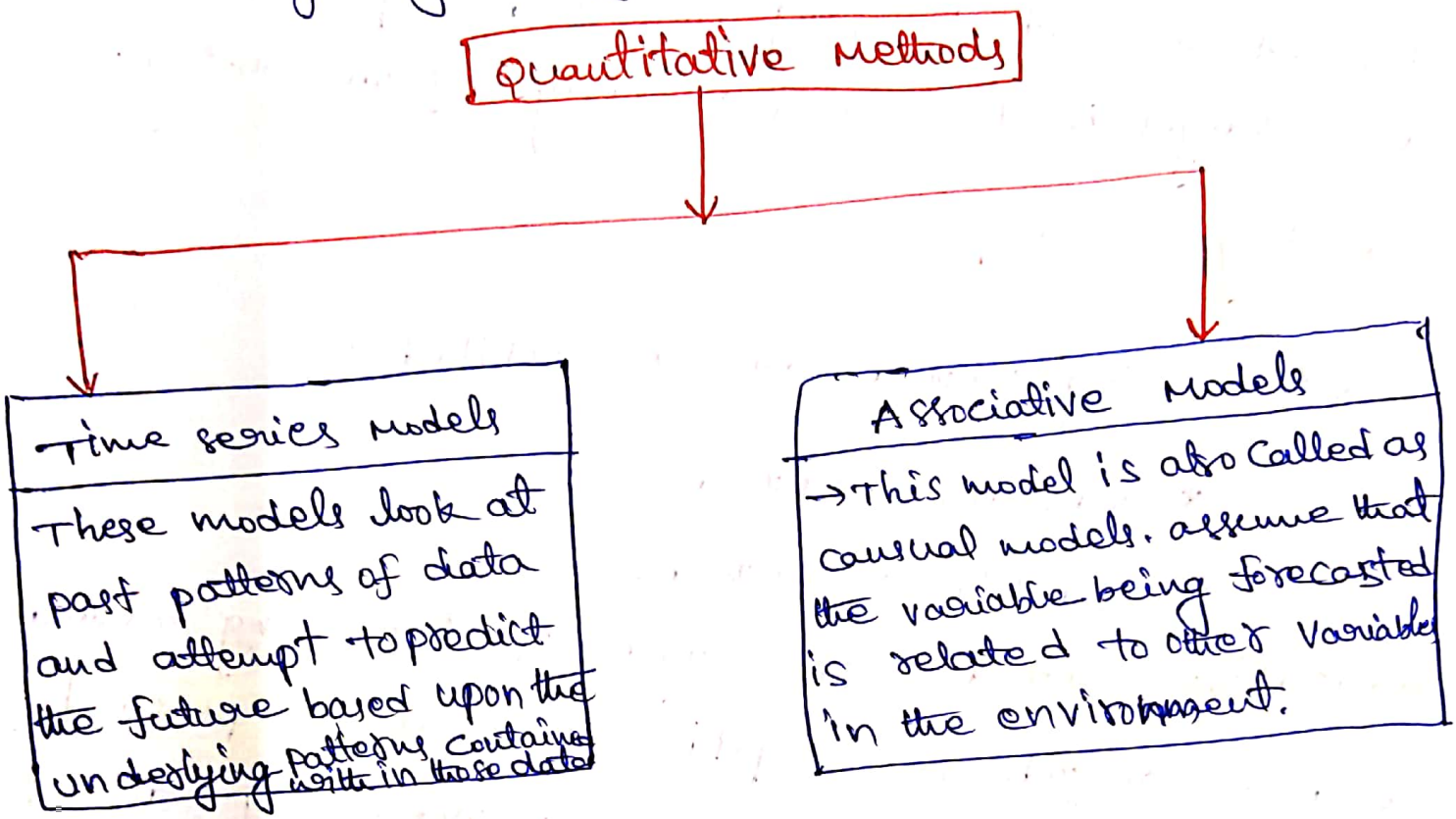
→ Forecasting methods can be classified as

* Qualitative methods
* Quantitative methods.

Qualitative methods:- These types of forecasting methods are based on judgements, opinions, emotions (or) personal experiences and are subjective in nature. They do not rely on any rigorous mathematical computations.



Quantitative methods:- These types of forecasting methods are based on mathematical models and are objective in nature. They rely heavily on mathematical computations.



Methods of forecasting:-

→ Sales force composite method.

→ Market share method.

→ Survey of Experts opinion method.

→ Survey of Buyers intention method.

→ Executive opinion method.

→ Analytical and statistical Method

a) Moving average method
b) Exponential smoothing
c) Time series analysis
d) Regression Analysis.
e) least square Method.

① Moving average Method :-

→ A moving average may be defined as an average of some fixed or predetermined number of observations in a time series, which moves through the series by dropping the top item of the previous average group and adding the next item below, in each successive average.

→ The calculations depend upon the period to be odd (or) even.

Advantages :-

→ This Method provides a simple and good estimate.

→ In this Method equal weightage is assigned to all the periods chosen for averaging.

Disadvantages :-

→ Records of the demand data have to be retained over a fairly long period.

→ It is more accurate than graphical Method as it is based on mathematical calculations.

→ choice of period of moving average is difficult

→ cannot be applied if some observations are missing

② Exponential Smoothing Method :-

→ It is similar to moving average and used fairly extensively. In fact, It is an improvement over moving average method of forecasting.

→ this method is particularly useful when forecasts of a larger number of items are made.

→ this method is also adaptable for trend corrections and smoothing of forecast errors.

→ It is one of the most accurate statistical techniques for forecasting.

→ The fundamental concept of exponential smoothing method is that

$$F_t = \alpha D_{t-1} + (1-\alpha) F_{t-1}$$

where

F_t = forecast at time (t)

F_{t-1} = Forecast at time $(t-1)$

D_t = actual demand at time (t)

D_{t-1} = actual demand at time $(t-1)$

α = smoothing constant

→ α value lies between 0 to 1

→ Generally chosen value in between 0.1 to 0.3

Least Square Method :-

→ Many methods can be used to fit a straight line to a given scatter, which suggests a linear trend, but the most widely acceptable method is that of the least Squares.

Advantages :-

→ Method is simple and easy to understand.

→ There is no need to conduct any simple survey as only past information about sales is required.

→ Under normal situations, the method is likely to give reliable and accurate results.

Disadvantages :-

→ The method is based on some mathematical formulae which may not be understood by common people.

→ The Assumptions that other things remaining constant may not hold good in practice.

Equation For least Square Method.

Trend value $\boxed{Y = a + bX}$

$$a = \frac{\Sigma Y}{N} \quad ; \quad b = \frac{\Sigma xY}{\Sigma x^2}$$

x = Deviation values.

problems

① The following series relates to the annual sales in thousands of a product during the period 1975-1990. Find the trend of sales using a) 3 yearly moving averages
b) 5 yearly moving averages
c) 7 yearly moving averages.

year	sales in thousands.
1975	16
1976	18
1977	15
1978	17
1979	20
1980	22
1981	25
1982	24
1983	25
1984	28
1985	26
1986	22
1987	28
1988	24
1989	25
1990	30.

Sol:-

i) 3 yearly period.

Year	Sales in Thousands	Three yearly moving total	Three yearly moving average trend values
1975	16		
1976	18	49	49/3 = 16.33
1977	15	50	16.77
1978	17	52	17.33
1979	20	59	19.66
1980	22	67	22.33
1981	25	71	23.66
1982	24	74	24.66
1983	25	67	22.33
1984	28	79	26.33
1985	26	76	25.33
1986	22	76	25.33
1987	28	74	24.66
1988	24	77	25.66
1989	25	79	26.33
1990	30		

Total →

ii) 5 yearly period

year	Sales in thousand	Five yearly moving Total	Five yearly moving average
1975	16	—	—
1976	18	—	—
1977	15	86	$86/5 = 17.2$
1978	17	92	18.4
1979	20	99	19.8
1980	22	108	21.6
1981	25	116	23.2
1982	24	124	24.8
1983	25	128	25.6
1984	28	125	25.0
1985	26	129	25.8
1986	22	126	25.2
1987	28	125	25.0
1988	24	129	25.8
1989	25	—	—
1990	30	—	—

iii) 7 yearly period.

year	Sales in thousand	Seven yearly moving Total	Seven yearly moving avg
1975	16	—	—
1976	18	—	—
1977	15	—	—
1978	17	133	$\frac{133}{7} = 19.00$
1979	20	141	20.142
1980	22	148	21.142
1981	25	161	23.00
1982	24	179	24.285
1983	25	172	24.571
1984	28	178	25.428
1985	26	177	25.285
1986	22	178	25.428
1987	28	183	26.142
1988	24	—	—
1989	25	—	—
1990	30	—	—

(2) Exponential Smoothing Method :-

* Forecast the demand for the following series by exponential Smoothing Method?

Period	1	2	3	4	5	6	7	8	9	10
Actual demand	10	12	8	11	9	10	15	14	16	15

Sol:-

Let us ASSume $\alpha = 0.3$

the initial forecast & demand for t-1 period is equal to (10)

$$F_t = \alpha D_{t-1} + (1-\alpha) F_{t-1}$$ Formulae.

period	Actual demand	forecast.
1	10	—
2	12	10
3	8	10.66
4	11	9.82
5	9	10.74
6	10	9.822
7	15	9.875
8	14	11.412
9	16	12.188
10	15	13.33

1st Period No Forecast

2nd $\Rightarrow F_{t(2)} = \alpha D_{t-1} + (1-\alpha) F_{t-1}$

$= 0.3(10) + (1-0.3)10$

$F_t = 10$

3rd $\Rightarrow F_{t(3)} = \alpha (D_{t-1}) + (1-\alpha) F_{t-1}$

$= 0.3(12) + (1-0.3)10$

$F_t = 10.66$

4th period

$$F_{t(9)} = \alpha(D_{t-1}) + (1-\alpha) F_{t-1}$$

$$= (0.3)(8) + (1-0.3)10.66$$

$$= 9.82$$

$$F_{t(8)} = 0.3(11) + (1-0.3)9.82$$

$$= 10.74$$

$$F_{t(6)} = 0.3(9) + (1-0.3)10.74$$

$$= 9.822$$

$$F_{t(7)} = 0.3(10) + (1-0.3)9.822$$

$$= 9.875$$

$$F_{t(8)} = 0.3(15) + (1-0.3)9.875$$

$$= 11.412$$

$$F_{t(9)} = 0.3(14) + (1-0.3)11.412$$

$$= 12.188$$

$$F_{t(10)} = 0.3(16) + (1-0.3)12.188$$

$$= 13.33$$

Final value (or) forecasting for 11th period.

$$F_t = \alpha(D_{t-1}) + (1-\alpha) F_{t-1}$$

$$F_{t(11)} = 0.3(15) + (1-0.3)13.33$$

$$\boxed{F_{t(11)} = 13.83}$$

(3) Least square method :-

* The Annual sales of a company are as given below

year	1980	1981	1982	1983	1984
Sales in (Rs)	50,000	65,000	75,000	52,000	72,000

Using the method of least squares, Find the trend values of the 5 years? also estimate the annual sales for the year 1985?

Sol:-

year	sales in (100/-) y	Deviation x from (x)	x^2	xy	Trend values $y = a + bx$
1980	50	-2	4	-100	56.60
1981	65	-1	1	-65	59.70
1982	75	0	0	0	62.80
1983	52	1	1	52	65.90
1984	72	2	4	144	69.00
$n = 5$	$\Sigma y = 314$	$\Sigma x = 0$	$\Sigma x^2 = 10$	$\Sigma xy = 31$	

For Trend values eqn is

$$\boxed{y = a + bx} \longrightarrow (1)$$

$$a = \Sigma y / n = \frac{314}{5} = 62.80$$

$$b = \frac{\Sigma xy}{\Sigma x^2} = \frac{31}{10} = 3.1$$

by substituting the values of a and b in equation (1) we get $\boxed{y = 62.80 + 3.1x}$

$$y = 62.8 + 3.1x$$

By substituting the deviation of x values

$x = -2$

$$y = 62.8 + (3.1)(-2) = 56.60$$

$x = -1$

$$y = 62.8 + (3.1)(-1) = 59.70$$

$x = 0$

$$y = 62.8 + (3.1)(0) = 62.8$$

$x = 1$

$$y = 62.8 + (3.1)(1) = 65.90$$

$x = 2$

$$y = 62.8 + (3.1)(2) = 69.00$$

⇒ Expected values of sales for the year 1985

Then

$x = 3$

$$y = 62.8 + (3.1)x$$

$$y = 62.8 + (3.1)(3)$$

$$y = 66.10$$

$$y = 66.10 \times 1000 = 66,100/-$$

(*) Find the trend using least square method for data given below? Also estimate the demand for 1984? (10)

Year	1975	1976	1977	1978	1979	1980	1981
Demand in 1000units.	85	75	80	72	65	60	55

Sol:-

year	Sales in (1000/-) y	Deviation of (x) x from 1978	x^2	xy	Trend values $y = a+bx$
1975	85	-3	9	-255	84.75
1976	75	-2	4	-150	79.928
1977	80	-1	1	-80	75.107
1978	72	0	0	0	70.285
1979	65	1	1	65	66.003
1980	60	2	4	120	60.64
1981	55	3	9	165	55.819
n=7	$\Sigma y = 492$	$\Sigma x = 0$	$\Sigma x^2 = 28$	$\Sigma xy = -135$	

For Trend values equation

$$y = a + bx$$

$$a = \Sigma y / n = \frac{492}{7} = 70.285$$

$$b = \frac{\Sigma xy}{\Sigma x^2} = \frac{-135}{28} = -4.822$$

$$y = 70.285 + (-4.822)x$$

$x = -3$

$y = 84.751$

$x = -2$

$y = 79.928$

$x = -1$

$y = 75.107$

$x = 0$

$y = 70.285$

$x = 1$ $y = 66.003$

$x = 2$ $y = 60.641$

$x = 3$

$y = 55.819$

Trend value for the year 1984

(*) $x = 6$

$y = 70.285 + (-4.822)\,6$

$y = 41.353$

$y = 41.353 \times 1000$

$y = 41353$ units

Case ii)

⇒ even & years missing case

** Estimate trend values and also estimate production for the year 1993?

year	1983	1985	1986	1987	1989	1990
production	62	83	90	80	90	95

Sol:-

year	production (y)	deviation	x (2×deviation)	x^2	xy	trend value y=a+bx
1983	62	-3.5	-7	49	-434	61.28
1985	83	-1.5	-3	9	-249	73.88
1986	90	-0.5	-1	1	-90	80.18
1987	80	0.5	1	1	80	86.48
1989	90	2.5	5	25	450	99.08
1990	95	3.5	7	49	665	105.38
n=6	$\Sigma y = 500$			$\Sigma x^2 = 134$	$\Sigma xy = 422$	

$$a = \Sigma y / n = \frac{500}{6} = 83.33$$

$$b = \frac{\Sigma xy}{\Sigma x^2} = \frac{422}{134} = 3.15$$

$y = a + bx$

$$y = 8.33 + 3.15x$$

for

$x = -7$; $y = 83.33 + 3.15(-7) = 61.28$

$x = -3$; $y = 83.33 + 3.15(-3) = 73.88$

$x = -1$; $y = 80.18$

$x = 1$; $y = 86.48$

$x = 5$; $y = 99.08$

$x = 7$; $y = 105.38$

Estimation for 1993

$x = 13$

$y = 83.33 + 3.15(13)$

* For a canteen actual demand for disposal cubs 500 units in Jan and 600 units in feb the forecast for Jan is 400 units then considering smoothing coefficient as 0.75 what is forecast for march?

$D_J \rightarrow$ Demand Jan

$f_J \rightarrow$ forecast Jan

Sol:- $\alpha = 0.75$; $D_J = 500$; $F_J = 400$

forecast for February

$$F_{feb} = F_{Jan} + \alpha(D_{Jan} - F_{Jan})$$

$$= 400 + 0.75(500 - 400) = 475$$

For March

$$F_{March} = F_{Feb} + \alpha(D_{feb} - F_{feb})$$

$$F_{march} = 475 + 0.75(600 - 475) = 568$$

Regression Analysis:- It is a statistical method in which there is a causal relationship between Input and output.

→ most cases consider linear regression

$$y = a + bx$$

⊛ Solve the problem by using regression analysis?

Months	Jan	Feb	March	April	may
Demand	10	11	16	19	25

Forecast June month demand?

Sol:-

Month	(y) Demand	(x) Deviation	xy	x^2
Jan	10	-2	-20	4
Feb	11	-1	-11	1
March	16	0	0	0
April	19	1	19	1
may	25	2	50	4
n=5	$\Sigma y = 81$	$\Sigma x = 0$	$\Sigma xy = 38$	$\Sigma x^2 = 10$

$$\Sigma y = na + b\Sigma x$$

$$\Sigma y = na + b(0)$$

$$\boxed{\Sigma y = na} \qquad a = \frac{\Sigma y}{n} = \frac{81}{5} = 16.2$$

$$\Sigma xy = a\Sigma x + b\Sigma x^2$$

$$38 = a(0) + b\Sigma x^2$$

$$38 = b\Sigma x^2$$

$$\boxed{b = \Sigma xy / \Sigma x^2 = \frac{38}{10} = 3.8}$$

$$y = a + bx$$

$$y = 16.2 + 3.8x$$

Forecast for June

$\boxed{x = 3}$

$$y = 16.2 + 3.8(3),$$

$$\boxed{y = 27.6}$$

UNIT-III

Inventory:-

Inventory is defined as the list of movable goods which helps directly (or) indirectly in the production of goods for sale.

→ Inventory is a service to production. It is just a sort of Investment In the form of raw materials, tools, gauges, supplies etc---

Inventory control:-

It is defined as "the scientific method of finding out howmuch stock should be maintained in order to meet the production demands and be able to provide right type of material at right time in the right quantities and at competitive prices".

→ In simple terms inventory control can be defined as "Not too much, not too little and at lower cost for higher profit".

Classification of Inventories:-

* Direct Inventories
* Indirect Inventories.

Direct Inventories:-

*) The Inventories which play a direct role in the manufacture of a product and become an integral part of the finished product are called "direct Inventories".

⇒ Raw materials:- These are the materials which are machined (or) processed before they are ready to be used in assembly of the finished products.

Ex:- copper, tin, steel etc--

⇒ In process Inventories:- In process Inventories are the semifinished goods at various stages of manufacture. The output of one machine is fed to another machine for further processing.

⇒ purchased parts:- These are some purchased items [components, sub-assemblies, finished parts etc--] purchased from outside supplies instead of manufacturing in the factory itself.

Ex:- Ball bearings, screw, nuts, bolts.

⇒ Finished Goods:- Finished goods Inventories contain the output of the production process. These are the finished (final) products ready for dispatching to the customers.

Indirect Inventories :-

⇒ These Inventories are those materials which help the raw materials to get converted into the finished products but donot become an integral part of the finished products.

a) TOOLS :-

* standard tools used on machines such as lathe tools, milling cutters, drill, reamers, etc - -
* Hand tools such as hand saws, chisels, drill guns, hammers, mallets etc - -

b) Supplies :- It includes materials used in running the plant but donot go into the product.

i) miscellaneous consumable stores such as cotton waste, vimpowder, jute etc - - -
ii) Brushes, maps, bobs etc - - -
iii) oils and greases such as kerosene, transformer oil, petrol, diesel, lubricating and cutting oils.

Functions of Inventories (Need for Inventories) :-

* No business can operate without Inventories. Every Firm must maintain adequate stock of Inventories for the following reasons :-

① To Ensure against delays in deliveries :-

⇒ when an order is placed for fresh stock, the materials are not immediately available but some time elapses before it arrives. This period between the time of placing the order and the time of stock arrival is often subjected to variations.

② To allow for possible increase in output :-

⇒ Changes in the manufacturing programme may occur because of variation in the demand. To meet the Increased demand of the finished goods the company should have enough stock of Inventories so as to allow the production without interference.

③ Maintain smooth and efficient production flow :-

⇒ when a company has little inventory and runs out of stock, stock-out of essential materials means interruptions in production which raises cost of production.

④ To keep better customer relations :-

⇒ stock outs means stoppage or interruptions in production. Therefore it may delay the delivery of finished goods to the customer

⑤ To take advantage of quantity discounts :-

→ Materials and components may be cheaper when purchased in large quantities owing to larger discounts and lower transportation costs.

⑥ To utilize to advantage price fluctuations :-

→ price fluctuations of materials have a marked effect on the procurement policy of a company. If these fluctuations are to be used to some advantage, the company should purchase in adequate quantities when prices are low.

⑦ To ensure against scarcity of materials in the market

Sometimes there are wide fluctuations in the output of certain materials and in the demand for them so that materials may become scarce and difficult to get.

⑧ To have a better utilization of men and machinery

→ If there is a stockout of materials the men and machinery will remain idle. Therefore, the company should keep enough stock of Inventories to have better utilization of men and machinery.

⇒ Advantages of Inventory control :-

* There is no shortage of materials at any stage of production.
* materials are made available at most economical rates
* Delays (or) interruptions in production due to non-availability of materials do not occur.
* Exact and accurate delivery dates can be forecast
* production schedules and delivery dates are maintained
* the materials are protected from spilage, deterioration etc - - -
* there is an increase in overall efficiency / productivity of the company.

Relevant Inventory costs :-

⇒ In order to control inventories appropriately, one has to consider all cost elements that are associated with the Inventories.

⇒ Total inventory costs consist of

- → purchase cost
- → Inventory carrying cost (or) holding cost
- → ordering cost (or) procurement cost (or) setup cost
- → shortage cost (or) stock-out cost

purchase cost:-

The cost of purchasing a unit of an item is called as "purchase cost". It is the actual price paid for the procure-ment of items. It's measurement is Rs. per unit.

purchase cost = price per unit x Demand per unit time

Inventory carrying cost:- [H (or) C]

carrying costs which are also known as holding costs are the costs incurred in maintaining the stores in the firm.

→ They are based on average inventory and consist of

* storage cost
* cost of capital
* Cost of insurance.

→ Carrying costs are almost directly proportional to the order quantity.

ordering cost:- [S]

It is the cost of placing an order from a vendor. This includes all costs incurred from calling for quotations. to the point at which the item is taken into stock.

It consists of → Receiving quotations
→ Receiving materials and then inspecting it.
→ processing sellers invoice.

shortage cost :-

when an item cannot be supplied on the consumer's demand, the penalty cost for running out of stock is called "shortage cost"

ABC Analysis :-

⇒ ABC stands for Always Better Control

⇒ It helps segregating the items from one another and tells howmuch valued the item is and controlling it to what extent is in the interest of the organisation

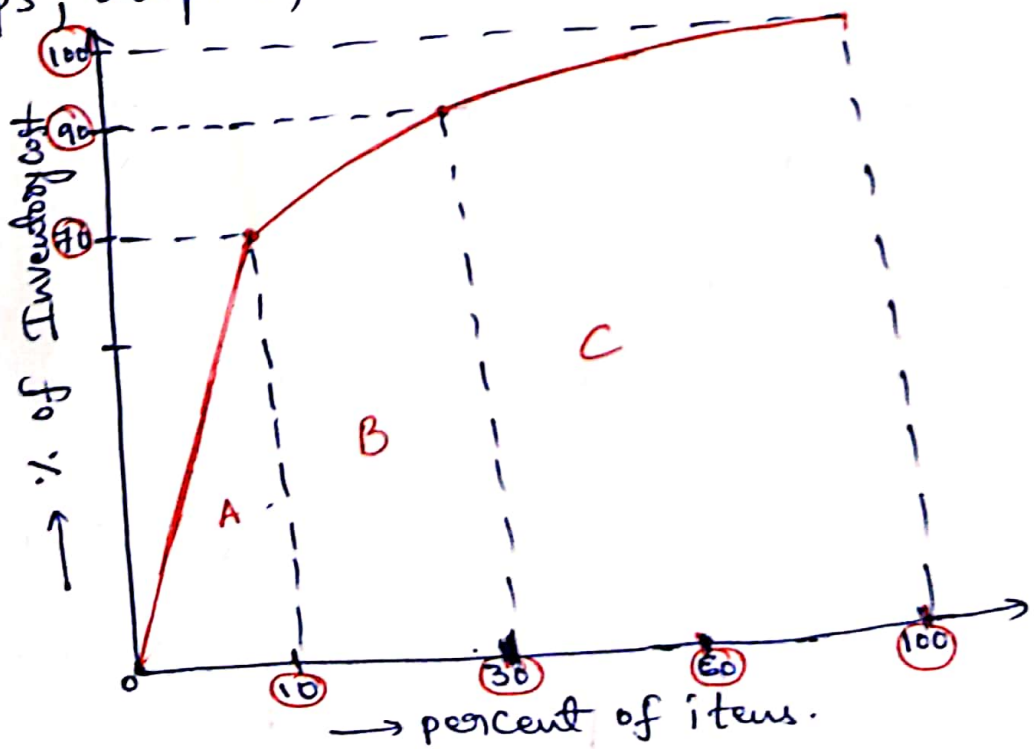
⇒ This policy can be applied in various other aspects of materials management such as purchase, sales, inspection, inventory control, store keeping etc---.

⇒ According to ABC analysis method of inventory control, all the items of the industry are divided into 3 groups, based on the percent of items and percent of value of items. They are -

① A-class items :- These are high valued but are limited or few in number. They constitute 10% of items but account for 70% of Total inventory cost. They need careful and close inventory control, proper handling and storage facilities.

(2) **B- Class items:-** These are medium valued but their number lies between A and C items. They constitute 20% of total inventory cost and about 20% of the total items, they need moderate control. They are more important than C- items. They are purchased on the basis of past requirements. These items being comparatively less costly, a safety stock of upto 3 months may be kept.

(3) **C- class items:-** they are low valued, but maximum numbered items. They constitute 10% of the total inventory cost and 70% of total items. These items donot need any control, rather controlling them is uneconomical. These are the least important items like clips, all pins, washers etc - - -



Advantages of ABC analysis :-

→ It becomes possible to concentrate all efforts in areas which need genuine efforts.

→ It is most effective and economical method as it is based on selective approach.

→ It helps in placing the orders, deciding the quantity of purchase, safety stock etc---

Limitations :- (ABC)

→ ABC analysis doesnot consider all relevant problems of Inventory control such as a firm handling adequate by low valued "C" items.

→ The importance of an item is computed based on its consumption value and not its criticality.

Applications :- (ABC)

→ ABC analysis can be effectively used in materials management such as

⟹ Controlling raw materials components

→ Controlling work in process inventories.

VED Analysis:-

→ VED stands for vital, essential and desirable.

→ this Analysis relates to the classification of maintenance spare parts and denotes the essentiality of stocking spares.

→ The spares are split into 3 categories in order of importance.

→ From the view-points of functional utility, the effects of non-availability at the time of requirement or the operations, process, production, plant or equipment or and urgency of replacement in case of breakdown.

V (Vital):-

→ vital items which render the equipment or the whole line operation in a process totally and immediately inoperative (or) unsafe; and if these items go out of stock or are not readily available, there is loss of production for the whole period.

E (Essential):-

Essential items which reduce the equipment's performance but donot render it inoperative or unsafe; non-availability of these items may result in temporary loss of production (or) dislocation of production work.

Desirable :-

→ Desirable items which are mostly non-functional and donot affect the performance of the equipment. However, the decision regarding the stock of spares to be maintained will depend notonly on how critical the spares are from the functional point of view but also on the Annual consumption cost of spares.

Economic order quantity (EOQ) :-

→ EOQ stands for Economic order quantity also known as the "wilson formulation"

→ This model is applied when objective is to minimize the total annual cost of inventory in organization.

→ Economic order quantity is that size of the order which helps in attaining the above set objective.

EOQ model is applicable for following conditions :-

→ Demand per year is deterministic in nature.

→ planning period is one year

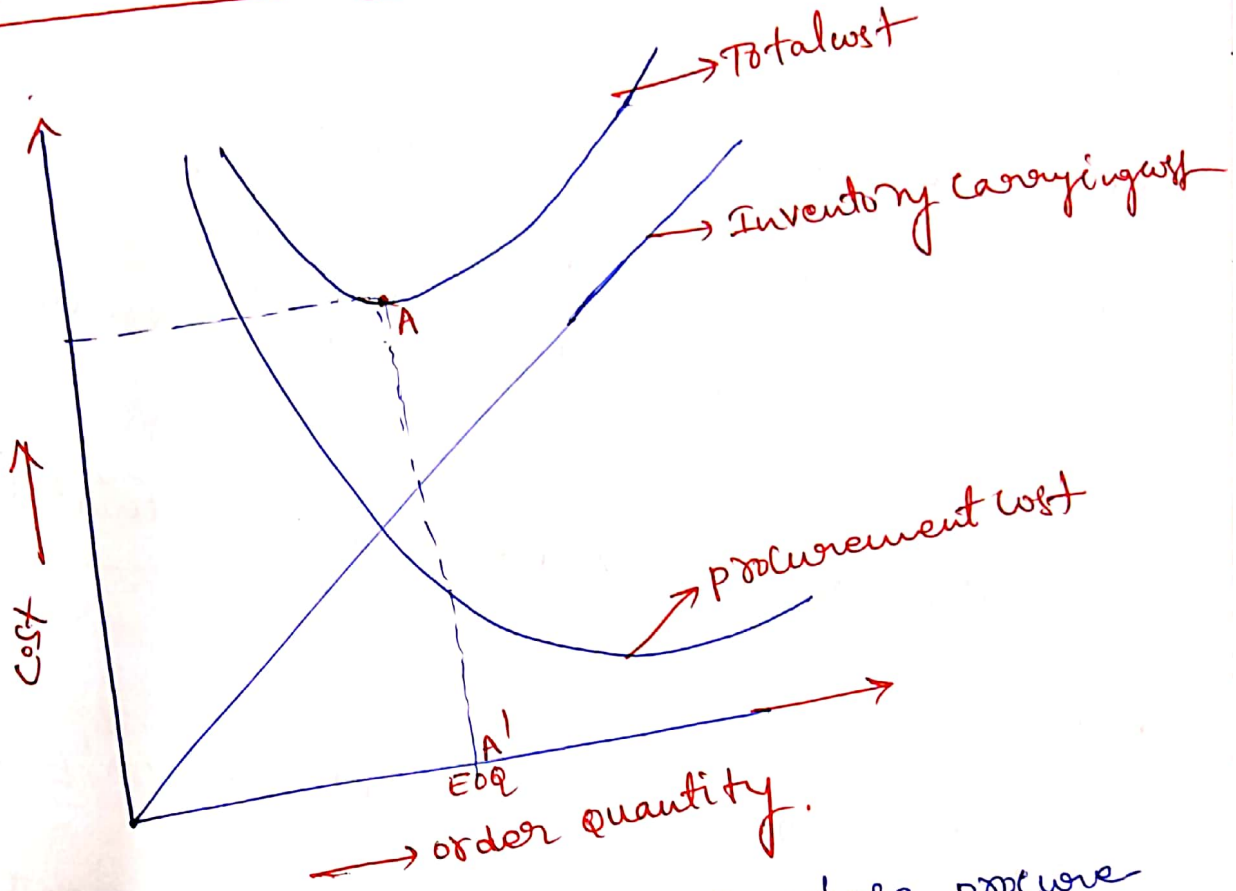
→ lead time is zero (or) constant and deterministic in nature.

→ Demand/consumption rate is uniform and known in advance.

→ Replenishment of items is instantaneous.

→ No stock out condition exist in the organization.

Relation between cost and quantity :-



The EOQ is obtained by the quantity whose procurement cost is equal to the Inventory carrying cost.

→ The total cost is calculated by adding procurement cost and carrying cost.

→ From the above Figure the procurement cost, Inventory carrying cost and total cost have been plotted with respect to quantity per order.

→ AS EOQ, is the quantity to be ordered, at a time, by reducing the total cost.

→ From the figure total cost is minimum at the point (A) and (A') Represents the economic order quantity EOQ. and at procurement cost is equal to inventory carry cost.

→ From the figure, we can say that procurement cost decreases as the order quantity increases and inventory carrying cost increases as the order quantity increases.

Derivation of EOQ mathematically calculated as given below :-

→ Q^* is the Economic lot size (or) EOQ

→ S is the set-up cost (or) procurement cost per order (or) ordering cost

→ H is the inventory carrying cost (or) Holding cost

→ D is the total items consumed per year

(or)

Demand per year

→ Co is Cost of each item.

Then total procurement cost per year = No. of orders placed in a year × procurement cost per order

$$= \frac{D}{Q^*} \times S$$

Inventory carrying cost per year =

Average inventory x annual inventory carrying cost per unit.

$$= \frac{Q^*}{2} \times H$$

Total cost = procurement cost + Inventory carrying cost

$$T.C = \frac{D}{Q^*} \times S + \frac{Q^*}{2} \times H \quad \rightarrow (1)$$

This total cost is minimum when

procurement cost = Inventory carrying cost

$$\frac{DS}{Q^*} = \frac{Q^*}{2} \times H$$

$$Q^{*2} = \frac{2DS}{H}$$

Economic order quantity $(Q^*) = \sqrt{\frac{2DS}{H}} \quad \rightarrow (2)$

Substituting the value Q^* in equation (1) we get

$$\text{Total cost} = \frac{DS}{\sqrt{\frac{2DS}{H}}} + \sqrt{\frac{2DS}{H}} \times \frac{H}{2}$$

$$= \frac{\sqrt{DSH}}{\sqrt{2}} + \frac{\sqrt{DSH}}{\sqrt{2}} = \frac{2\sqrt{DSH}}{\sqrt{2}} = \sqrt{2DSH}$$

Total inventory cost $= \sqrt{2DSH}$

Total annual cost = D × cost of each item + $\sqrt{2DSH}$

Total annual cost $= D \times C_0 + \sqrt{2DSH}$

problems:-

① Find Economic order quantity from the following data.

Average annual demand = 30,000 units

Inventory carrying cost = 12% of the unit value per year

Cost of placing an order = 70/-

cost of each unit = 2/-

Given:-

Demand (D) = 30,000 units

Carrying cost (H) = 12% of unit value.

$= \frac{12}{100} \times 2 = 0.24$

set up cost (S) = 70/-

$$EOQ\ (Q^*) = \sqrt{\frac{2DS}{H}}$$

$$= \sqrt{\frac{2 \times 30,000 \times 70}{0.24}}$$

$$Q^* = 4184 \text{ units}$$

(2) The rate of use of a particular raw material from stores is 20 units per year. The cost of placing and receiving an order is 40/-. The cost of each unit is 100/-. The cost of carrying inventory in percent per year is 0.16 and it depends on the average stock. Determine EOQ? If the lead time is 3 months. calculate reorder point?

Given:-

Demand (D) = 20 units/year

Setup cost (S) = 40/-

Cost of each unit = 100/-

Cost of carrying Inventory = 0.16 of each unit

Lead time (L) = 3 months

Inventory carrying cost (H) = $0.16 \times 100 = 16/-$

$$EOQ\ (Q^*) = \sqrt{\frac{2DS}{H}} = \sqrt{\frac{2 \times 20 \times 40}{16}}$$

$$Q^* = 10 \text{ units.}$$

Re-order point = Lead time × Annual Consumption per month

$$= 3 \times \frac{20}{12} = 5 \text{ units}$$

③ Annual demand of a particular product is 18,000 units. ordering cost is 400/- per order. Inventory carrying cost is 1.20/- per unit per year. Cost per unit is 1/-. Assume No shortages, determine

a) EOQ b) No of orders per year c) Time between orders d) Total inventory cost e) Total annual cost?

Given :-

$D = 18,000$ units/year

$S = 400$ /-

$H = 1.20 \times 1 = 1.20$

a) EOQ $(Q^*) = \sqrt{\frac{2DS}{H}} = \sqrt{\frac{2 \times 18000 \times 400}{1.2}} = 3465$ units

b) No of orders per year $= \frac{D}{Q^*} = \frac{18000}{3465} = 5.2 \approx 6$ orders

c) Time between orders $= \frac{Q^*}{D} = \frac{3465}{18000} = 70.2 \approx 71$ days

d) Total cost $= \sqrt{2DSH} = \sqrt{2 \times 18000 \times 400 \times 1.2}$

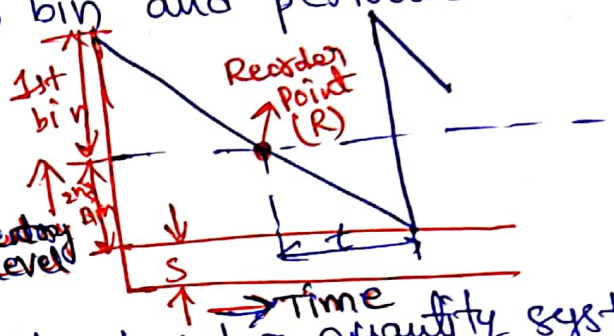
$= 4157$ /- per year

e) Total annual cost = D x cost of unit + Total cost

$= 18000 \times 1 + 4157 = 22,157$ /-

Inventory control systems:-

* ⇒ Two bin system, fixed order quantity system (or) Q system
* ⇒ periodic inventory ordering system (or) P-system.
⇒ combination of two bin and periodic inventory ordering system.



Two Bin System:-

⇒ It is also called as fixed order quantity system (or) mini-max system.

⇒ This is the oldest and most commonly used inventory control system. In this system the stock location of each item is divided in two sections (bins).

⇒ The first bin holds the normal issue stock and it is intended for satisfying current demand. The second bin holds the reserve supply of materials equal to the amount that will be consumed during the lead time plus safety stock if any. The second bin comes into use only after the first bin is emptied.

⇒ Therefore, when the first piece is withdrawn from the second bin, the purchasing order is to be initiated.

⇒ when a fresh stock is received, the level of the second bin, the purchasing order is to be initiated.

⇒ In most cases actual second bin is not always required. The reorder point quantity can be separated from the normal issue stock by wrapping it or by placing a separator.

Advantages:-

⇒ The main advantage of the two bin system is simplicity and reliability.

⇒ It is comparatively cheap to operate and easy to explain to new stock control personnel.

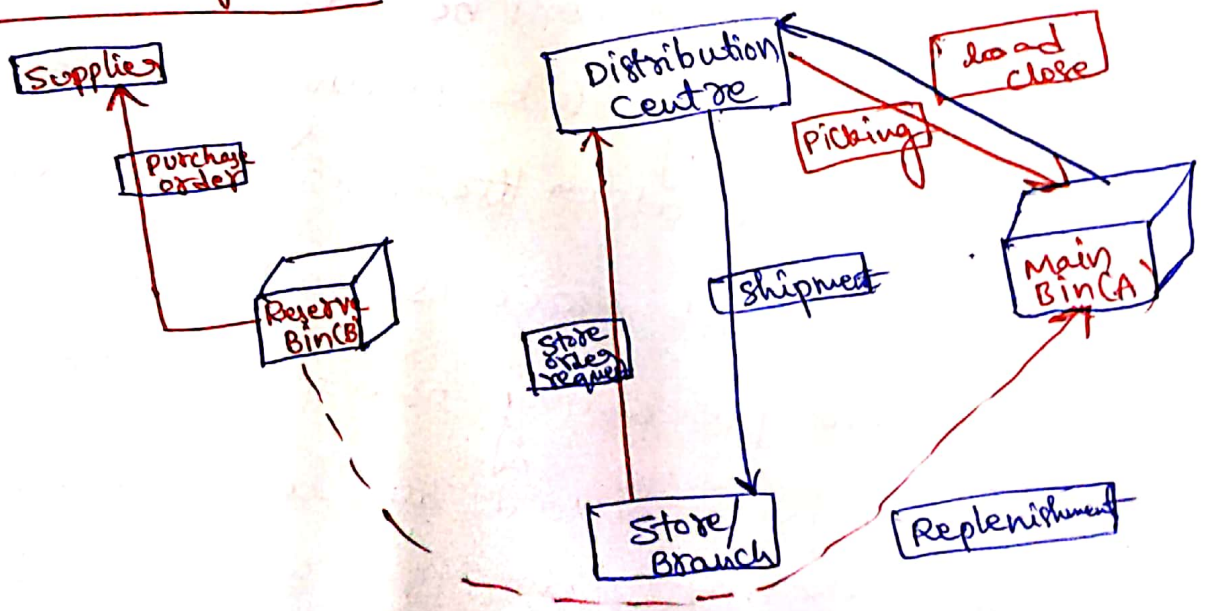
⇒ Reorder point is indicated easily.

⇒ Each item can be purchased in its most EOQ.

Disadvantages:-

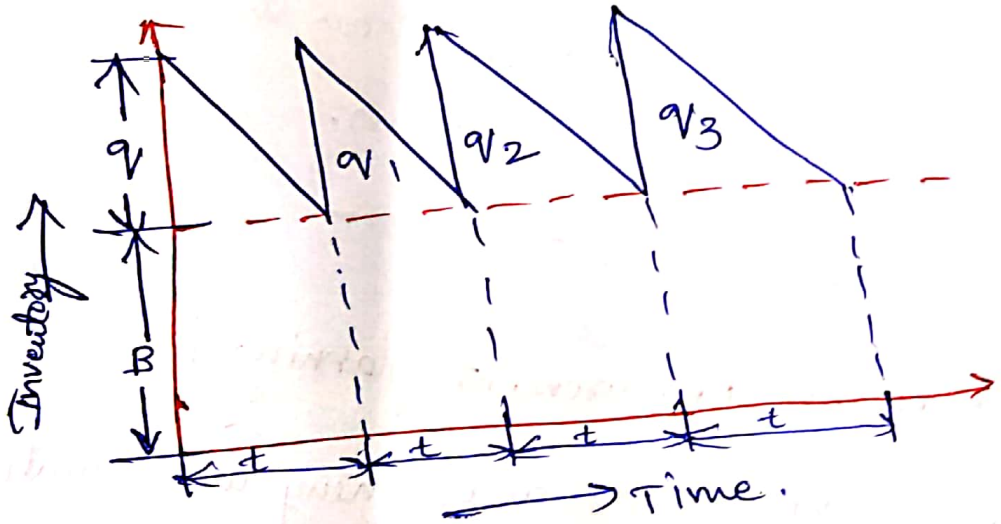
⇒ Because of absence of adequate data on stock levels and consumption rates in the simpler form, it is difficult to re-evaluate order quantity.

Two Bin system:-



periodic inventory ordering system :-

⇒ The periodic Inventory ordering system is based on periodic reordering of all items. Therefore in this system orders for replenishment are placed at fixed intervals of time. The order quantity is not fixed but the ordering Interval is fixed.



The order quantity is determined such that the total inventory is always brought up to certain level. In this system the fixed ordering Interval may be fortnightly, monthly, quarterly etc-- and order quantity is decided by conidering the balance stock.

Advantages:-

→ The main advantages of this system over the two bin system is that all orders for replenishment are issued at the same time.

→ The ordering mechanism is regular and not subjected to warning signals from the stores.

Disadvantages:-

⇒ usually, more stock is held when this system is adopted than with two bin system.

(*) MRP-I:- [Material Requirement planning]

⇒ MRP-I is a technique for determining the quantity and timing for the acquisition of dependent demand items needed to satisfy master production schedule requirements.

objectives:-

→ Inventory reduction.

→ Reduction in the manufacturing and delivery lead times.

→ Realistic delivery commitments.

→ Increased efficiency.

MRP-I System:-

A simple sketch of an MRP system is shown in below figure It can be seen from the figure that an MRP system has three major input components.

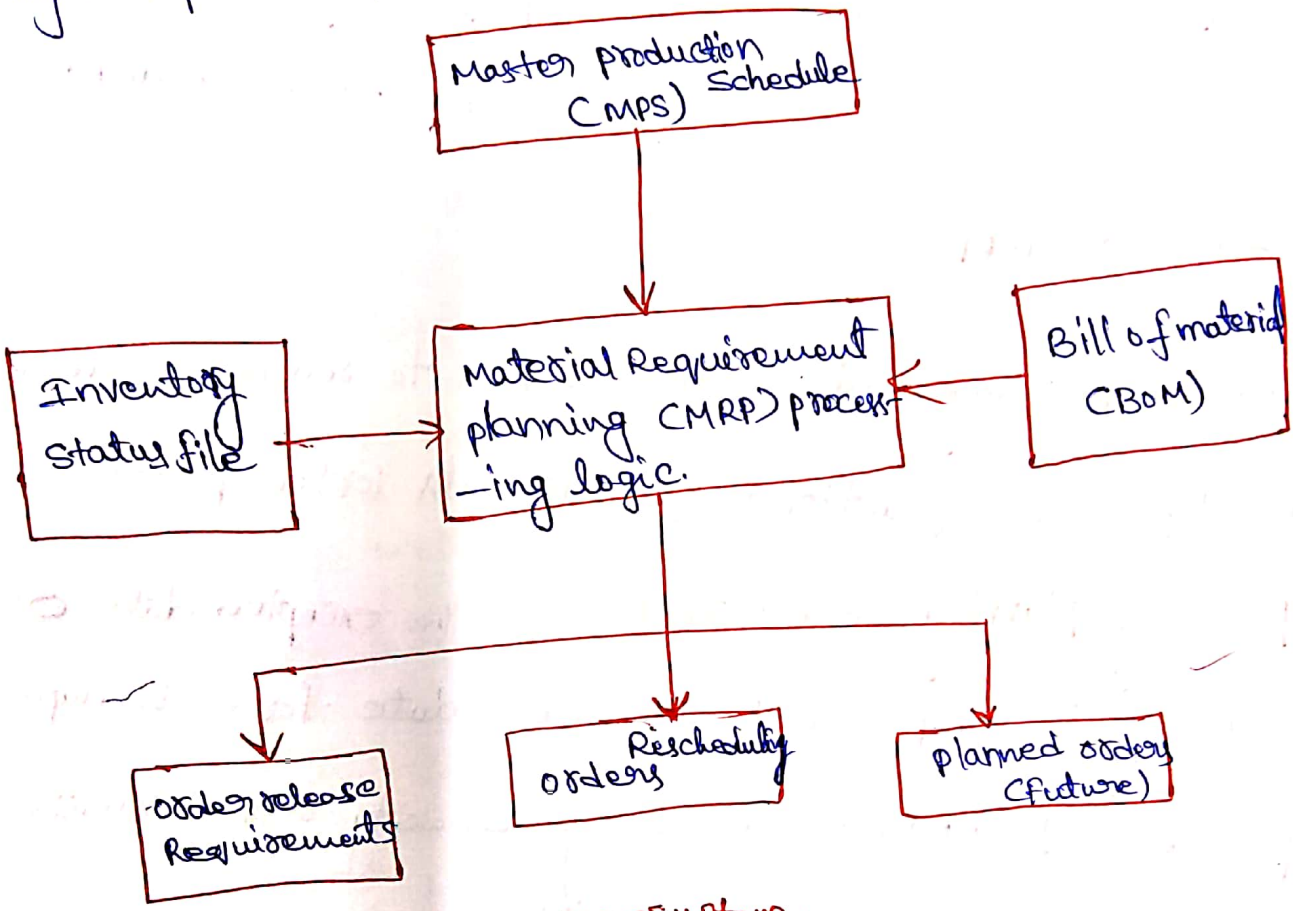


Fig:- MRP-I System.

Master production Schedule:- (MPS)

→ It is series of time phased quantities for each item that a company produces, indicating how many are to be produced and when.

Inventory status file :- Every inventory item being planned must have an inventory status file which gives complete information on hand quantities, gross requirements, scheduled receipts and planned order releases for item.

Bill of materials (BOM) :- To schedule the production of an end product, the MRP system must plan for all the materials, parts and subassemblies that go into the end product.

MRP logic :- Net requirements = project gross requirements
- (Inventory on hand scheduled receipts)

Functions of MRP :-

→ order planning and control :- when to release orders and for what quantities of materials (or) components.

→ priority planning and control :- How the excepted date of availability is compared to the need date for each component

→ provision of a basis for planning capacity requirements and developing a broad business plans.

Manufacturing Resource planning (MRPII)

→ "Manufacturing Resource planning is a system built around materials, requirements, planning and also Including the additional functions of production planning master production scheduling and capacity requirement planning".

MRP-II:-

Further, once planning phase is complete and plans has been accepted as attainable, the execution functions come into play. They include the shop floor control functions of input-output measurements, detailed scheduling and dispatching plus anticipated delay reports from the shops the vendors, purchasing, follow up and control etc--

⇒ MRP-II System again evolved from MRP System

⇒ MRP-II is a method for the effective planning of all resources of a manufacturing company.

MRP-II Benefits:-

→ Improved customer service
→ Improved productivity.
→ Reduction in purchase cost
→ higher Inventory turnover
→ Better financial planning
→ Improved cash flow
→ Better utilization of Machines.

MRP-II Limitations:-

→ Non availability of basic and accurate data
→ Complexity in manufacturing, planning and control
→ Lack of TOP Management support.
→ High initial cost of software.

A typical MRP-II system :-

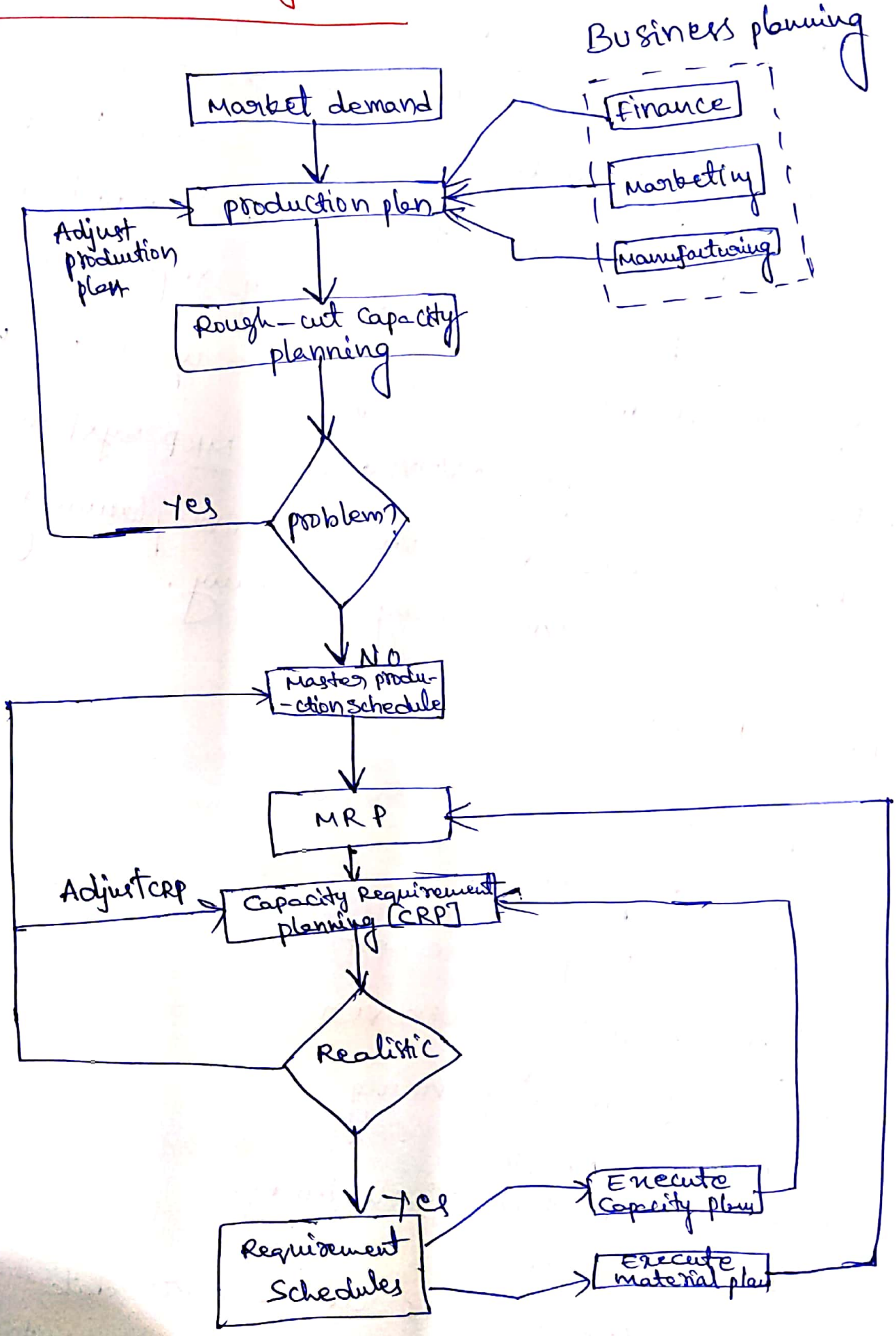


Fig:- MRP-II System -

ERP (Enterprise Resource planning):-

⇒ ERP is a software architecture that facilitates the flow of information among different functions of an enterprise.

⇒ It encompasses a broad set of activities. It is supported by multi-module application software, which helps the firm to manage its business activities that include product planning, purchasing, maintaining inventories, vendor/customer service and tracking orders.

⇒ Many application modules are common with the available ERP vendors.

⇒ Finance, HRD, logistics and manufacturing and supply chain are some of the commonly available application modules.

⇒ The core of the entire ERP system is integration of commonly designed applications and consolidating all business operations to uniform system environment.

features:-

→ It has an excellent planning and scheduling capability.

→ It offers significant gains in productivity.

→ It results in dramatic increase in customer service

→ It enables much higher inventory turns.

→ It provides greater selection in material costs.

Main features of ERP:-

→ A software architecture, which integrates all the functions of the business.

→ Integration is seamless i.e without apparent change in the decision and support system across different modules this is achieved through

a) common data base

b) Instant sharing of information, which is common and simultaneous.

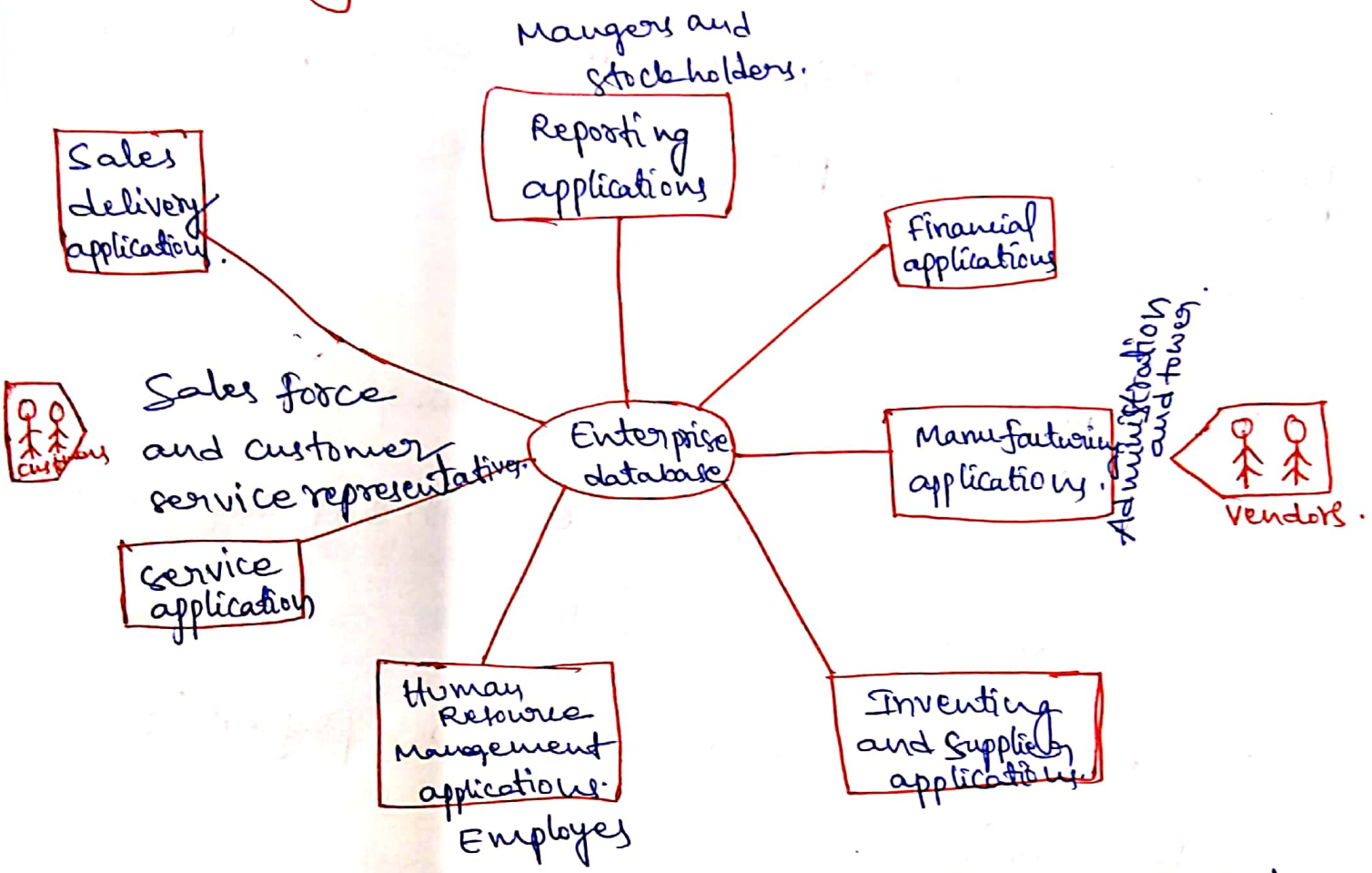
c) one time entry being sufficient for the entire enterprise to get updated.

→ Extremely powerful, user-friendly "graphic-user-Interface" GUI technology.

→ Supported by client server architecture for communication at different levels of the system.

→ uniform system environment.

Anatomy of an enterprise system :-



→ The integrated enterprise system is supported by a central database. which is also known as "enterprise database"

→ It works as a heart of the enterprise's models. Information is stored, updated, retrived and manged in this portion.

→ It draws data from and feed data into various enterprise applications that support different functions.

→ single database reduces information time-lag, reduces distortion in information.

Line of Balancing :- [LoB]

Line of Balancing is a manual planning and scheduling technique. It is utilised in determining production progress in terms of percent of task completion.

Objectives :-

→ To study the progress of jobs at regular intervals

→ To Compare the actual progress with that required to satisfy delivery requirements.

→ To identify those operations, in which progress is unsatisfactory.

* LoB technique is an example of management by exception since it deals only with the important (or) crucial operations in a job, establishes a schedule (or) plan for them.

* It is particularly useful where large batches of fairly complex items requiring many operations, are to be completed over a period of time.

Line of Balancing [LOB] technique consists of following five main stages :-

→ A graphical representation of the delivery objective.

→ A chart of production programme showing the sequence and duration of all activities required to produce a product.

→ A progress chart of the current status of component completion.

→ A Line of balance drawn to show the Relationship of Component progress to the output needed to meet the delivery schedule.

→ Analysis of progress.

———— x ————

JIT (JUST IN Time):-

It is defined as "philosophy that focuses attention on eliminating waste by purchasing or by manufacturing just enough of the right items just-in-time."

→ It is a Japanese management philosophy applied in manufacturing, which involves having the right items, of the right quality and quantity, in the right place, at the right time.

→ JIT refers to production and supply of required numbers of parts when needed.

Characteristics of JIT:-

→ JIT management allows an organisation to meet Consumer demand regardless of the level of demand. It is made possible through the use of a pull system of production.

→ JIT allows a reduction in raw materials, work in process and finished goods inventories.

→ JIT production technique uses containers for holding parts. It allows easy identification and monitoring of inventory levels.

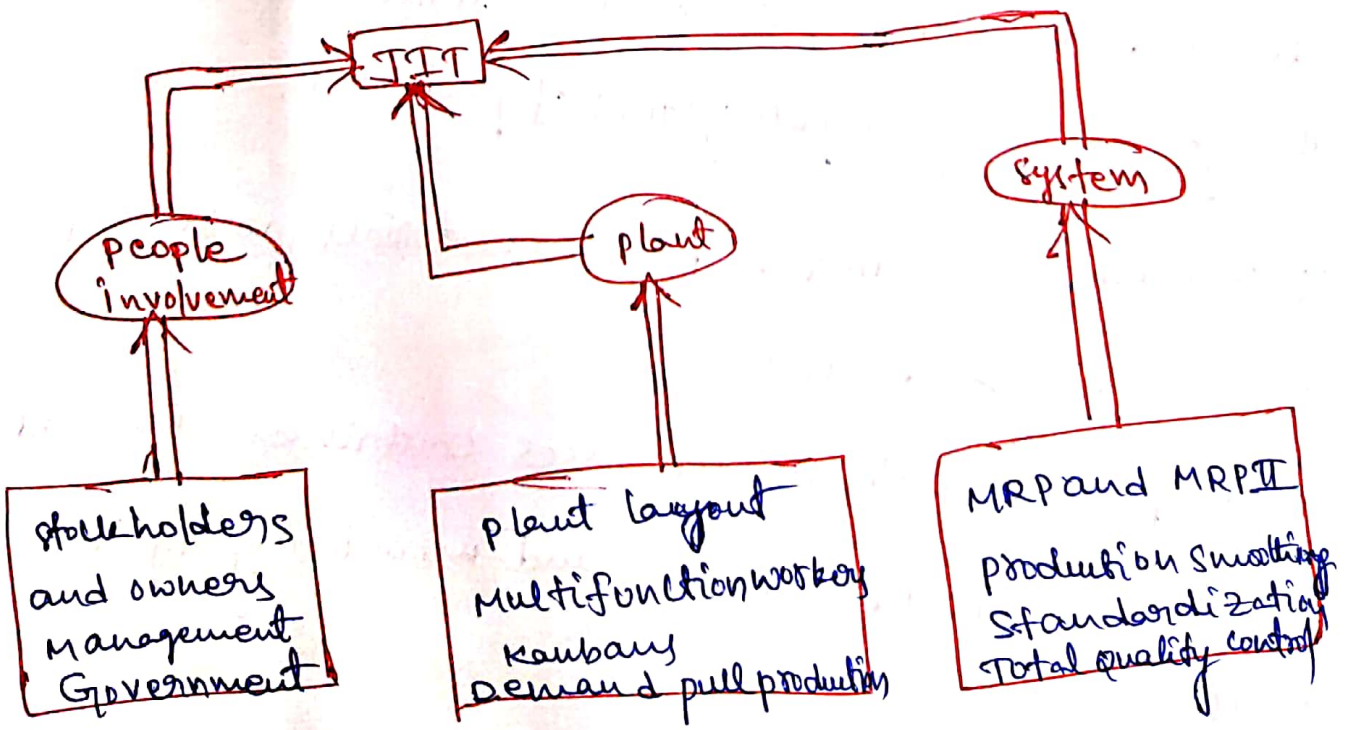
→ JIT production involves the use of "visible signals" to display the status of machinery.

Elements of JIT :-

→ JIT manufacturing consists of several components (or) elements, which must be integrated together to function in harmony for its succesful implementation.

→ These elements essentially include the human resources and the production, purchasing, manufacturing, planning and organising functions of an organisation. These elements can be grouped together in production system of people, plants and systems.

JIT System :-



Benefits :-(JIT)

→ improved quality
→ increased flexibility, lower costs and higher productivity
→ Less inventory of raw materials.
→ improved working relations between employees.
→ higher profits, reduction in lead time to customer and improved customer satisfaction.
→ Stronger and more reliable working relations with suppliers.

limitations of JIT :-

→ There is no flexibility
→ There is no safety stock to offset inaccurate demand forecasts
→ JIT production is effective only when the daily demands are fairly stable.

KANBAN system:-

A kanban system is a system of inventory and production control which uses kanbans as the principal information transmission device. kanban is a Japanese word meaning signal.

Functions of the kanban:-

→ They are used as a means for process improvement, which helps to reduce the level of inprocess inventories.

→ The role played by kanban in production control is to tie the different manufacturing processes together and to ensure that the necessary amount of materials and parts arrive at the appropriate time and place.

→ The operation of the basic kanban system can be described using the interchange between a preceding workstation supplying partially processed items or components to a succeeding workstation. Basically there are two types of kanbans

- → withdrawal kanban
- → production kanban

→ The withdrawal kanban is used to indicate the type and amount of product, which the next process should withdraw from the preceding process.

→ The production kanban specifies the type and quantity of product, which the next process must produce.

⇒ kanban System aims at continuous reduction of inventory.

UNIT-4

Routing and Scheduling

Routing:-

Routing may be defined as the selection of the path which each part of the product will follow, while being transformed from raw material to finished products.

⇒ path of the product will also give sequence of operations to be adopted while manufacturing.

Routing involves the following analysis:-

⇒ Type of work to be done on product or its parts

⇒ operation required to do the work

⇒ sequence of operations required

⇒ where the work will be done

⇒ A proper classification about the personnel required and the Machine for doing the work.

For effective control of a well managed industry with standard conditions, the routing plays an important role, so as to get best results obtained from available plant capacity. Thus routing provides the basis for scheduling, dispatching and followup.

Routing procedure :-

*① **Analysis the product :-** The finished part is analysed to determine the parts / components / subassemblies etc -- required for the product.

*② **Make or buy decision :-** It means to decide the whether all components are to be manufactured in the plant itself or some are to be purchased from outside suppliers. Make or buy decision depends upon the workload in the plant already existing, availability of equipment, skills, know how and economic considerations.

*③ **Raw material requirements :-** A part list is prepared, which contains drawings, specifications, standard of quality and identification symbols. A bill of materials is also prepared combined with the part list. It shows name of part, identification number, quantity required, material specification, amount of material required for each part.

*④ **Determine the manufacturing operations and their sequence :-**

The operations necessary to manufacture the article are determined. They are arranged in a proper sequence and listed.

*⑤ **Determine the lot size :-** It depends primarily on the type of manufacture involved. If the product is to be manufactured strictly to a sold order, the quantity to be made will usually equal to that required for the customer orders.

* (6) Determine the scrap factor and rejections at each stage of production.

* (7) Estimate the cost of the product. The routing selection also depends on cost accounting department for cost estimation of the product.

* (8) Machines to be used, their capacity also listed.

* (9) Time required for each operation and also sub assemblies is listed.

* (10) prepare Routsheet :- the data thus obtained is utilised for ~~depart~~ preparing routesheets, production order form, job card, labour card, inspection card, toolticketsetc---

⇒ Routesheets :-

→ The operation sheet and the Routesheet differ only slightly. An operation sheet, shows everything about the operations Ex:- operation descriptions, their sequence, type of machinery, tools, jigs and fintures required, set up and operation times.

→ where as routesheet also details the section and the particular Machine, on which the work is to be done. The operation sheet will remain the same if the order is repeated but the route sheet may have to be revised if certain machines are already engaged to other orders on-hand.

Except this small difference both sheets contain practically the same information and thus generally combined into one sheet known as operation and routesheet.

⇒ The route sheet also provides the sequence of various orders as well as best/optimum sequence for the desired operations taking into consideration the resources available. This can be done by sequencing assignment, CPM and PERT methods.

The following points must be kept in mind for drawing route sheets:-

→ The machines are to be operated at full capacity

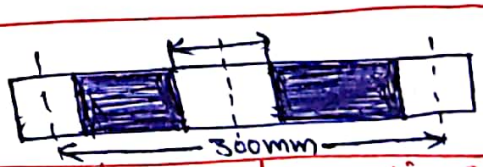
→ The product passes through those work centres, which are manned by best possible personnel.

→ The route is shortest and economical

→ The person solving routing problem should be well-acquainted with various operations.

Routesheet

Part No. Ac/57
Name: Gear
Material: M.S
Quantity - 100 Nos.



Department	Machine	operation	Description	Tool	Jigs/Fixtures	time	
						setup time	operation time
Smithy	Power hammer PH/15	1 2	Forge leaving for all over Punching the hole in the forging	–	–	4 hrs 1 hr	30 min 25 min
Heat treatment	Furnace F/H/4	3	Normalising	–	–	4 hrs	4 hrs
Machine shop	Centre lathe C/L/5	4	Face two ends, turn outer and inner face	lathe tool	Chuck	15 min	1 hr
	Milling machine M/M C/15	5	Cut teeth	Side and face cutter	Dividing head	40 min	5 hrs
	Slotter SL/7	6	Make keyway	Slotting tool		10 min	30 min
		7					

Bill of materials:-

⇒ After proper analysis of the product the quality and quantity of materials required is determined and the bill of materials as shown in below figure.

→ From this proforma the quantity of material required for each part is known and accordingly can be procured. Some firms prepare separate lists for finished components and raw materials To know - how much material is to be purchased or procured the amount of materials in the stores should be known.

Bill of material

Date: Ref. Drg. No.

Part No.

Sl No	Part No.	Name of the part	Drg. No	Input material					No. off	wt. piece	Total	Remarks
				Finished components		Raw material						
				Name	Specifi-cation	Length	Width	Thickness				

Factors affecting routing procedure :-

→ Type of manufacturing process / Technique employed.

→ plant equipment characteristics.

→ Availability of plant and equipment etc.

→ Difficulties in Routing due to non-availability of requisite Skilled Manpower.

① Type of manufacturing process :-

It is the case of use of line type of layout where the production process is serialized according to the sequence of operations, thus making routing automatic. Automobile industries adopt this type of layout. The setup requires change only when new models are introduced. The same type of routing may be adopted in batch production also.

② plant equipment characteristics :-

The same product may be possible to manufacture on two or many machines avaible in the plant. in such cases the cheapest one should be selected, whether small, heavy and automatic or mechanised machine for routing propose.

③ availability of plant and equipment :-

Recommended actions have to be taken in order to select that equipment or machines, which will help in production

of parts at cheapest rate. but sometimes the services of such machines or processes may not be available due to machine load conditions, breakdowns or absenteeism of workers. in such conditions, the routing division must have alternatives available to keep the materials moving for manufacturing of the product. This alternative may be in the form of detours around the breakdown machines or by changing the sequence of operations.

(4) Difficulties in Routing due to Non-availability of requisite skilled manpower:-

→ Manpower required in the plant may be highly skilled, semi skilled (or) unskilled. on certain particular machines, where high precision work is done, only services of experienced highly skilled workers can be utilized. Routine work may affect the routing procedure in content to manpower are job incentives, lot size, light, heavy or medium sized work .etc--

Advantages of Routing:-

→ Effective utilization of available resources
→ Reduction in production costs.
→ quality improvement occurs.
→ productivity of the system improves
→ provides a basis for loading & scheduling.

Scheduling:-

It is defined as the determination of time that should be required to perform each operation and also time necessary to perform the entire series as routed, making allow-ances for all factors concerned.

Factors affecting scheduling:-

⇒ External factors

⇒ Internal factors

External factors:-

The external factors are the factors, which are not within the control of the management. They are dictated by the outside forces, to which the management tries to adjust.

→ important external factors are

* Customer's demand
* Customer's delivery dates
* Stock of goods already lying with dealers and retailers.

Internal factors:-

These are the factors, which are with in the control of the management. These factors should be manipulated in such away that objectives of the production function can be achieved most efficiently and economically.

Some internal factors are:-

→ stock of finished goods with the firm.
→ Time interval to process finished goods from raw material.
→ availability of equipment and machines.
→ Availability of manpower.
→ Availability of materials.
→ Additional manufacturing facilities if required.
→ Feasibility of economic production runs.

Scheduling difference with loading:-

⇒ loading is concerned with assigning jobs to work centers and corresponding to various machines in the work Centers.

⇒ Approaches to loading work centers.

Infinite loading:- In Infinite loading jobs are assigned to work centers without considering the capacity of the work centers.

Finite loading:- Finite loading estimates the actual start and stop time of each job at each work centers.

objectives of loading and scheduling:-

→ Scheduling aims to achieve the required rate of output with a minimum of delay and disruption in processing.

→ To provide quantities of goods necessary, to maintain finished inventories at levels predetermined to meet delivery commitments.

→ The aim of loading and scheduling is to have maximum utilization of men, machines and materials by maintaining a free flow of materials along the production line.

→ To prevent unbalanced allocation of time among production departments or work centers with a view to eliminate idle capacity.

→ To keep the production cost minimum.

———— x ————

UNIT-5

Scheduling

⇒ Scheduling is defined as the determination of time that should be required to perform each operation and also time necessary to perform the entire series as routed, making allowances for all factors concerned.

Principles of Scheduling:-

→ **principle of optimum task size:-** Scheduling tends to achieve maximum efficiency when the task sizes are small, and all tasks of same order of magnitude.

→ **principle of optimum production plan:-** the planning should be such that it imposes an equal load on all plants.

→ **principle of optimum sequence:-** Scheduling tends to achieve the maximum efficiency when the work is planned so that work hours are normally used in same sequence.

Types of Scheduling:-

① Forward Scheduling

② Backward Scheduling.

1. Forward Scheduling:-

⇒ It is commonly used in job shops where customers

place their orders on "needed as soon as possible" basis.

→ Forward scheduling determines start and finish times of next priority job by assigning it the earliest available time slot and from that time, determines when the job will be finished in that work centre.

→ Since the job and its components start as early as possible, they will typically be completed before they are due at the subsequent work centres in the Routing.

→ The forward method generates in the process inventory that are needed at subsequent work centres and higher inventory cost.

→ Forward scheduling is simple to use and it gets jobs done in shorter lead times, compared to back scheduling.

Backward scheduling:-

→ It is often used in assembly type industries and commit in advance to specific delivery dates.

→ Backward scheduling determines the start and finish times for waiting jobs by assigning them to the latest available time slot that will enable each job to be completed just when it is due, but done before.

→ By assigning jobs as late as possible, backward scheduling minimizes inventories since a job is not completed until it must go directly to the next work centre on its routing.

Scheduling policies :-

There are different scheduling policies which are described below.

→ First come first serve (FCFS)

→ shortest job first (SJF)

→ priority scheduling

→ Round Robin Scheduling.

First come first Serve (FCFS) :-

⇒ This algorithm is the simplest scheduling algorithm.

⇒ processes are dispatched according to their arrival time on the ready queue. being a non-pre emptive discipline, once a process has a CPU, it runs to completion.

⇒ The FCFS scheduling is fair in the formal sense.

⇒ FCFS is more predictable than most of other schemes since it offers time.

⇒ xFCFS scheduling is simple to write and understand. the code for

Advantages :-

⇒ Easy to implement.

⇒ It is very simple.

⇒ It is also intuitively fair.

Disadvantages :-

→ problematic with some time sharing systems.

→ Average waiting time is very large.

Shortest Job first :- [SJF]

⇒ It is a non preemptive discipline in which waiting job with the smallest estimated run-time-to completion is run next.

⇒ The SJF scheduling is especially appropriate for batch Jobs for which the run times are known in advance.

⇒ The SJF algorithm favours short jobs at the expense of longer ones.

Advantages :-

⇒ overall performance is significantly improved interms of response time.

⇒ It is having least average waiting time and average response time

Disadvantages :-

⇒ There is a risk of Starvation of longer processes

⇒ It is difficult to know the length of the next CPU burst time

—X—

Scheduling Techniques :-

⇒ Mathematical analysis. ① CPM ② PERT

* critical path Method :- [CPM]

The critical path in the CPM method plays an important role in planning and scheduling. A critical path is the time wise longest path in a network In CPM network a critical path is the one which passes through critical activities. In CPM, an activity has only one time estimate.

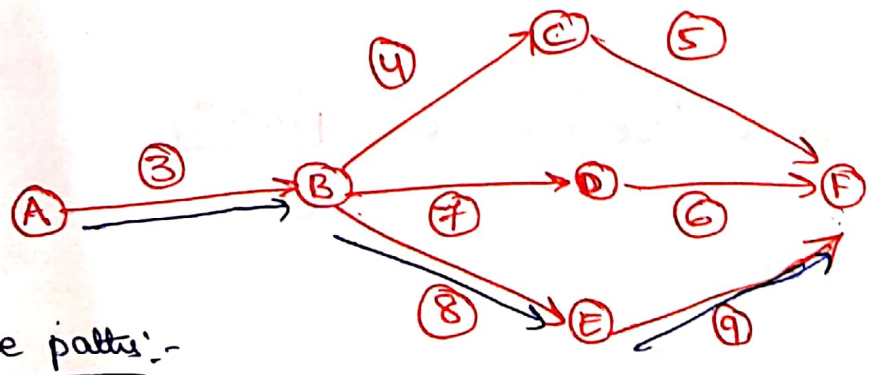
⇒ CPM network generally used in

a) for repetitive type projects.

b) for the projects for which fairly accurate estimate time for completion of each activity can be made.

c) for which cost estimations can be made with fair degree of accuracy

CPM Network :-



Possible paths :-

A - B - C - F = 12
A - B - D - F = 16
A - B - E - F = 20

Critical path :-

A - B - E - F = 20

⊛ Program Evaluation and Review Technique:- (PERT)

⇒ It is a technique used for scheduling and controlling the projects whose activities are subjected to considerable degree of uncertainity in performance time.

⇒ PERT can be employed at those places where a project cannot be easily defined in terms of time or resources required.

⇒ PERT technique proves very much advantageous when used for non-repetitive type of projects, R&D, defence projects, etc---.

⇒ PERT has three time estimates.

3 Time estimates for PERT:-

⇒ optimistic time (t_o) → minimum possible time

⇒ most likely time (t_m) ⇒ It is lies between t_o & t_p

⇒ pessimistic time (t_p) → Maximum possible time to complete work.

$$\text{Expected time } (t_e) = \frac{t_o + 4t_m + t_p}{6}$$

Standard Scheduling Methods:-

⇒ The scheduling Methodology depends upon the type of Industry, organization, product and level of sophistication required. They are

① Gantt charts and boards

② priority decision rules

③ Mathematical programming methods.

* linear programming model

* PERT/CPM network model.

① Gantt charts and Boards:-

⇒ Gantt charts and associated scheduling boards have been extensively used scheduling devices in the past, although many of the charts are now drawn by computer.

⇒ Gantt charts are extremely easy to understand and can quickly reveal the current or planned situation to all concerned.

⇒ They are used in several forms namely, scheduling or progress charts, which depicts the sequential schedule, load charts, which show the work assigned to group of workers or machines and Record a chart, which are used to record the actual operating times and delays of

workers and machines.

② Priority decision Rules :-

⇒ These rules are simplified guidelines for determining the sequence in which jobs will be done.

⇒ Some firms these rules take the place of priority planning systems such as MRP systems.

⇒ Following are the some priority rules

FCFS → First come first served

EDD → Earliest duedate

LS → Least slack [least processing time)

SPT → Shortest processing time

LPT → longest processing time.

③ Mathematical programming methods :-

⇒ Scheduling is a complex resource allocation problem.

a) linear programming model :-

⇒ Here all the constraints and objective functions are formulated as a linear equation and then problem is solved for optimally. Simplex method, transportation methods and Assignment method are major methods used here.

b) PERT/CPM network Model :-

This network is the network showing the sequence of operations for a project and the precedence relation between the activities to be completed.

Line Balancing :-

⇒ It is defined as the process of assigning tasks to work stations in such a way that the workstations have approximately equal time requirements.

objectives of line balancing :-

⇒ To equalize the work load among the operations.

⇒ To identify the [bottleneck] operation
↓
The workstation taking the longest time.

⇒ To establish the speed of the production line.

⇒ To determine the number of workstations.

⇒ To determine the labour cost of production and packout.

⇒ To establish the percentage workload of each operator.

⇒ To assist in plant layout.

⇒ To reduce production cost.

Line balancing factors:-

⇒ The problem of line balancing is particularly important in product layout. It may arise due to the following factors.

* the finished product is the result of many sequential operations.
* The production capacity of each machine/workstation in the sequence is not identical.

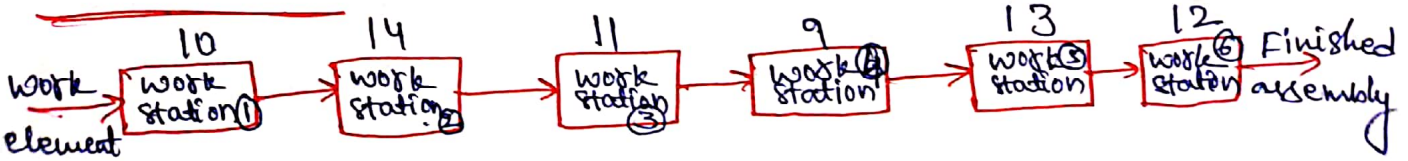
⇒ In an assembly line, the problem is to design the work-stations.

⇒ Each workstation is designed to complete a few processing and assembly tasks.

⇒ The line balancing problems may be looked upon as problems of minimising idle time along the production line resulting from unequal task times assigned to various workstations

⇒ let us consider a six station assembly system, in which the station times are:- 10, 14, 11, 9, 13 and 12 minutes. The slowest station is station 2, which takes 14 minutes while station 4 is fastest with 9 minutes of station time.

Station time (min):-



* Six station assembly system

Aggregate planning :-

Aggregate planning is to determine the planned production quantity by period to meet forecast demand over a medium range planning horizon.

⇒ Aggregate plan is a broad level plan used by the managers to plan and control operations.

The main objectives of aggregate planning :-

⇒ Maximize Customer service
⇒ Minimize inventory investment
⇒ Minimize changes in work force levels
⇒ Minimize changes in production rates
⇒ Maximize utilization of plant and equipment.

Costs Relevant with Aggregate planning :-

⇒ payroll costs
⇒ Costs of overtime, second shifts
⇒ costs of hiring and laying off workers
⇒ Costs of excess inventory and backlog.
⇒ Costs of production rate changes.

The behaviour of cost with respect to changes in decision variables is not easy to quantify. However, often approximations are made by assuming the costs to be linear (or) Quadratic function of the approximate Decision variable.

Problem structure:-

Single stage aggregate planning decision system:-

The simplest structure of the aggregate planning problem is represented by the single stage system. In a single stage system, the planning horizon is only one period ahead. The stage of the system at the end of the last period is defined by W_0, P_0, and I_0

W_0 = aggregate work force size

P_0 = the production (or) activity rate

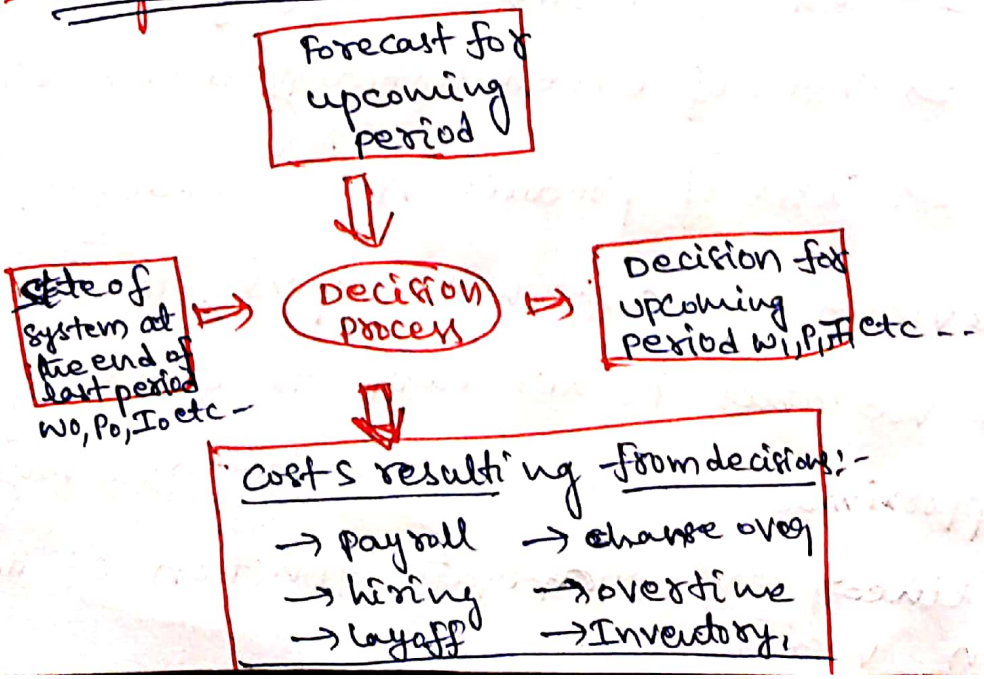
I_0 = the Inventory level

The ending state conditions for one period become the initial conditions for the upcoming period.

∴ projected ending inventory $I_1 = I_0 + P_1 - F_1$

F_1 → forecasted sales

Fig:- Single stage aggregate planning decision system.



Aggregate planning strategies:-

There are two pure planning strategies available to the aggregate planner:-

1. Level strategy
2. Chase strategy (or) Chase planning.

Level Strategy:-

⇒ A level strategy seeks to produce an aggregate plan that maintains a steady production rate and steady production level.

⇒ In order to satisfy changes in customer demand, the firm must raise or lower inventory levels in anticipation of increased or decreased levels of forecast demand.

⇒ The firm maintains a level workforce and a steady rate of output when demand is somewhat low.

⇒ this allows the firm to establish higher inventory levels than are currently needed.

⇒ As demand increases, the firm is able to continue a steady production rate/steady employment level, while allowing the inventory surplus to absorb the increased demand.

⇒ A second alternative would be to use a backlog (or) backorder.

⇒ A level strategy allows a firm to maintain a constant level of output and still meet demand.

Chase strategy (or) chase planning :-

⇒ A chase strategy implies matching demand and capacity period by period.

⇒ This could result in a considerable amount of hiring, firing or laying off of employees, insecure and unhappy employees, increased inventory carrying costs; problems with labour unions, and erratic utilization of plant and equipment.

⇒ It also implies a great deal of flexibility on the firm's part.

⇒ The major advantage of chase strategy is that it allows inventory to be held to the lowest level possible and for some firms this is a considerable savings.

⇒ Most firms embracing the just-in-time production concept utilize a chase strategy approach to aggregate planning.

⇒ Most firms find it advantageous to utilise a combination of the level and chase strategy.

⇒ A combination strategy can be found to better meet organizational goals and policies to achieve lower costs than either of the pure strategies used independently.

Aggregate planning Methods/Techniques:-

① Trial and error method

② Mathematical method.

⇒ Techniques for aggregate planning range from informal trail and error approaches, which usually utilize simple tables or graphs, to more formalized and advanced mathematical techniques. This general procedure consists of following steps.

① Determine demand for each period.

② Determine capacity for each period. This capacity should match demand, which means it may require the inclusion of overtime or subcontracting.

③ Identify the company, departmental or union policies that are pertinent.

④ Determine unit costs for units produced. These costs typically include the basic production costs [fixed and variable costs as well as direct and indirect labour costs.]

⑤ Develop alternative plans and compute the cost for each.

⑥ If satisfactory plans emerge, select the one that best satisfies objectives.

—x—

Expediting:-

⇒ Expediting is a concept in purchasing and project management for securing the quality and timely delivery of goods and components.

Controlling aspects:-

⇒ The procument department or an external expeditor controls the progress of manufacturing at the supplier concerning quality, packing, conformity with standards and set timelines.

⇒ Thus the expeditor make sure that the required goods arrive at the appointed date in the agreed quality at the agreed location.

⇒ Expediting exists in several levels:-

① * production control:- The expeditor inspects the factory whether the production is upto the standards of the country the goods are destinated for.

② * Quality control:- The components are tested whether the function as required standards of customer.

③ * Packing :- This is the lowest & most used level of expediting

④ * Project management:- At a large scale project not only goods are controlled.

Purpose of Expediting:-

Expediting is especially needed in large scale projects

Ex:- In ship building or when a refinery is being erected, because a delay caused by late delivery.

* To save this unnecessary costs and minimise the potential risks, the supplier and customer may agree on the use of third party expeditor.

———— ✕ ————

UNIT-6

Dispatching and Follow up

Dispatching:-

⇒ Dispatching function executes planning function. It is con -cerned with getting the work started.

⇒ Dispatching ensures that the plans are properly implemented.

⇒ Dispatch function authorizes the workers to do the work.

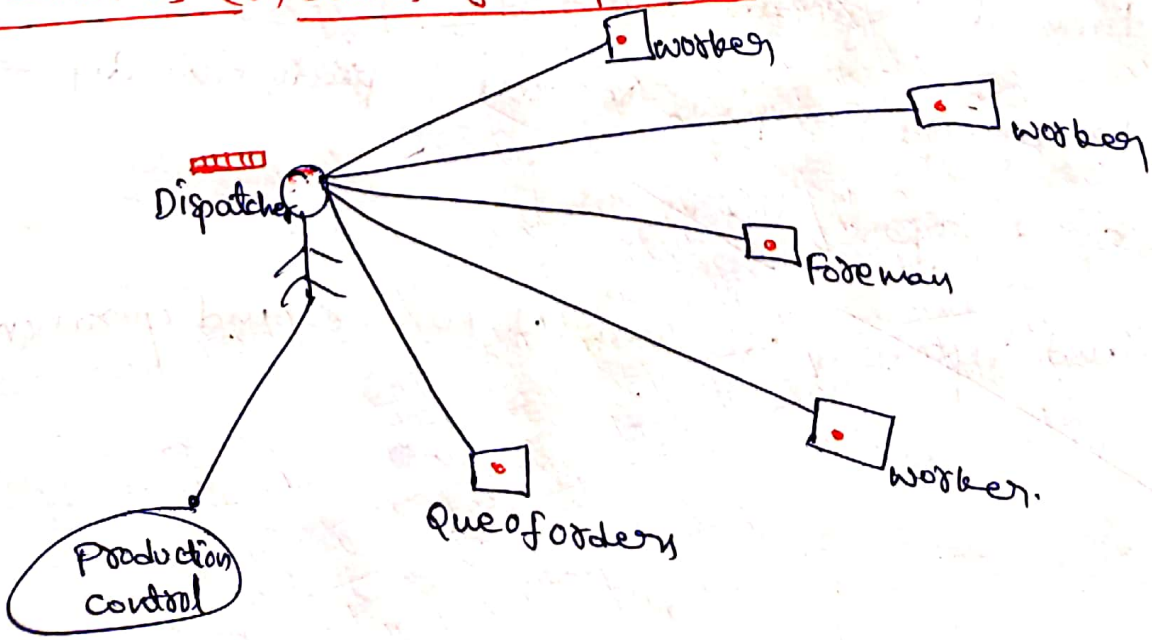
⇒ The information collected in scheduling and route sheet is transmitted into the orders.

⇒ The prepared orders are released to the concerned departments for actual implementation.

⇒ It is also important mechanism of production control.

⇒ The meaning of dispatching is sending to destination or starting something on way.

Activities (or) Duties of Dispatcher :-



Activities of Dispatcher:-

⇒ Assignment of work to different machines of work placemen.

⇒ Movement of material from stores to the first process and from process.

⇒ Issue of tool orders, instructing the tool department to collect and make ready jigs and fixtures in advance of time, at which the operation will commence

⇒ Issue of time ticket, drawing, instruction cards & other necessary information presented performing the work.

⇒ Issue of inspection order after each operation to determine the result in the number of pieces "good" and the "bad" and cause of spoilage.

⇒ Issue of more orders and collection of time tickets, drawings, instruction cards for all completed operations.

⇒ Recording time of beginning and completing jobs hand calculate duration of forwarding complete records to production department and time card pay roll department.

⇒ Recording and reporting idle time of machine and operation.

Functions of Dispatching :-

⇒ Assignment of work to individual men, machine or workplace

⇒ Release necessary orders and production forms.

⇒ Authorise for issue of materials, tools, jigs, fixtures, gauges, dies for various jobs.

⇒ Required material are authorised to move from stores (or) from operation to operation.

⇒ Issue machine loading and schedule charts, route sheets and other necessary instructions and forms to be filled up.

⇒ To issue inspection orders stating the type of inspections required at various stages.

⇒ To issue job orders authorising operations, in accordance with the planned schedule.

⇒ Issue of time tickets, drawings, instruction cards and other necessary informations.

⇒ Issue necessary formats to exercise production control.

Terminology used in Dispatching :-

a) **Store issue order :-** Authorise stores to deliver required raw material.

b) **Tool order :-** Authorise tool store to release the necessary tools. The tools can be collected by the tool room attendant.

c) **Job order :-** Instruct the worker to proceed with the operation

d) Time ticket :- It records the beginning and ending time of the operations and forms the basis for worker's pay.

e) Inspection order:- Notify the inspectors to carry out necessary inspections and report the quality of the component.

f) Move order:- Authorise the movement of materials and components from one facility (machine) to another for further operations.

Dispatching procedures :-

⇒ Manner in which schedule or orders are issued depends upon whether the dispatching is in the

→ Decentralized
→ centralized

⇒ In the Decentralized dispatching :-

- The manufacturing schedules or work orders in blanket fashion to the foreman or dispatch clerks with in department
- It is duty of foreman or clerk to dispatch the orders of material to each machine and operator.

⇒ In the centralized dispatching :-

- This involves the dispatching of orders from central dispatching division to machine or work station.

* capacity and characteristic of each machine is recorded in central dispatching station.
* Regardless of type of dispatching it is customary for department to department themselves informed of the starting dates, progress of each order by means of wall chart visible index file (or) one of the several types of department dispatching orders.

(or)

Centralised Dispatching:-

In a centralised dispatch system, a central dispatching department orders directly to work stations.

⇒ It maintains full record of capacity of each equipment and workload against each machine.

⇒ the orders are given to the shop supervisor, who runs the machines accordingly.

⇒ In most of the cases, the supervisor can give suggestions as regarding loading of men and machines under him.

Advantages:-

⇒ A greater degree of overall control can be achieved.

⇒ Effective coordination between different facilities is possible.

⇒ It has a greater flexibility.

⇒ there is effective and better utilization of manpower and machinery.

Decentralised Dispatching:-

In a decentralised system, the shop supervisor performs the dispatch functions. He decides the sequence of different orders and materials to each equipment and worker.

⇒ He is required to complete the work within the prescribed duration.

⇒ In case he suspects delay with due reasons of the same, he informs the production control department accordingly.

Advantages:-

⇒ Shop supervisor has a better knowledge of his shop, therefore he can allot the work to the most appropriate worker and the machine.

⇒ Elaborate reports and duplication of postings can be reduced

⇒ It is easy to solve day-to-day problems.

⇒ Communication gap is reduced.

Follow up

⇒ After despatching production order to various shops it is necessary to regulate the progress of job through various processes.

⇒ For this purpose, a follow-up section is formed.

⇒ The function of follow up section is to report daily the progress of work in each shop in as prescribed proforma and to investigate the causes of deviation from the planned performance.

Functions of follow-up :-

Follow up is done for the following purposes.

a) **Material :-** Material should reach to shops in required time so that production could be started as per schedule

b) **Job progress :-** For this, follow-up section sees that a particular product is passing through all its operations from raw-material to final shape as per schedule

* There are more changes of delay, when one of the process is completed, during a production of any one product Follow up section tries to remove this delay.

c) **Assembly :-** Assembly shops are responsible for assembling the various components. Follow-up section sees that all the parts should remain ready for assembling purposes in required quantity at required time

Causes of Delay in Followup:-

⇒ Following are the causes which are generally responsible for delay and should be checked by follow-up section.

* Errors in routing, scheduling and despatching.
* shortage (or) delay of material.
* Equipment and machine breakdown.
* Lack of proper tools, gauges, jigs and fixtures etc--
* More rejections.

Types of followup

① Materials followup :-

* Followup of the materials purchased is the primary responsibility of the purchase department.
* ~~Hence~~ the follow up section of the production control department has to followup the outstanding material requistion which are vital for keeping the plan schedules.
* For this purpose, a copy of requistion may be kept in the daily followup file.
* Delivery Information may be obtained from the purchase department.

② Work-in-process follow up :-

⇒ The follow up work-in-process varies according to the type of production. In flow production with product layout, follow up consists of checking of materials required and recording the production completed for comparison with the pre-planned schedules.

③ Assembly and Erection follow up :-

⇒ In case, of assembly manufature the responsibility for assembly and erection is usually vested in one follow up person. In case of large and highly complicated products, usually the assembly and erection have to be done at customer's site.

⇒ This is particularly so in case of heavy machines and highly technical articles.

⇒ The follow up person in such cases, have to be well versed with engineering details of the product.

Application of computer in production planning and control:-

⇒ over the last 40 years, the role of computers in the production planning process has changed dramatically.

⇒ In the 1970's, a calculator was considered a high-priced luxury item and business mainframe programs were stored on cards.

⇒ Today, every production planner has a personal computer with more processing capability than the mainframes of the past.

⇒ Advances in computer hardware and software have enable -d production planning processes to operate more efficiently and effectively than ever before.

Some of the areas where computers are used in business and Industry are as follows:-

* Inventory control
* production planning
* Budgeting and variable analysis
* plant capacity utilization
* Quality control
* market Research
* purchase Accounting
* Sales Accounting
* payroll accounting
* Information Management.

Role of Computer:-

* with the expansion of business activities, the volume of business transactions has increased.
* the manual method of maintaining books of accounts is found to be unmanageable and gradually computers have replaced the manual method of accounting.
* And finally the database technology has revolutionized the accounting departments of business organizations.
* Computer is an electronic device that can perform a variety of operations in accordance with a set of instructions called program.
* It is fast electronic data processing machine, which can provide solutions to all complicated situations.
* It accepts data from the user, converts the data into information and provides the desired results.
