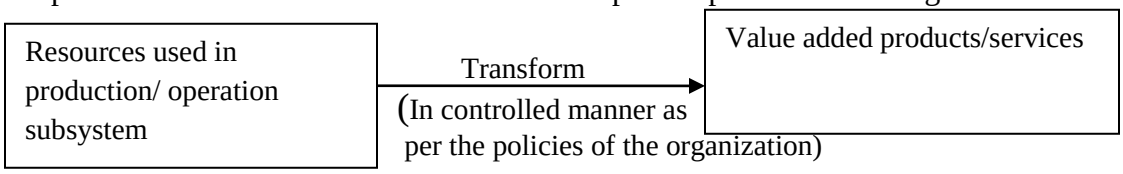
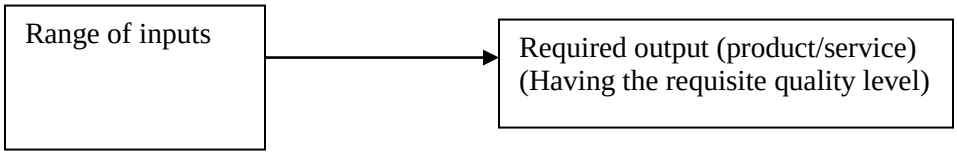
CHAPTER-I
PRODUCTIVITY

1.1 Introduction

Production/Operation management is the process which combines and transforms various resources used in the production/operation subsystem of the organization into value added products/services in a controlled manner as per the policies of the organization.



Production/Operation function:

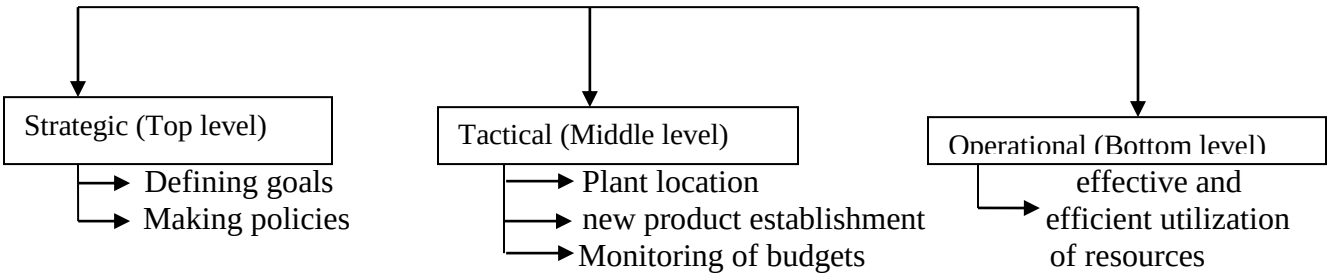


The set of interrelated management activities which are involved in manufacturing certain products is called production management and for service management, then corresponding set of management activities is called as operation management.

Examples: (Products/goods)
Boiler with a specific capacity,
Constructing flats,
Car, bus, radio, television.

Examples: (Services)
Medical facilities,
Travel booking services.

In the process of managing various subsystems of the organization executives at different levels of the organization need to track several management decisions. The management decisions are Strategic, tactical and operational.



Corrections from feedback information:

- Tight quality check on the incoming raw-material.
- Adjustment of machine settings.
- Change of tools.
- Proper allocation of operations to machines with matching skills.
- Change in the production plans.

1.2 Productivity:

Productivity is a relationship between the output (product/service) and input (resources consumed in providing them) of a business system. The ratio of aggregate output to the aggregate input is called productivity.

Productivity = output/Input

- For survival of any organization, this productivity ratio must be at least 1.If it is more than 1, the organization is in a comfortable position. The ratio of output produced to the input resources utilized in the production.

1.3 Importance:

Benefits derived from higher productivity are as follows:

- ✓ It helps to cut down cost per unit and thereby improve the profits.
- ✓ Gains from productivity can be transferred to the consumers in form of lower priced Products or better quality products.
- ✓ These gains can also be shared with workers or employees by paying them at higher rate.
- ✓ A more productive entrepreneur can have better chances to exploit expert opportunities.
- ✓ It would generate more employment opportunity.
- ✓ Overall productivity reflects the efficiency of production system.
- ✓ More output is produced with same or less input.
- ✓ The same output is produced with lesser input.
- ✓ More output is produced with more input.
- ✓ The proportional increase in output being more than the proportional increase in input.

1.4 Productivity Measurement:

Productivity may be measured either on aggregate basis or on individual basis, which are called total and partial measure.

Total productivity Index/measure = Total output/ Total input

$$= \frac{\text{Total production of goods and services}}{\text{Labour+material+capital+Energy+management}}$$

Partial productivity indices, depending upon factors used, it measures the efficiency of individual factor of production.

Labour productivity Index/Measure = $\frac{\text{Output in unit}}{\text{Man hours worked}}$

Management productivity Index/Measure = $\frac{\text{Output}}{\text{Total cost of management}}$

Machine productivity Index/Measure = $\frac{\text{Total output}}{\text{Machine hours worked}}$

Land productivity Index/Measure = $\frac{\text{Total output}}{\text{Area of Land used}}$

Partial Measure = $\frac{\text{Output}}{\text{Labour}}$ or $\frac{\text{Output}}{\text{Capital}}$ or $\frac{\text{Output}}{\text{Materials}}$ or $\frac{\text{Output}}{\text{Energy}}$

PROBLEMS:

Example-1

The input and output data for an industry given in the table. Find out various productivity measures like total, multifactor and partial measure.

<u>Output and Input production data in dollar ($)</u>

<u>Output</u>

1.	Finished units	10,000
2.	Work in progress	2,500
3.	Dividends	1,000
4.	Bonds	-------
5.	Other income	--------

<u>Input</u>

1.	Human	3,000
2.	Material	153
3.	Capital	10,000
4.	Energy	540
5.	Other Expenses	1,500

Solution:

Total measure = $\frac{\text{Total Output}}{\text{Total Input}} = \frac{13,500}{15,193} = 0.89$

Multi factor measure = $\frac{\text{Total Output}}{\text{Human+Material}} = \frac{13,500}{3,153} = 4.28$

Multi factor measure = $\frac{\text{Finished units}}{\text{Human+Material}} = \frac{10,000}{3,153} = 3.17$

Partial Measure$_1$ = $\frac{\text{Total Output}}{\text{Energy}} = \frac{13,500}{540} = 25$

Partial Measure$_2$= $\frac{\text{Finished units}}{\text{Energy}} = \frac{10,000}{540} = 18.52$

Note: For multifactor and partial measures it is not necessary to use total output as numerator. Often, it is describe to create measures that represent productivity as it relates to some particular output of interest.

Other fields for the measurement of partial measures of productivity are:

Business	**Productivity Measure**
Restaurant	Customers (Meals) per labour hour
Retail Store	Sales per square foot
Utility plant	Kilowatts per ton of coal
Paper mill	Tons of paper per cord of wood

Example-2
A furniture manufacturing company has provided the following data. Compare the labour, raw materials and supplies and total productivity of 1996 and 1997.

Output: Sales value of production in dollar ($)
22,000 (in 1996) and 35,000 (in 1997)

	1996	**1997**
Inputs: Labour	**10,000**	**15,000**
Raw materials and Supplies	**8,000**	**12,500**
Capital equipment depreciation	**700**	**1,200**
Other	**2,200**	**4,800**

Solution:

	1996	1997
a. Partial productivities		
Labour	2.20	2.33
Raw materials and Supplies	2.75	2.80
b. Total Productivity	1.05	1.04

1.5 Productivity measurement approaches at the enterprises level:

As stated above total productivity is expressed as the ratio of aggregate output to the aggregate input. That the total overall performance is captured in this ratio, becomes apparent, if we examine the relationship between this ratio and the age-old performance measure of profit.

If the outputs and input for the period for which productivity is measured, are expressed in rupees, then under such restrictive assumptions one can write:

Aggregate output =Gross Sales=G (Say)

Aggregate input=Cost =C (Say)

Total Productivity=P(Say)= $\frac{G}{C}$ ……..(1)

From the definition of profit, we have;

Profit= π = G-C …….(2)

By dividing eq^{n} (2) by C, $\frac{\pi}{C} = \frac{G}{C} - 1$

So from (1), $\Rightarrow \frac{\pi}{C}$ =P-1

For Zero profit (π =0), $P = 1$

For a Loss, ($\pi \langle$ 0), $P \langle 1$

For a profit, $\pi \rangle 0, P \rangle 1$

Zero profit will give a productivity value of 1, while a loss will give productivity value less than 1.The profit to cost ratio will determine the increase in productivity.

The above relationship that demonstrates that increased profit to cost ratio will lead to increased overall productivity, is constituent with our expectation on how an overall performance measure should behave. However it suffers from a number of drawbacks. Some of which are listed here,

a) Given that our objective in productivity measurement is to capture the efficiency of utilization of resources, the effect of price variations over time need to be corrected. Thus aggregate output should be equal to gross sales suitably inflated or deflated with respect to a base year.
b) Equating output to sales implies, whatever is produced in the particular period is sold. Possibility of inventory, material manufactured for own use, etc. are n't taken in to consideration.
c) Equating aggregate input to cost raises a host of problems and involves several restrictive assumptions. How to account for the fixed investment and working capital, whether to take the fringe benefits in to account etc. are some of the problems.

The different approaches to measurement have arisen mainly in the context of correcting the above drawbacks.

1.6 Techniques for Productivity Improvement:

Higher productivity in organization leads to national prosperity and better standard of living for the whole community. The methods contribute to the improvement of productivity are method study and work measurement by reducing work content and Ineffective time.

Work content means the amount of work “contained in” a given product or process measured in man-hour or machine-hour. Except in some cases like in processing industries, actual operation times are far in excess of the theoretical minimum.

Ineffective time is the time for which the worker or machine or both are idle due to the shortcomings of the management or the worker.

CHAPTER-II
PRODUCTION SYSTEM

2.1 Introduction

A "Production System" is a system whose function is to transform an input into a desired output by means of a process (the production process) and of resources. The definition of a production system is thus based on four main elements: the input, the resources, the production process and the output.

Resources
Input-Production Process-Output

Most of the organizations (including non-profit organization) can be described as production systems.These organizations transform (or convert) a set of inputs (such as materials, labour, equipment, energy etc.) in to one or useful outputs. The outputs of a production system are normally called products. These products may be:

(a)Tangible goods (b)Intangible services (c)combination of (a) and (b)
(Steels,chemicals etc.) (Teaching,health care etc.) (fast food,tailoring etc.)

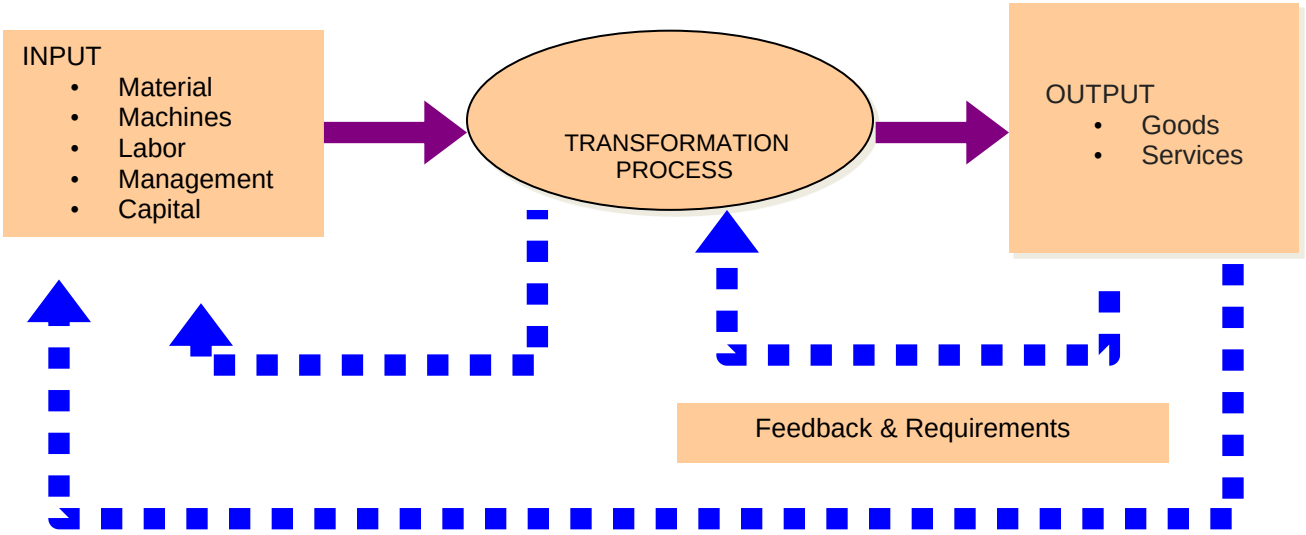


Fig 2.1 A simple block diagram of a production system

Production system refers to manufacturing subsystem that includes all functions required to design, produce, distribute and service a manufactured product. So this system produces goods and/or services on a continuous and/or batch basis with or without profit as a primary objective.

Production is the basic activity of all organizations and all other activities revolve around production activity. The output of production is the creation of goods and services which satisfy the needs of the customers. In some organization the product is physical (tangible) good. For example, refrigerators, motor cars, television, toothpaste etc., while in others it is a service (insurance, healthcare etc.).The production system has the following characteristics:

- Production is an organized activity, so every production system has an objective.
- The system transforms the various inputs (men, material, machines,information,energy) to useful outputs (goods and/or services).
- Production system doesn't oppose in isolation from the other organization system such as marketing, finance etc.
- There exists a feedback about the activities which is essential to control and improve system performance.

  The transformation process involves many activities and operation necessary to change inputs to output. These operations and activities can be mechanical, chemical, inspection and control, material handling operation etc.

2.2 Models of Production system:

A model is a representation of reality that captures the essential features of an object/system/process. Three types of models are there such as physical, schematic and mathematical.

I. *Physical model:* Replica of a physical object with a change of scale.
   a. For big/huge structure of physical object: small scale (Ex. solar system)
   b. For microscopic objects: magnified scale(Ex. Atomic model)

II. *Schematic model:* These are 2-D models which represents
   - Price fluctuations with year.
   - Symbolic chart of activities in sequence for a job.
   - Maps of routings
   - Networks of timed events.

   The pictorial aspects are useful for good demonstration purposes.

III. *Mathematical model:*
   Formulas and equations have long being the servants of physical sciences. One can represent the important aspect of a system/problem in mathematical form using variables, parameters and functions. This is called mathematical model .by analyzing and manipulating the mathematical model, we can learn how the real system will behave under various conditions.

2.3 Product vs. services

Product	Services
1-tangible, durable products. 2- Output can be inventoried. 3-consumption/use takes more time. 4-low costumer's involvement. 5-long response time. 6-available at regional, national and international market. 7-Reqire large facilities. 8-Capital intensive. 9-Quality easily measured. 10-Demand variable on weekly, monthly, seasonally.	1- Intangible, perishable products. 2- Output can't be inventoried. 3-Immidiate consumption. 4- High costumer's involvement. 5- Short response time. 6-local market. 7- Require small facilities. 8-Labour intensive. 9- Quality not easily measured. 10- Demand variable on hourly, daily, weekly basis.

Explanations

Manufacturing organization generally transfer tangible inputs or raw materials into some tangible output (ex: steel, refrigerator, toothpaste, soap etc.) Other inputs such as labour skills, management skills, capitals are used as well. Manufacturing organizations perform some chemical /physical processes (such as blending refining, welding, grinding.etc) to transfer their raw material into tangible products. Service providing organization though transform a set of input into set of output, they don't produce a tangible output.(ex: mail service, library service, restaurant etc.).or provide service(ex: health care, hair care, watch and automobile repair etc.). The service of service providing organization is intangible.

A 2nd distinction is based on inventories .durable goods can be kept for longer time these goods can be stored for longer time and can be transported in anticipation in future demand .Thus with durable goods ,operation manager can co up with the peaks and valleys in demand by creating inventories and smoothing out output levels. Whereas service can't be pre produced. For example: getting fast food from a fast food center, getting treatment from hospital etc.

A 3rd distinction is based on consumption/use of output. The products (goods) generally take longer period for its use, for ex refrigerator, T.V. automobile etc. can be used at least for 10 years. On the other hand, the output produced from a service operation (i.e. service) is consumed within a small time. Ex. consumption of fastfood,taking hair care, enjoying journey by a bus/train/aero plane enjoying entertainment program.

A 4th distinction is based on customer contact. Most of the consumers/customers have little or no contact with production system/organization. Whereas, in many service providing organization

consumers/customers are directly involved. For example: students in an educational institution, patients in hospital.

The 5th distinction is based on lead time/response time to customers demand. Manufacturers take generally some lead time (i.e. time period from placing the order to get the product) in terms of days/week. Whereas the services are offered within few minutes of customers arrival. For ex: ATM Service, getting postal stamps, getting grocery from a retail shop and getting examined by a doctor etc.

The 6th distinction is on availability. Products can be available from regional, national or international markets due to availability of transportations and distribution facilities whereas, service can't shipped to distant locations. Thus service organization requiring direct customer contact must locate very near to the customers.

The 7th distinction is based on liabilities/facilities. Manufacturing unit/organization producing products generally require larger facilities, more automation and greater capital investment than service providing organization.

The 8th distinction is based on capital/labour priority. Generally manufacturing firm producing goods/products require more capital than a service provider. Ex. An automobile firm requires more capital than a post office/Nursing home. The 9th and 10th distinction is based on quality and demand variation.

2.4 Various types of Layout:

Plant layout means the disposition of the various facilities (equipment, material, manpower etc.) and services of the plant within the area of site located.

Objectives

- Material handling and transportation is minimized and effectively controlled.
- Bottlenecks and points of congestions are eliminated (by line balancing) so that the raw-material and semi-finished goods move fast from one workstation to other.
- Workstations are designed suitable and properly.
- Suitable spaces are allocated to production centers and service centers.
- The movements made by the workers minimized.

Layout can be classified into the following four categories:

a. process layout
b. product layout
c. Group layout(combination layout)
d. Fixed position layout

a. process layout:

- It is also known as functional layout.
- Here similar machines and services located together Ex. All the lathe machines will be at one place and all milling machines at another place and so on.
- This type of layout generally employed for industries engaged in job-shop production and non-repetitive kind of production.
- When there variety of products manufactured at low volume we prefer this type of layout.
- Ex. furniture manufacturer company, restaurant etc.

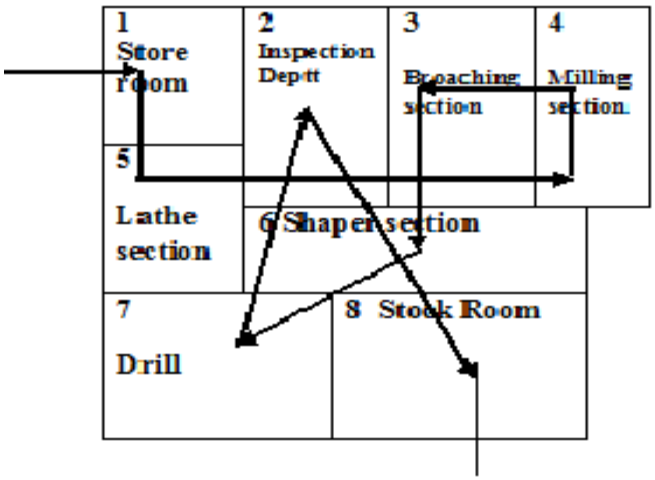


Fig 2.2 process layout

b. Product layout

- It is also known as line (type) layout.
- The flow of product will smooth and logical.
- When the machines and auxiliary services are located according to the processing sequence we prefer this layout.
- It implies that various operations raw material are performed in a sequence and the machines are placed along the product flow line.
- The product layout is selected when the volume of production of a product is high such that separate production line to manufacture it can be justified.
- Assembly line production or mass production prefer this type layout. Ex. Assembly of television sets assembly of computer key-board etc.

Fig 2.3 product layout

c. *Group layout:*

- It is the combination of both process and product layout.
- In this type of layout a set of machinery or equipment is grouped together in a section so that each group of machines or equipment is used to perform similar operations to produce a family of components. These machines grouped in to cells.
- It minimizes the sum of cost of transport and the cost of equipment.

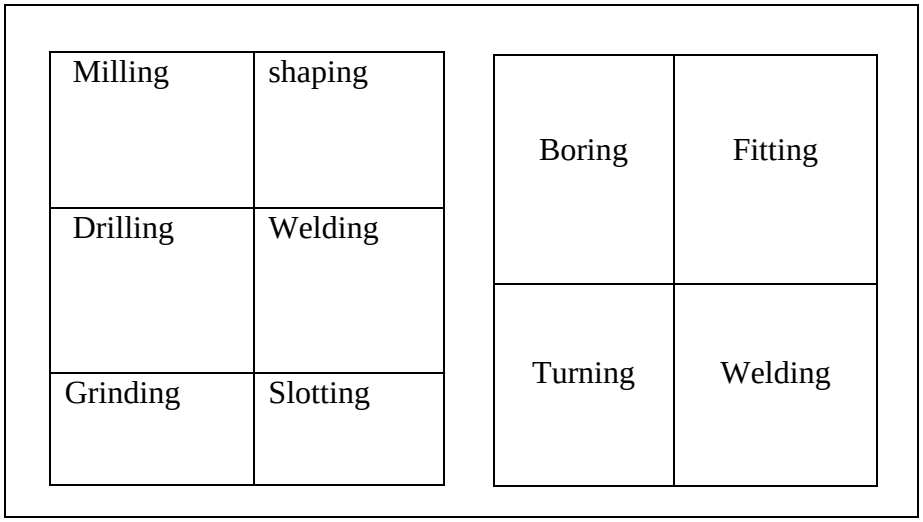


Fig 2.4 Group layout

d. *Fixed position layout*

- It is also called static product layoutin which the physical characterstics of the product dictate as to which type of machine and men are brought to the product.
- This type layout is inherent in ship building,aircraft manufacture and big pressure vessels fabrication.
- In other type layout the product moves past stationary production equipment where as in this case men and equipment are moved to the material at one place and the product is completed at the place where the material lies.

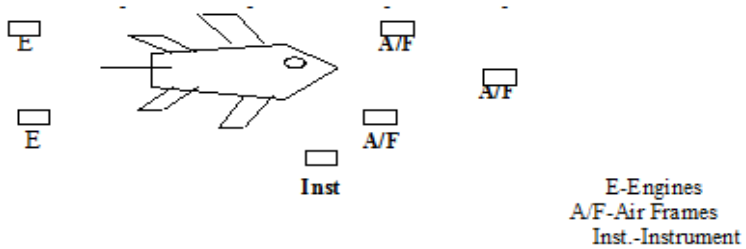


Fig 2.5 Fixed position layout

2.5 Process-focused and product-focused system:

In process-focused system the arrangement of facilities is made according to the process layout and in product-focused system the arrangement of facilities is made according to the product layout.

Comparison of process oriented layout and product oriented layout

Sl No.	Different Aspects	Process oriented	Product oriented
1	Product	Diversified products using operations, varying rate of output or small batches of many different products	Standardized product, large volume,stable rate of output
2	Workflow	Variable flow depending on nature of job	Identical flow and same sequence of operations for each unit.
3	Human skills	Semiskilled craftsman and able to do various/different categories of work	Highly specialized and able to perform repetitive tasks at fixed place
4	Supporting staffs	Less;scheduling,material handeling,production and inventory control	Large; schedule materials and people, monitor and maintain works
5	Material handling	Material handling cost high,handeling sometimes duplicated	Less dectble , flow systematized and often automated.
6	Inventory	In process inventory less	In process inventory high
7	Space utilization	Space and capital are tied up by work in process	Less space is occupied by work in transit and for temporary storage.
8	Capital requirement	Comparatively low investment in machines required	Large investment in specialized equipment and processes
9	Production cost	Relatively low fixed cost, high variable cost(for direct labour,material and material handling)	Relatively high fixed cost, low variable cost (for labour and materials)
10	Production time	Through time is larger.	Throughput time is lesser.
11	Flexibility of design change	high	low
12	Effect of breakdown	Break down of any machine doesn’t effect much on the final output	Seriously affected; as all are interrelated system.

2.6 Product life cycle

A product life cycle consist of 5 stages through which a product passes that is *introduction *growth*maturity*decline. the figure shown previously represent sales and profit associated with each stage and some practical example of products are also shown on it.

1. Introduction

At this stage, sales begin and profit goes from –ve to +ve. In this stage ,the demand is low .because the costumer don't know much about the product. The organization has to invest heavily in advertisement to make the product familiar to the costumers. the volume sales are low,and if proper care is not taken, there is chances to product failure.

2.Growth

The product next enters a stage at rapid growth. Early in this stage (due to acceptability of the product by the costumer) there is drastic jump in sales and profit rise. It is because of limited or no competition. During this stage the mandate for operation is somehow to keep up with demand; efficiency is less of concern.

3.Maturity

During this stage, sales level off and profit begins to decline. New competition create to cut costs and ultimately on unit profit margin. Now operation must stress on efficiency, although marketing can ease the pressure by intensifying to differentiate the product.

4.Decline

At last the existing product enters to a declining stage and becomes obsolete. Either demand despisers or a better less expensive product.

Life cycle suggest when to eliminate the existing product and introduce a new one. This life cycle varies greatly from product to product. For example it took 15 years for "Xerox" to introduce electrostatic copy m/c .in contrast and computer and microchip industry, products become obsolete in months.

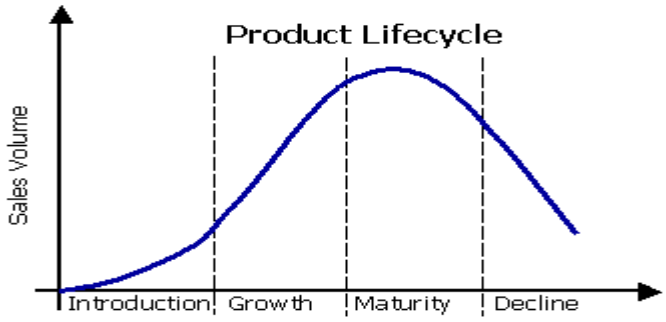


Fig 2.6. product life cycle

2.7 Production function

(a) Functions of industrial enterprise

(b) Functions of process

(a)Functions of industrial enterprise

The major functions of a relatively large industrial firm is represented by the following figure

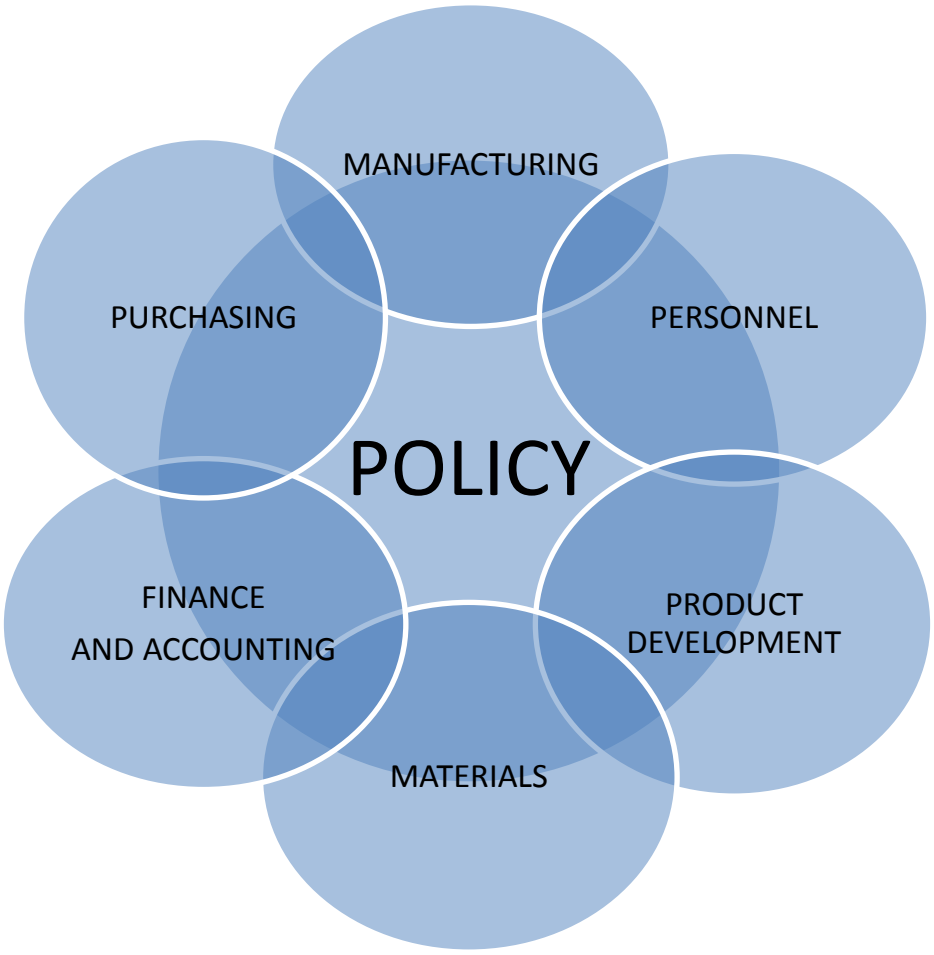


Fig 2.6 of production function a enterprise

The core area of the diagram represents the organization's policy making group. In a hierarchic triangle, this group would occupy the apex. The overlapping portions of the circle denote the co-operation needed from the two groups in order to establish overall policy. The slope of each function and its relationship to the production process are briefly discussed in the following.

(i)Manufacturing

A fundamental function of much production system is to produce a physical output. Manufacturing includes the operations and direct support services for making the product operation management is concerned with production scheduling, performance standards, method improvement, quality control, plant layout and material handling. A plant service section handles shipping receiving, storing and transporting raw material parts and tools. The plant engineering group is usually responsible for in-plant construction, maintenance, design of tools and equipment and other problems of mechanical, hydraulic or electrical nature.

(ii) personnel

The recruitment and training of the personnel needed to operate the production system are the traditional responsibilities of the personnel function. Along with it, this department takes care health, safety, wage administration of the employees. Labour relation and employee services and benefits are increasingly important.

(iii) Product development

Many organizations give major emphasis on product development because the ultimate profit of any organization depends primarily on the nature/quality of product. The product must be customized. A separate section is responsible for this task.

(iv)Marketing

Many ideas of product development comes through the marketing function. Selling is the primary interest of marketing. Sales forecasts and estimate of the nature of future demands is also performed by this department. Contact with customers provide feedback about the quality expected from the firm and opinion on how well the products meet quality standard.

(v) Finance and accounting

Internal financing includes reviewing the budgets for operating sections, evaluating of proposed investments for production facilities and preparing balance sheet. Besides these the other responsibilities is to see how well the firm is scoring in the business competition game.

In this business game analogy the accounting functions are collection of cost data for materials direct labour and overhead. Special reports are prepared regarding scarp, parts and finished goods inventories, pattern of labour hours and similar data applicable to production activities.

(vi) Purchasing

In a narrow sense, purchasing is limited to accounting materials from outside sources. But while carrying out this activity, it requires to investigate the reliability of vendors, type of materials needed, co-ordinating material purchase volume with the requirement as per schedule, discovering new material and process. The purchasing function serves the other functional areas, overlap sometimes with inventory control, material inspection, shipping and receiving, sub-contracting and internal transportation.

(b)Functions of production process

Another was to group functions is according to their relative position in a production process. the sequential arrangement is shown in the following

Fig 2.7 functions of production process

2.8 Types of production system:

The production system of a company mainly uses facilities, equipments and operating methods(called the production system) to produce goods that satisfy customers' demand.The above requirements of a production system depend on the type of product that the company offers and the strategy that it employs to serve its customers. The classification of production system is explained in the table.

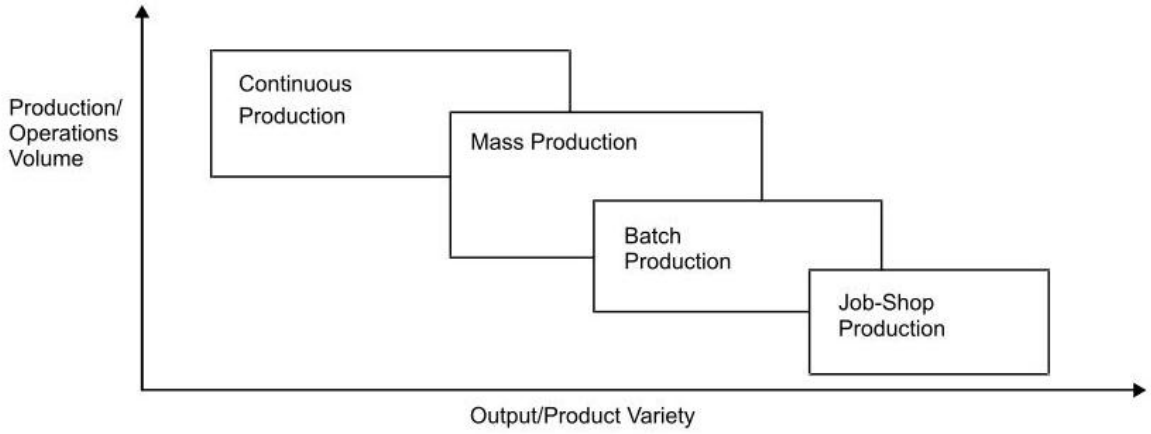


Fig 2.6 Classification of production systems

Job shop production

- Job shop is appropriate for manufactures of small batches of many different products, each of which is custom designed and requires its own unique set of processing steps or routing through production process.
- The production system in which different types of product follow different sequences through different shops. Ex. Furniture manufacturing company, restaurant, prototype industry.
- Much time is spent waiting for access to equipment. Some equipment overloaded.
- A process technology suitable for a variety of custom designed products in some volume.
- This production system adopts process layout as by this production system we manufacture more variety of products at low product volume.

Batch production

- A process technology suitable for variety of products in varying volumes.
- Here limited product variety which is fixed for one batch of product. Ex. Bakery shop, medicine shop.

- Within the wide range of products in the facility, several are demanded repeatedly and in large volume.
- This type of production system should be preferred when there is wide variety of products in wide variety of volumes.

Assembly line (mass) Production

- A process technology suitable for a narrow range of standardized products in high volumes.
- The successive units of output undergo the same sequence of operation using specialized equipment usually positioned along a production line.
- The product variety is fixed here. Ex. Assembly of television sets, assembly of auto, assembly of computer keyboard, cold drinks factory etc.

Continuous production

- A process technology suitable for producing a continuous flow of products.
- The product is highly standardized.
- Material and products are produced in continuous, endless flows, rather than in batches or discrete units.
- Continuous flow technology affords high volume, around-the clock operation with capital intensive, specialized automation.

2.9 Dimensions of Product Strategies:

- **Product-Positioning.**
- **Product-Repositioning.**
- **Product-Overlap.**
- **Product Scope.**
- **Product-Design.**
- **Product Elimination.**
- **New Product.**
- **Diversification.**
- **Value-Marketing.**

Product Positioning: The Procedure

1. **Analyze** product attributes that are salient to Customers.
2. **Examine** the distribution of these attributes among different segments.

3. **Determine** the optimal position for the product in regard to each attribute, taking into consideration the position occupied by existing brands.
4. Choose an overall position for the product (based on overall match between product attributes and their distribution in the population and the position of existing brands)

Product Positioning Strategy

- **Definition**: Placing a brand in that part of the market where it will have a favorable reception compared with competing brands.
- For Ex The marketers of "Liril" soap wants the people to think "Liril" when they think soap. The marketers of "Colgate" want the consumers to think "Colgate" when they think toothpaste etc.
- **Objective**
  - To position the product in the market so that it stands apart from competing brands. (b) To position the product so that it tells customers what you stand for, what you are, and how you would like customers to evaluate you. In the case of positioning multiple brands:
    - (a) To seek growth by offering varied products in differing segments of the market.
    - (b) To avoid competitive threats to a single brand
- **Requirements**: Use of marketing mix variables, especially design and communication efforts.
  - Successful management of a single brand requires positioning the brand in the market so that it can stand competition from the toughest rival and maintaining its unique position by creating the aura of a distinctive product.
  - Successful management of multiple brands requires careful positioning in the market so that multiple brands do not compete with nor cannibalize each other. Thus it is important to be careful in segmenting the market and to position an individual product as uniquely suited to a particular segment through design and promotion.
  - Expected Results:
  - Short term success
  - Meet as much as possible the needs of specific segments of the market

- Limit sudden changes in sales.
- Make customers faithful to the brands.

Product Re-positioning Strategy

- **Definition**: Reviewing the current positioning of the product and its marketing mix and seeking a new position for it that seems more appropriate.
- **Objectives**: (a) To increase the life of the product. (b) To correct an original positioning mistake.
- **Requirements:**
  - If this strategy is directed toward existing customers, repositioning is sought through promotion of more varied uses of the product.
  - If the business unit wants to reach new users, this strategy requires that the product be presented with a different twist to the people who have not been favorably inclined toward it. In doing so, care should be taken to see that, in the process of enticing new customers, current ones are not alienated.
  - If this strategy aims at presenting new uses of the product, it requires searching for latent uses of the product, if any. Although all products may not have latent uses, there are products that may be used for purposes not originally intended.
- **Expected Results:**
  - Among existing customers: increase in sales growth and profitability.
  - Among new users: enlargement of the overall market, thus putting the product on a growth route, and increased profitability.
  - New product uses: increased sales, market share, and profitability.

Product Overlap Strategy

- **Definition**: Competing against one's own brand through introduction of competing products, use of private labeling, and selling to original-equipment manufacturers.
- **Objectives:** Product overlap strategies can include selling similar goods in different markets, regions or international countries. For example, a company may sell widgets and cogs; both offer extremely similar consumer benefits. However, the company may sell widgets in the United States and cogs in Canada.
-

- **(a)** To attract more customers to the product and thereby increase the overall market.
- (b) To work at full capacity and spread overhead.
- (c) To sell to competitors; to realize economies of scale and cost reduction.

- **Requirements:**
  - (a) Each competing product must have its own marketing organization to compete in the market.
  - (b) Private brands should not become profit drains.
  - (c) Each brand should find its special niche in the market. If that doesn't happen, it will create confusion among customers and sales will be hurt.
  - (d) In the long run, one of the brands may be withdrawn, yielding its position to the other brand
- **Expected Results:**
  - Increased market share.
  - Increased growth.

Product Scope Strategy

- **Definition**: The product-scope strategy deals with the perspectives of the product mix of a company. The product-scope strategy is determined by taking into account the overall mission of the business unit. The company may adopt a single-product strategy, a multiple-product strategy, or a system-of-products strategy.
- **Objectives:**
  - Single product: to increase economies of scale by developing specialization.
  - Multiple products: to cover the risk of potential obsolescence of the single product by adding additional products.
  - System of products: to increase the dependence of the customer on the company's products as well as to prevent competitors from moving into the market.
- **Requirements:**
  - (a) Single product: company must stay up-to-date on the product and even become the technology leader to avoid obsolescence.
  - (b) Multiple products: products must complement one another in a portfolio of products.

- (c) System of products: company must have a close understanding of customer needs and uses of the products.

- **Expected Results:** Increased growth, market share, and profits with all three strategies. With system-of-products strategy, the company achieves monopolistic control over the market, which may lead to some problems with the Justice Department, and enlarges the concept of its product/market opportunities.

Product Design Strategy

- **Definition**: The product-design strategy deals with the degree of standardization of a product. The company has a choice among the following strategic options: standard product, customized product, and standard product with modifications.
- **Objectives:**
  - Standard product: to increase economies of scale of the company.
  - Customized product: to compete against mass producers of standardized products through product-design flexibility.
  - Standard product with modifications: to combine the benefits of the two previous strategies.
  - Requirements:
  - Close analysis of product/market perspectives and environmental
  - Changes, especially technological changes.
- **Expected Results:**
  - Increase in growth, market share, and profits. In addition, the
  - third strategy allows the company to keep close contacts with the market and
  - Gain experience in developing new standard products.

Product Elimination Strategy

- **Definition**: Cuts in the composition of a company's business unit product portfolio by pruning the number of products within a line or by totally divesting a division or business.
- **Objectives:**
  - To eliminate undesirable products because their contribution to fixed cost and profit is too low,

- Eliminate Products that its future performance looks grim, or because they do not fit in the business's overall strategy.
- The product elimination strategy aims at shaping the best possible mix of products and balancing the total business.
- Requirements:
- No special resources are required to eliminate a product or a division.
- However, because it is impossible to reverse the decision once the elimination

- **Requirements:**
  - No special resources are required to eliminate a product or a division.
  - An in-depth analysis must be done to determine
    - (a) the causes of current problems;
    - (b) The possible alternatives, other than elimination, that may solve problems (e.g., Are any improvements in the marketing mix possible?);
    - (c) The repercussions that elimination may have on remaining products or units.
    - Expected Results:
  - In the short run, cost savings from production runs, reduced
  - inventories, and in some cases an improved return on investment can be
  - Expected. In the long run, the sales of the remaining products may increase because more efforts are now concentrated on them.

New Product Strategy

- **Definition:** A set of operations that introduces (a) within the business, a product new to its previous line of products; (b) on the market, a product that provides a new type of satisfaction. Three alternatives emerge from the above: product improvement/modification, product imitation, and product innovation.
- **Objectives**: To meet new needs and to sustain competitive pressures on existing products. In the first case, the new-product strategy is an offensive one; in the second case, it is a defensive one.
- **Requirements:** A new-product strategy is difficult to implement if a "new product development system" does not exist within a company. Five components of this system should be assessed:

  - Corporate aspirations toward new products,
  - Organizational openness to creativity.
- **Requirements:** A new-product strategy is difficult to implement if a "new product development system" does not exist within a company. Five components of this system should be assessed:
  - Environmental favor toward creativity
  - Screening method for new ideas, and Evaluation process
- **Expected Results:** Increased market share and profitability.
  - are now concentrated on them.

Diversification Strategy

- **Definition**: Developing unfamiliar products and markets through:
  - Concentric diversification (products introduced are related to existing ones in terms of marketing or technology),
  - Horizontal diversification (new products are unrelated to existing ones but are sold to the same customers)
  - Conglomerate diversification (products are entirely new).
- **Objectives:** Diversification strategies respond to the desire for:
  - Growth when current products/markets have reached maturity,
  - Stability by spreading the risks of fluctuations in earnings,
  - Security when the company may fear backward integration from one of its major customers,
  - Credibility to have more weight in capital markets.
- **Requirements:** In order to reduce the risks inherent in a diversification strategy, a business unit should:
  - Diversify its activities only if current product/market opportunities are limited.
  - Have good knowledge of the area in which it diversifies.
  - Provide the products introduced with adequate support.
  - Forecast the effects of diversification on existing lines of products.
  - Expected Results:
  - Increase in sales.
  - Greater profitability and flexibility

Value Marketing Strategy

- **Definition**: The value-marketing strategy concerns delivering on promises made for the product or service. These promises involve product quality, customer service, and meeting time commitments.
- **Objectives:** Value-marketing strategies are directed toward seeking total customer satisfaction. It means striving for excellence to meet customer expectations.
- **Requirements:**
  - (a) Examine customer value perspectives.
  - (b) Design programs to meet customer quality, service, and time requirements.
  - (c) Train employees and distributors to deliver on promises.
  - Expected Results: This strategy enhances customer satisfaction, which leads to customer loyalty, and, hence, to higher market share. This strategy makes the firm less vulnerable to price wars, permitting the firm to charge higher prices and, thus, earn higher profits.

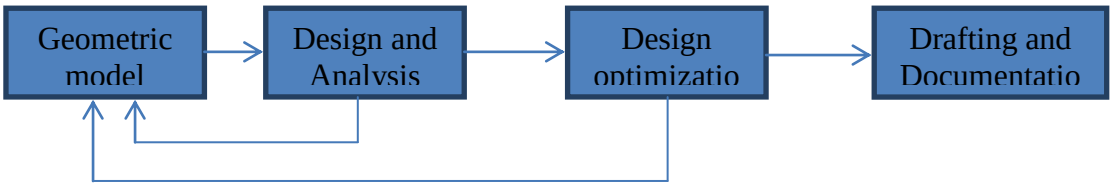
Chapter 8: Modern Trends in Mabufacturing

Basic concepts of CAD

Computer Aided Design (CAD) involves the use of computer in

- Creating
- Analyzing
- Modifying
- Optimizing
- Drafting/ Documenting

A product data so as to achieve its design goal efficiently and effectively. The various phases of CAD section are presented in the following form:



As per the above figure, there are four phases of CAD process. A geometric model is generated first. It is analyzed for the desired design conditions and is optimized before finally getting documented and drafted.

CAD tool includes the following three elements.

(i) Computer modelling and computer graphics

Geometric modelling and computer graphics help to generate and visualize models on which the analysis is done subsequently. Modelling and designing are being used as synonyms now a day's. The kind of analysis which can be done on a model is controlled by the type of model used. Hence the computer aided model must be made only after confirming the kind of analysis which is to be performed on the model. Eg. Some model may not work for fluid dynamics and vibration analysis.

(ii) Analysis and optimization tools

These are the algorithms and programs for exclusive application which are applied on to the virtual product already modelled. This section can predict the behaviour of the model under the loading condition when all constraints are simulated using boundary conditions. The analysis process is iterated number of times with varying attributes to optimize the results. The results so obtained from the model can be anticipated from the behavior of actual model in real situation.

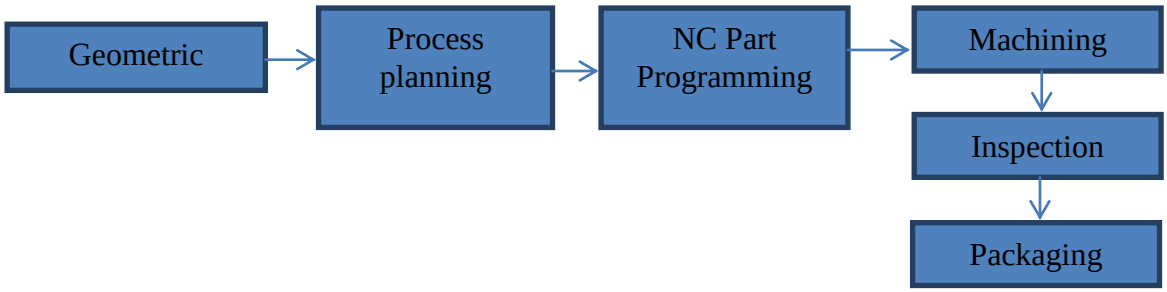
(iii) Drafting and documentation

The model already created, analysed and optimized guarantees a safe model under the real conditions. This safe model drawing is to be communicated to production floor with technical illustrations. The tool used for this application is called Computer Aided Drafting orcalled Computer Aided Design and Drafting (CADD). Computer Aided Modelling/Designing and Computer Aided Drafting represent two different concepts. Their differences are presented in the following:

Sl.No.	Computer Aided Modelling/Designing	Computer Aided Drafting
1.	This is done before analysis is performed on the geometric model.	This is done after analysis is performed on the geometric model.
2.	This provides dimension which may/maynot be safe.	The dimensions are safe since these are obtained after the analysis.
3.	This is 2D drawing/3D model	This is generally 2D drawing.
4.	This model is used for design analysis	These are made basically for conveying the production design.

Basic concepts of CAM (Computer Aided Manufacturing)

CAM is defined as a process of use of computers in planning, manufacturing, inspecting and controlling the manufacturing operation directly or indirectly. CAM includes those activities which manufacture the product with the product drawing and technical illustration as a input from the CAD and then make the product ready for shipment after inspection and packaging. The various phases of CAM section are shown below.



CAM Processes

In CAM, the basic information required is actually geometrical information which is supplied to the CAM processes through the CAD model already generated and analyzed. Interface algorithm extract that necessary geometrical information from the CAD model and feed it for process planning, part programming, machining, inspection and packaging.

CAM tool includes the following three elements:

(i) **CAD Tool**: The basic geometric information of the model is extracted from the geometric model created in the CAD phase of the product cycle. From the model necessary information regarding the shape, contour and sizes is extracted so as to implement in the manufacturing tool.

(ii) **Manufacturing tool**: The fundamental of manufacturing process which are used defines the manufacturing tool. It describes the method in which the product can be manufactured. This includes generation of part programming and manufacturing and computer aided process planning (CAPP) and tool and cutter design, etc.

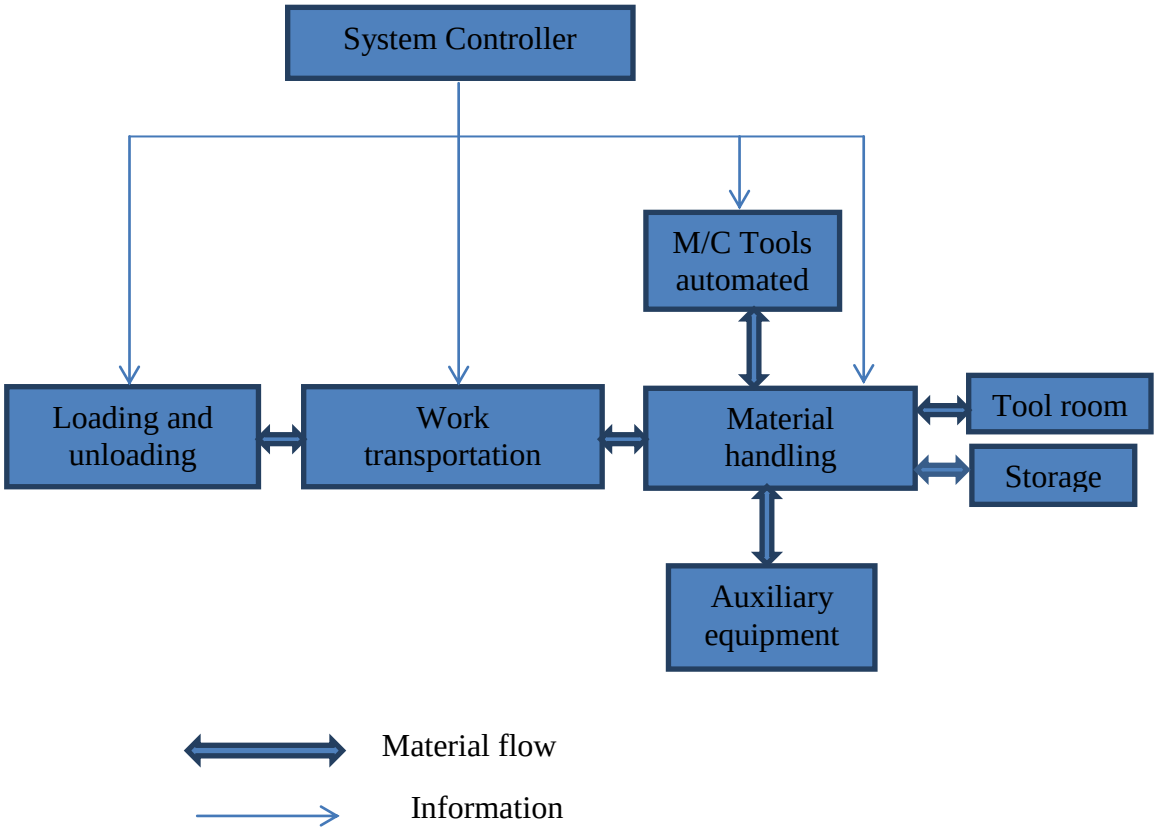
(iii) **Networking tools**: The knowledge of networking and interfaces is required for communication capability between various machines and computers. e.g. transferring a part program from one computer to 04 different machines, controlling a robot from a computer etc. a communication or networking tool is a must for CAM to be operational effectively.

CAM employs computers for 02 basic purposes:

(a) **Computer monitoring and control:** Where computers are used to control and monitor the applications. The major applications include in this category are: controlling machines and robots.

(b) **Manufacturing support application**: It includes those applications which are not controlled directly by computer but are used to support the primary and direct operation. Such applications include numeric part programming, CAPP, generating computer aided schedules and all other kinds of planning.

(c) **Flexible Manufacturing System (FMS)**: A FMA integrates all major elements of manufacturing into a highly automated system. FMS has born in the latter half of 1960's as a means to improve productivity of small and medium volume production.



Structure of FMS

The major components are:

(a) **Automated m/c tools**: In order to achieve the system flexibility, NC/Computer controlled general purpose m/c tools are normally used.
(b) **Work transportation device**: These devices are used to carry parts between loading area and machining station. Individual conveyors are used for high degree of flexibility.
(c) **Material handling device**: These devices transport work in process or tolls to assigned positions.
(d) **Loading and unloading station**: The raw materials and/or finished parts are loaded/unloaded in this area by robot.
(e) **Tool room and storage**: All the tools used in this system are stored in the tool room and transported to machining centers when required.
(f) **Auxiliary equipments**: Besides m/c tools, an FMS can also include cleaning online inspection, automated measurement and gauging equipments.
(g) **System controller**: The system controller oversees the operation of entire FMS. It coordinates the operation of variety of equipments in the system.

Advantages of FMS

1. There is a greater potential to make changes in terms of product, technology.
2. It reduces both direct and indirect labour cost because of automatic handling, gauging and inspection facilities.
3. It provides reduced manufacturing lead time, reduced inventory of parts (both stock and work in progress).
4. It improves the utilization of equipments. In this case, utilization is 85% compared to 50% in conventional method.
5. It provides a better management control by integration of computers.
6. It provides better and more consistent products.

Computer Integrated Manufacturing (CIM)

- CIM is defined as a process of integration of CAD, CAM and business aspects of a factory and it attempts to describe complete automation with all processes functioning under computer control.
- CIM includes Management Information System (MIS), sales marketing, finance, database management system, design, manufacturing, monitor and control and bar code software etc., which helps to manage and control the overall factory environment. CAD, CAM and CIM basically involve fundamental principles of these underlying branches with hardware and software to operate and utilize them effectively.

Just In Time (JIT)

The Just-in-time production concept was first implemented in Japan around 1970's to eliminate waste of

- Materials
- M/C
- Capital
- Manpower
- Inventory

through out the manufacturing system. The JIT concept has the following objectives:

- Receive supplies just in time to be used.
- Produce parts just in time to be made into subassembly.
- Produce subassemblies just in time to be assembled into finished products.
- Produce and deliver finished products just in time to be sold.

In order to achieve these objectives, every point in the organization where buffer stocks normally occur is identified. Then, critical examinations of reasons for such stocks are made. A set of possible reasons for maintaining high stock is listed below:

- Unreliable/unpredictable deliveries
- Poor qualities from supplier
- Increased variety of materials
- Machine break down
- Labourabsentism
- Frequent machine setting
- Variations in operators capabilities
- Schedule charges
- Changing product priorities
- Product modification

In traditional manufacturing, the parts are made in batches, placed in inventory and used whenever necessary. This approach is known as 'Push system' which means that parts is produced in accordance with the order. That means the rate at which the products come out at the end of final assembly matches with the order quantity for that product. There are no stockpiles within the production process. It is also called zero inventory, stockless production, demand scheduling. Moreover, parts are inspected by the workers as they are manufactured. This process of inspection takes a very short period. As a result of which workers can maintain continuous production control immediately identifying defective parts and reducing process variation. This JIT system ensures quality products. Extra work involved in stockpiling parts is eliminated.

Advantages of JIT

1. Exact delivery schedule is possible with JIT practices.
2. Quality of product is improved.
3. Lower defect rates i.e. lower inspection cost.
4. Lower raw material inventory, in process inventory and finished product inventory resulting lower product cost.
5. Satisfying market demand without delay in delivery.
6. Flexibility in utilizing manpower as workers is trained to do many jobs.
7. JIT helps in effective communication and reduce waste.
8. Less shop floor space is required.
9. Employee morale is high in an efficient working environment.
10. JIT reduces scrap and need for rework.

ISO 9000

ISO stands for International organization for standardization. It is an international body consists of representatives from more than 90 countries. The national standard bodies of these countries are the member of this organization. These are non-governmental

organizations and can provide common standards of goods and services on international trades.
ISO9000 series has 5 numbers of international standards on quality management which are listed below with different objectives.
ISO 9000: Provides guide lines on selection and use of quality management and quality assurance standards.
ISO 9001: This is applicable for industries doing their own design and development, production, installation and servicing. It has 20 elements.
ISO 9002: It has 18 elements. It is same as ISO 9001 without the 1sttwo tasks i.e. design and development.
ISO 9003: It has 12 elements covering final inspection and testing for laboratories and warehouses.
ISO 9004: This provides guidelines to interpret the quality management and quality assurance. It also has suggestions which are not mandatory.

Benefits of ISO 9000 Series

1. This gives competitive advantage in the global market.
2. Consistency in quality, as ISO helps in detecting non-conforming early which makes it possible to rectify.
3. Documentation of quality procedure adds clarity to quality system.
4. It ensures adequate and regular quality training for all members of the organization.
5. It helps in customers to have cost effective purchase procedure.
6. The customers during purchase from firm holding ISO certificate need not spend much on inspection and testing. This will reduce quality cost and lead time.
7. This will aid to improved morale and involvement of workers.
8. The level of job satisfaction will be more.
9. This will help in increasing productivity.

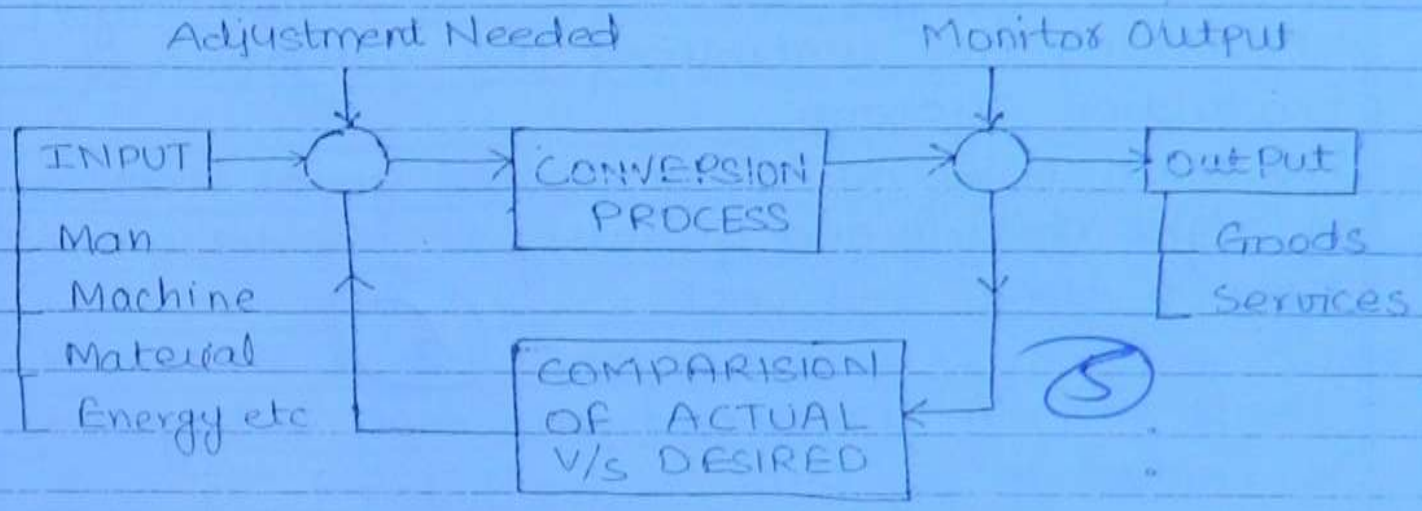
Steps in ISO 9000 Registration

1. Selection of appropriate standard from ISO 9001/9002/9003 using guidelines given in ISO 9000.
2. Preparation of quality manual to cover all the elements in the selected model.
3. Preparation of procedure and shop floor instruction which are used at the time of implementing the system. Also document these items.
4. Self-auditing to check compliance of the selected module.
5. Selection of a registrar (an independent body with knowledge and experience to evaluate any one of the three quality systems i.e. ISO 9001/ 9002/ 9003) and the application is to be submitted to obtain certificate for the selected quality system/ model.

Production is step by step Value Addition process of converting one form of material into another form to enhance the utility of the product for the user.

Input → Conversion process → Output

Production System



It is an organised process of Conversion of Raw material into finished Goods through a Feedback loop.

Productivity = $\frac{\text{Output}}{\text{Input}}$ [Different from efficiency, Always greater one (100%)]

- Output always more than input to make profit. so, Productivity will always increase.

- It is the Quantitative relation between what we produce and what we use as recources to produce them.
- It is the continuous effort to apply new technique and Methods.

Difference Between Industrial Engineer & Production Manager

Page No.

Industrial Engineer is concerned with the Design, improvement and Installation of Production System.
- His main objective is to increase productivity by Eliminating unproductive operations and improving the effective utilisation of Man, Power & Resources.

Production Manager is concerned with planning, organising and controlling the activities of Production system.
- His main objective is to produce goods & services of right quality and quantity at pre-determined ~~type~~ o time and cost

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- He is mainly concerned with Day to Day working of Production System.

Name of Sciencists: Important from objective Point

1. F.W. Taylor: Father of Industrial Engineering and He is primarily concerned with the concept of Productivity

2. Adam Smith: Laid the foundation of Scientific Manufacturing and Introduce the concept of Division of Labour.

3. Henry L. Gantt: He developed a Wage Incentive Plan and Gantt chart for Production Scheduling.

4. Gilberth: (Therbligs): Advancement of Motion study is contributed to Gilberth.

Date :

5. L.H.C. Tippet : Developed the concept of Work Sampling. (Time study)

6. George B. Dantzing : Regarded as Father of Linear programming

7. Henry Ford : Introduce the concept of Mass Production.

COST IN PRODUCTION.

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1. Prime or Direct Cost := Direct Material + Direct Labour + Direct Expenses
   - Part of Final Product
2. Factory Overhead or Expenses = Indirect Material + Indirect Labour + Indirect Expenses
   - (Not part of final Product but necessary for conversion Process)
   - Indirect Material includes Cotton, jute, lubricant, Cutting fluid
   - Indirect Labour : Watchman, Supervisor, Higher Officer
   - Indirect Expenses : Rent, Electricity bill, Telephone bills etc.
3. Factory Cost = Prime Cost + Factory O/H Cost (Cost at the Outlet of the Factory)
4. Total Cost = Factory Cost + Marketing, Advertising and Transportation Cost.
5. Selling Cost = Total Cost + Profit

5. Selling Cost = Total Cost + Profit

BREAK EVEN ANALYSIS (BEA)

Factors of Profit:

1. Total Cost
2. Selling Cost or Total Sales
3. Volume of Production.

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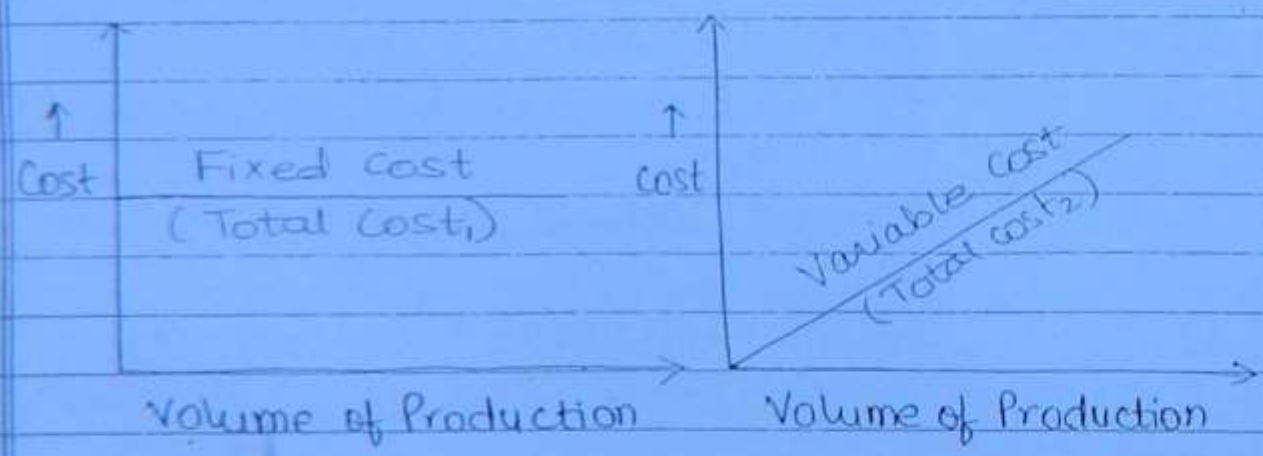
- BEA is the relation b/w the above three.

- It is a technique to study the relation between Total Sales, Total Cost and Volume of Production.

- Total Cost of a product consists of Fixed and Variable Cost



a) Fixed Cost : It remains fixed or constant irrespective of volume of Production and it includes

b) Fixed Cost : It includes Salaries of Higher officers, Supervisors, Rent of building, Insurance cost, cost

Date :

of Machine, taxes etc.

b) Variable Cost: These vary directly & Proportionally with Volume of production and there is a constant ratio between the change in cost and the change in the level of output normally Direct Material Cost and Direct Labour Cost are included in Variable cost.

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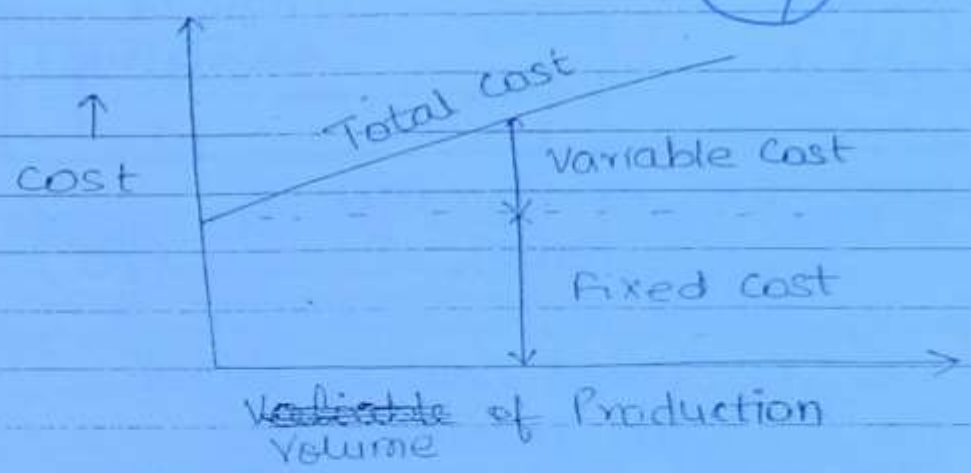

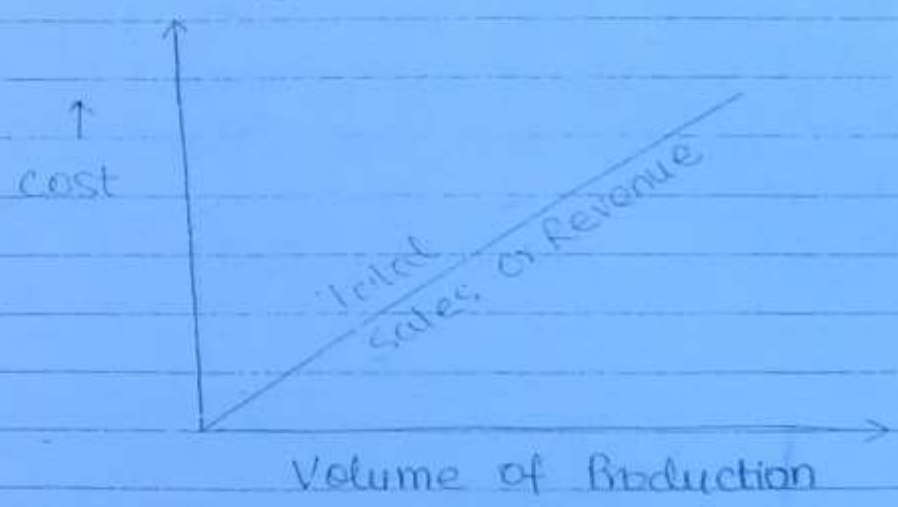

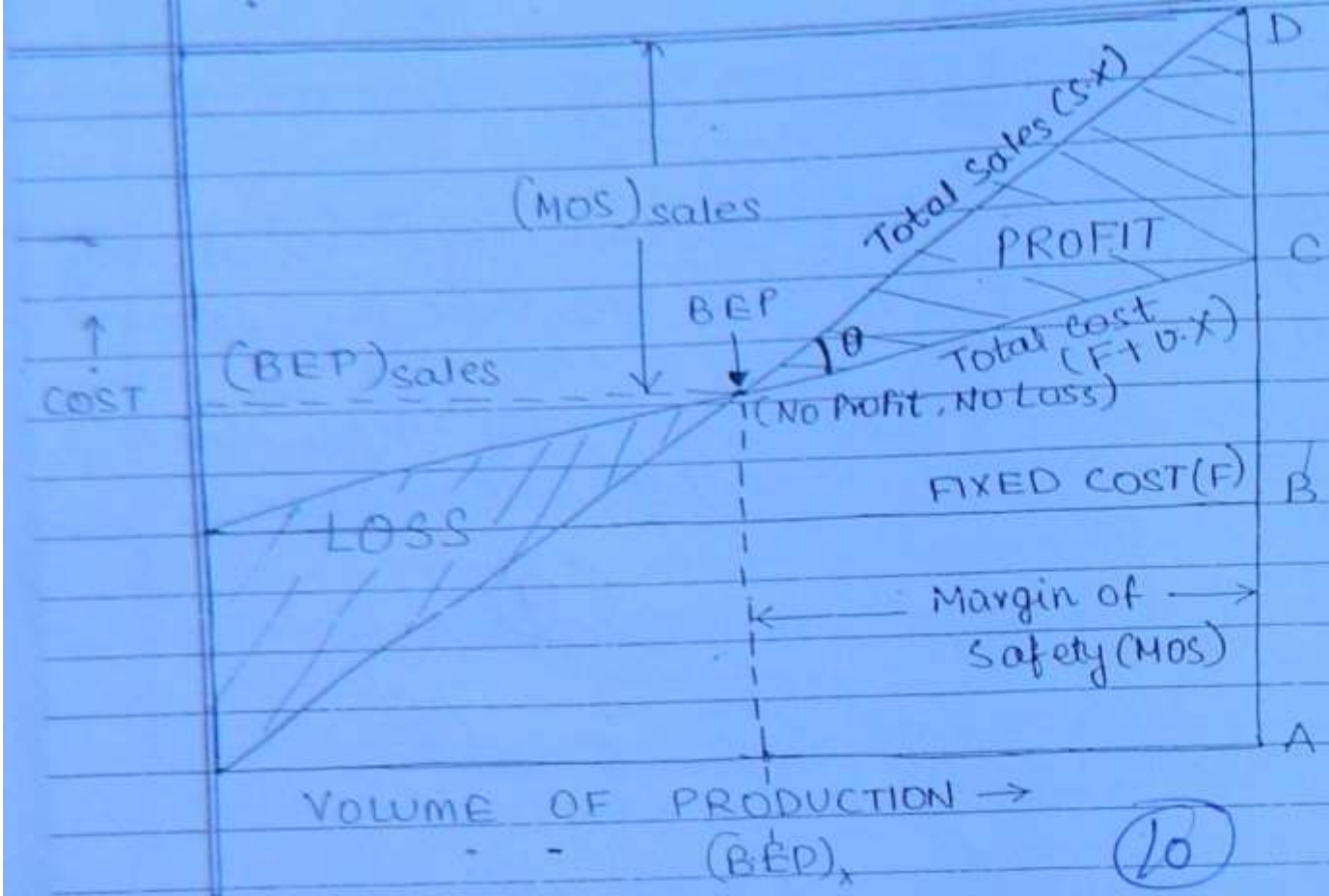

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Let 'F' : Fixed Cost in Rupess
X : No. of Units produced
v : Variable Cost per Unit (Rupees/Unit)
V : Total Variable Cost (= v × X)
s : Selling Cost per Unit (Rupees/Unit)
S : Total Sales or Revenue (= s × X)
P : Profit by producing Units 'X'.

Total Cost = F.C + V.C
= F + v.× X

Total Sales = s × X.

Also, Total Sales = Total Cost + Profit

$$* \quad \boxed{s \times X = (F + v \times X) + P} \quad *$$

$$(s - v) X = F + P$$

$$\Rightarrow \boxed{X = \frac{F+P}{s-v}}$$

for Profit $\boxed{\text{Selling Cost} > v}$

θ: Angle of Incidence b/w Total Sales & Total Cost (Can't be more to compete other companies)

Break Even Point: may be defined as that level of sales at which total sales = Total Cost and the organisation Neither Earns profit Nor suffer from Loss.

At BEP, Profit, P=0

$$\boxed{(BEP)_x = \frac{F}{S-V}}$$

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$$(BEP)_{sales} = (BEP)_x \cdot S = F + V\,(BEP)_x$$

$$\boxed{(BEP)_{sales} = \left(\frac{F}{S-V}\right) S}$$

Angle Of Incidence: It is the angle between the total sales line and the total cost line

- Larger this angle better the working conditions as profits are made at a faster rate

Contribution Margin: It is the difference between Total Sales − Total Variable cost

$$\boxed{CM = S - V = F + P}$$

Also, $S = F + V + P$

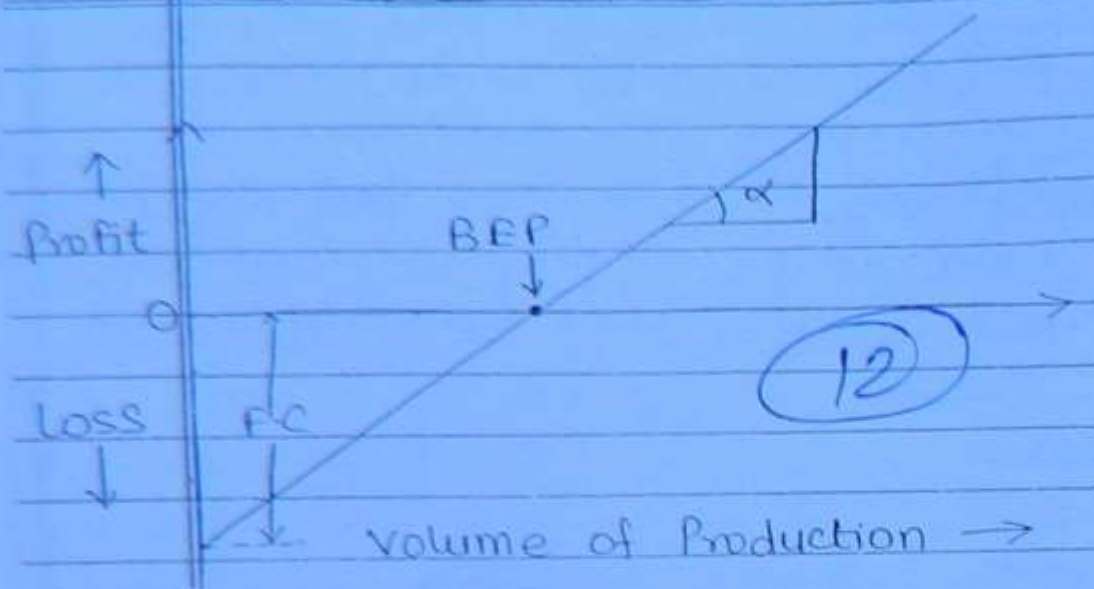
$S - V = F + P$

→ It is also known as Marginal Profit or Gross Margin.

From Fig: $CM = AD - BC = AB + CD$

PROFIT - VOLUME GRAPH

Date :



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$$S \cdot X = F + V X + P$$

$$\boxed{P = (S - V) X - F} \rightarrow (1)$$

Profit - Volume Ratio : (P/V ratio)

P/V Ratio gives relation between profit & Volume of Production and it measures the Profitability in relation to sales

$$P/V \text{ Ratio} = \frac{\text{Total Sales} - \text{Total Variable Cost}}{\text{Total Sales}}$$

$$\boxed{(P/V)_{Ratio} = \frac{S - V}{S} = \frac{CM}{S} = \frac{F + P}{S}}$$

$$(P/V)_{Ratio} = \frac{F}{(S)_{BEP}} \qquad [\because \text{At BEP}, P = 0]$$

$$\boxed{(P/V)_{Ratio} = \frac{F + P_x}{S_x}}$$

Margin Of Safety (M.O.S):-

(A) Sales Wise

It is the difference of output at any point compare to output at BEP

$$(MOS)_{sales} = (sales)_x - (sales)_{BEP}$$

13

$$= \$x - \$\left(\frac{F}{\$-v}\right)$$

$$= \$\left[\frac{(\$-v)x - F}{(\$-v)}\right]$$

from ①

$$(MOS)_{sales} = \$\left[\frac{P}{\$-v}\right]$$

$$\boxed{(MOS)_{sales} = \frac{P}{\left(\frac{\$-v}{\$}\right)} = \frac{P}{(P/V)_{Ratio}}}$$

(Rupees wise)

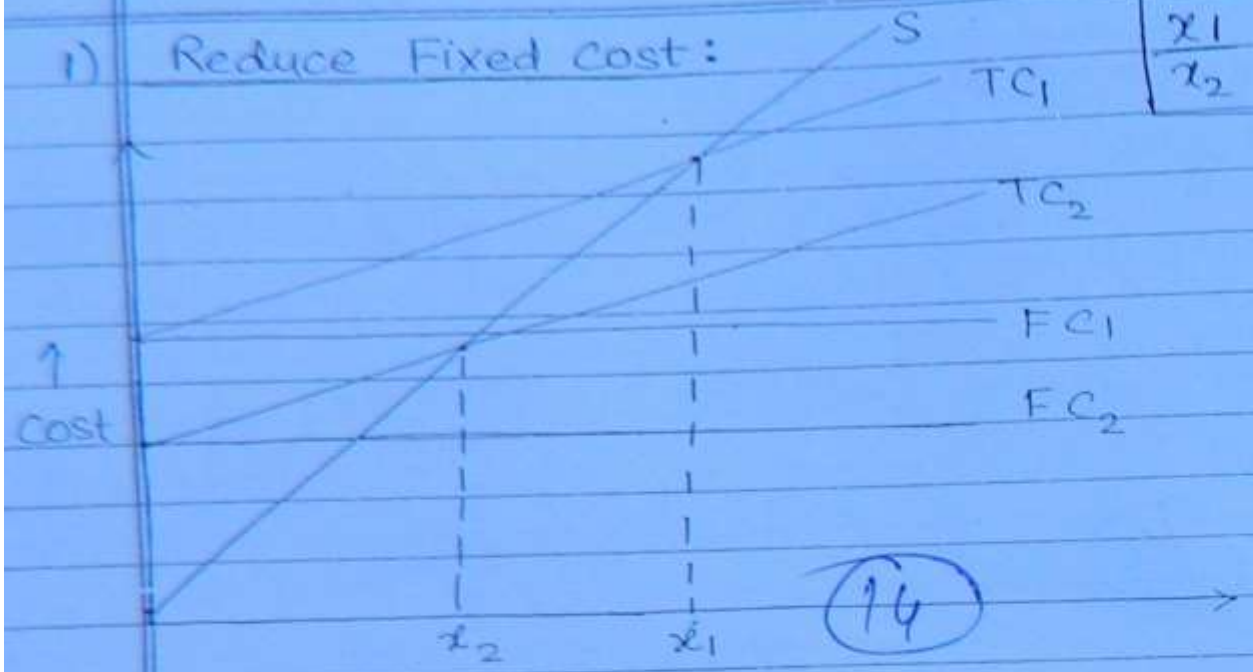
(B) Percentage Wise

$$(MOS)\% = \frac{(Sales)_x - (Sales)_{BEP}}{(Sales)_x} \times 100$$

$$(MOS)\% = \frac{(MOS)_{sales}}{(Sales)_x} \times 100$$

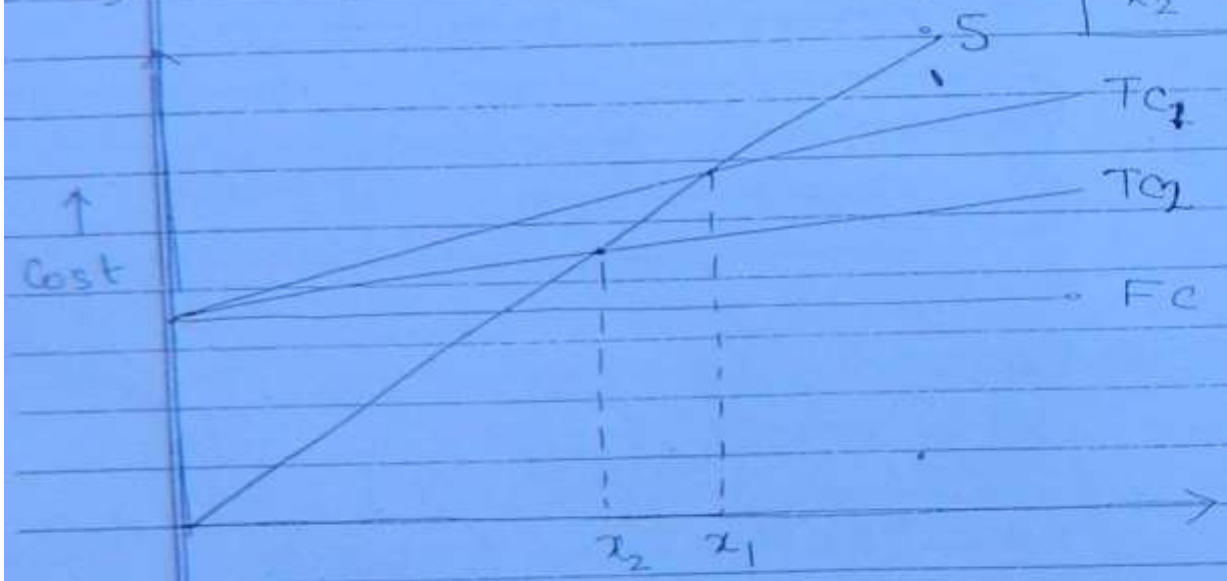
1) Reduce Fixed cost:

$$\frac{x_1}{x_2} = \frac{F_1}{F_2}$$



2) Reduce Variable cost / unit:

$$\frac{x_1}{x_2} = \frac{S - V_2}{S - V_1}$$



3) Increase selling cost / unit:

$$\frac{x_1}{x_2} = \frac{S_2 - V}{S_1 - V}$$