SRM INSTITUTE OF SCIENCE AND TECHNOLOGY , KATTANKULATHUR

FACULTY OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL ENGINEERING

18MEO111T INDUSTRIAL ENGINEERING

VI SEM

Unit -IV

A business can run smoothly its operating activities only when appropriate amount of inventory is maintained.
Inventory affects all operating activities like manufacturing, warehousing, sales etc.
The amount of opening inventory and closing inventory should be sufficient enough so that the other business activities are not adversely affected.
Thus, inventory plays an important role in operations management.

Inventory is an asset that is owned by a business that has the express purpose of being sold to a customer.
Inventory refers to the stock pile of the product a firm is offering for sale and the components that make up the product.
In other words, the inventory is used to represent the aggregate of those items of tangible assets.

The inventory may be **classified into three categories**:

Raw material and supplies: It refers to the unfinished items which go in the production process.

Work in Progress: It refers to the semi-finished goods which are not 100% complete but some work has been done on them.

Finished goods: It refers to the goods on which 100% work has been done and which are ready for sale.

Inventory management is the practice overseeing and controlling of the ordering, storage and use of components that a company uses in the production of the items it sells.

A component of supply chain management, inventory management supervises the flow of goods from manufacturers to warehouses and from these facilities to point of sale.

Inventory control means efficient management of capital invested in raw materials and supplies, work- in – progress and finished goods

Significance of holding inventory

Inventory is considered to be one of the most important assets of a business.
Its management needs to be proactive, accurate and efficient.
Inventory is essential for every organization to ensure smooth running of the production process, to reduce the ordering cost of inventory, to take advantage of quantity discount, avoid opportunity loss on sales, to utilize and optimize the plant capacity and to reduce the overall price.
Thus, it can be said that inventory is inevitable and has to be maintained in appropriate quantity.
However, the concept of Just In Time (JIT) is becoming popular which is an inventory strategy companies employ to increase efficiency and decrease waste by receiving goods only as they are needed in the production process, thereby reducing inventory costs.
This method requires producers to forecast demand accurately

Objectives of Inventory Management

The objective of inventory management is to maintain inventory at an appropriate level to avoid excess or shortage of inventory.

Inventory management systems reduce the cost of carrying inventory and ensure that the supply of raw material and finished goods remains continuous throughout the business operations.

The objectives specifically may be divided into two categories mentioned below:

A. Operating objectives:

a. To ensure continuous supply of materials.

b. To ensure uninterrupted production process.

c. To minimize the risks and losses incurred due to shortage of inventory.

d. To ensure better customer services.

e. Avoiding of stock out danger

B. Financial Objectives:

.To minimize the capital investment in the inventory.

.b. To minimize inventory costs.

.c. Economy in purchase.

Holding excess inventory lead to the following consequences:

- Unnecessary investment of funds and reduction in profit.
- Increase in holding costs.
- Loss of liquidity.
- Deterioration in inventory

Factors affecting the level of inventory

The level of inventory should be appropriate. The appropriateness of the amount of inventory depends upon a number of factors.

Some significant factors affecting the level of inventory are explained as follows:

.**Nature of business:** The level of inventory will depend upon the nature of business whether it is a retail business, wholesale business, manufacturing business or trading business.

.**Inventory turnover**: Inventory turnover refers to the amount of inventory which gets sold and the frequency of its sale. It has a direct impact on the amount of inventory held by a business concern.

. **Nature of type of product**: The product sold by the business may be a perishable product or a durable product. Accordingly, the inventory has to be maintained.

. **Economies of production**: The scale on which the production is done also affects the amount of inventory held. A business may work on large scale in order to get the economies of production.

5.Inventory costs: More the amount of inventory is held by the business, more will be the operating cost of holding inventory. There has to be a trade-off between the inventory held and the total cost of inventory which comprises of purchase cost, ordering cost and holding cost.

6. Financial position: Sometimes, the credit terms of the supplier are rigid and credit period is very short. Then, according the financial situation of the business the inventory has to be held.

7**. Period of operating cycle**: If the operating cycle period is long, then the money realization from the sale of inventory will also take a long duration. Thus, the inventory managed should be in line with the working capital requirement and the period of operating cycle.

8. Attitude of management: The attitude and philosophy of top management may support zero inventory concept or believe in maintaining huge inventory level. Accordingly, the inventory policy will be designed for the busines

Techniques of inventory control

Inventory control refers to a process of ensuring that appropriate amount of stock are maintained by a business, so as to be able to meet customer demand without delay while keeping the costs associated with holding stock to a minimum.

Inventory control signifies a planned approach of finding when to shift, what to shift, how much to shift and how much to stock so that costs in buying and storing are optimally minimum without interrupting production or affecting sales.

To solve these problems of inventory management various techniques are there.

These techniques are divided into two categories – modern techniques and traditional techniques

1) MODERN TECHNIQUES
a) Economic Order Quantity (EOQ)
b) Re-Order Point (ROP) (c) Fixing Stock Levels
c) Selective Inventory Control
(i) ABC Analysis
ii) VED Analysis
ii) SDE Analysis
v) FSN Analysis

(2) TRADITIONAL TECHNIQUES
a) Inventory Control Ratios
b) Two Bin System
c) Perpetual Inventory System
d) Periodic Order System

Modern techniques of inventory control refers to those techniques which are evolved through a scientific process. These techniques involve the use of a formula or a method which is logically derived to keep control on the inventory levels. These techniques are explained as below:

(a) ECONOMIC ORDER QUANTITY (EOQ) The optimal size of an order for replenishment of inventory is called economic order quantity.

Economic order quantity (EOQ) or optimum order quantity is that size of the order where total inventory costs (ordering costs + carrying costs) are minimized.

Economic order quantity can be calculated from any of the following two methods:

Formula Method

Graphic Method

Formula Method:

It is also known as ‘SQUARE ROOT FORMULA’ or ‘WILSON FORMULA’ as given below:

$$EOQ = \sqrt{\frac{2RO}{C}}$$

Where, EOQ = Economic Order Quantity

R = Annual Requirement or consumption in units

O = Ordering Cost per order

C = Carrying Cost per unit per year

No. of orders = R/EOQ

Time gap between two orders = No. of days in a year/No. of orders

Total Cost = Purchase Cost + Carrying Cost + Order Cost

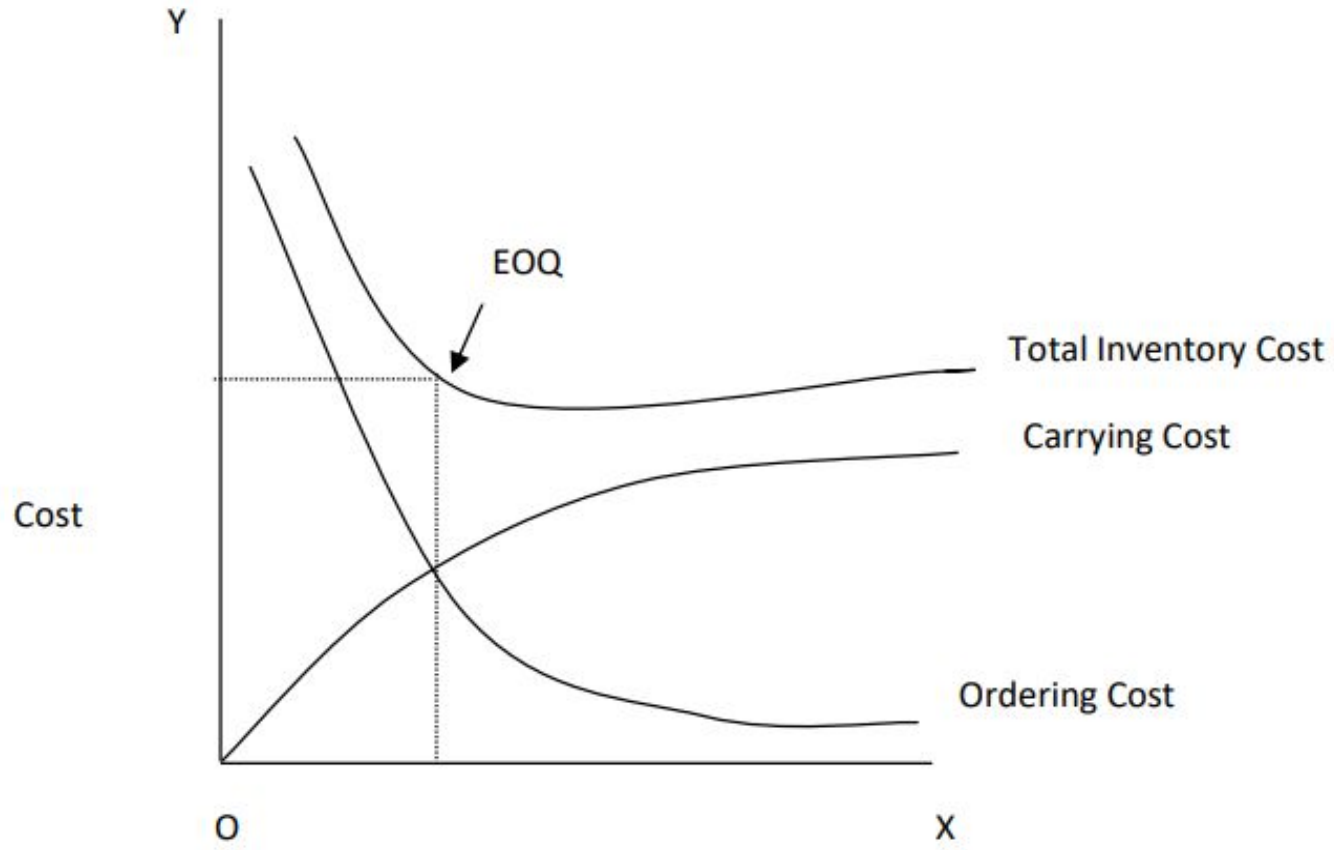
= (R x Unit Price) + (EOQ/2 x C) + (R/EOQ x O)

Graphic Method

The economic order quantity can also be determined with the help of graph. Under this method, ordering costs, carrying costs and total inventory costs according to different lot sizes are plotted on the graph.

The intersection point at which the inventory carrying cost and the ordering cost meet, is the economic order quantity.

At this point the total cost line is also minimum.



Assumptions: The following assumptions are made:

- The rate of consumption of inventory is assumed to be constant.
- Costs will not change over time.
- Lead time is assumed to be known and constant.
- Per order cost, carrying cost and unit price are constant.
- Carrying or holding costs are proportionate to the value of stock held.
- Ordering cost varies proportionately with the price.

RE-ORDER POINT

After determining the optimum quantity of purchase order, the next problem is to specify the point of time when the order should be placed.

Re-order level is that level of inventory at which an order should be placed for **replenishing the current stock of inventory**.

The determination of re-order point depends upon the lead time, usage rate and safety stock.

.Lead Time: Lead time refers to the time gap between placing the order and actually receiving the items ordered.

.Usage Rate: It refers to the rate of consumption of raw material per day.

Usage Rate = Total annual consumption / No. of days in a year.

3.Safety Stock: It is the minimum quantity of inventory which a firm decides to maintain always to protect itself against the risk and losses likely to occur due to stoppage in production and loss of sale, due to non- availability of inventory.

Formulae:

Re Order Point = (Lead Time x Usage Rate) + Safety Stock or

Re Order Point = Maximum usage x Maximum Re Order Period

Safety Stock = Usage Rate x Days of safety

Note: ROL – Re Order Level

ROQ – Re Order Quantity ROQ is also known as EOQ (Economic Order Quantity)

DANGER LEVEL

Danger level refers to the level below the minimum stock level. The following factors should be considered to determine the danger level:

Causes for failure of regular supplies

- Easy and quick sources of supply
- Rescheduling of work- order in the light of such exigencies
- Quickest means of transportation
- Emergency period of procurement

Formula

Danger Level = Minimum rate of consumption x Emergency delivery period.

Danger Level = Maximum rate of consumption x Emergency delivery period

(d) SELECTIVE INVENTORY CONTROL

Controlling all inventory in the stock is a very difficult task especially where huge inventories are maintained of variety of items. In such circumstances, following smart techniques for managing and controlling the different types of inventories held are as follows:

)ABC Analysis: ABC analysis may be defined as a technique where inventories are analyzed with respect to their value so that costly items are given greater attention and care by the management. Three categories are created namely A, B and C. Following table represents the approximate classification of items along with their value and quantity.

Category	% of Total Value	% of Total Quantity
A	70-80	5-10
B	20-25	20-30
C	5-10	60-70

(ii) VED Analysis: VED stands for Vital, Essential and Desirable. Highest control is over vital items, medium control is exercised over essential items and least control is inferred over desirable items.

(iii) SDE Analysis: SDE stands for Scarce, Difficult and Easy. Highest control is over scarce items, medium control is exercised over difficult items and least control is inferred over easily available items.

(iv) FSN Analysis: FSN stands for Fast Moving (F), Slow Moving (S) and Non Moving (N). Highest control is kept over fast moving items, medium control is exercised over slow moving items and least control is inferred on non-moving items

Traditional Techniques

Traditional techniques refers to those techniques which are prevalent before the evolution of the modern techniques.

These techniques were derived with the working practice and are based on experience and ease of usage by the workers and the small business enterprises.

These techniques are explained as follows:

)INVENTORY CONTROL RATIOS

Ratios related to inventory are calculated and further used as a measure of control.

Stock Turnover = Cost of goods sold / Average Stock

(b) TWO BIN SYSTEM

Under two bin system, all the inventory items are stored in two separate bins.

Bin means container of any size.

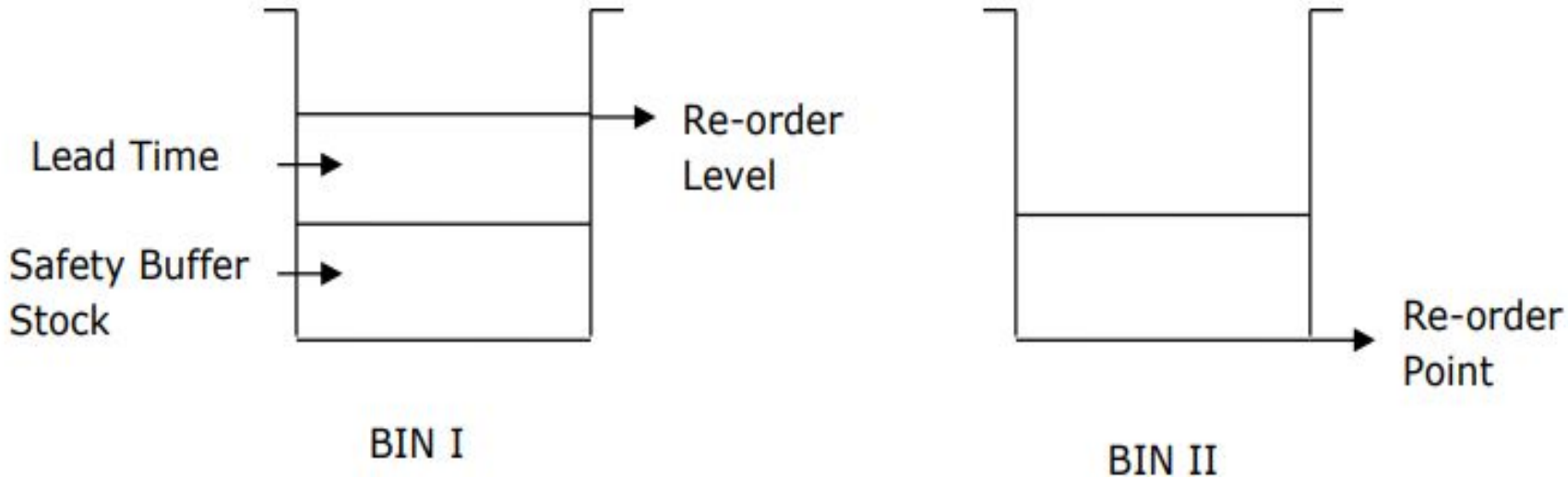
In the first bin, a sufficient amount of inventory is kept to meet the current requirement over a designated period of time.

In the second bin, a safety stock is maintained for use during lead time. When the stock of first bin is completely used, an order for further stock is immediately placed.

The material in second bin is then consumed to meet stock needs until the new order is received.

On receipt of new order, the stock used from the second bin is restored and the balance is put in the first bin.

Therefore, depletion of inventory in the first bin provides an automatic signal to re-order. Thus, this technique is traditional yet logical and can be used by illiterate workers also without using any formula.


Lead Time
Safety Buffer Stock
Re-order Level
BIN I
Re-order Point
BIN II

(c) PERPETUAL INVENTORY SYSTEM

Perpetual inventory system is defined as the method of recording stores balance after each receipt and each issue to facilitate regular checking of inventory.

It is also known as continuous stock checking.

The application of perpetual inventory control system involves –

)Attaching bin cards with bins.

) Continuous stock taking to compare the actual stock.

Bin cards refers to the cards attached to every bin in which the details regarding the quantity of material received, issued and balance left in that bin is recorded hand to hand. Under this system, statement of material, follow up actions, monitoring etc. can be smoothly carried out.

(d) PERIODIC ORDER SYSTEM

Under this system, the stock levels of all types of inventories held, are reviewed after a fixed time interval.

Time interval may be weekly, fortnightly, monthly, quarterly etc. depending upon the criticality of the item.

Critical items may require a short review cycle and on the other hand, lower cost and non-moving items may require long review cycle.

Therefore, for different items different time intervals should be used. After the review, the items which are less than the required level, order is placed to replenish their exhausted level.

Problems.1. Calculate the economic order quantity from the following particulars:

Annual requirement =2,000 units Cost of materials per unit =Rs. 20

Cost of placing and receiving one order= Rs. 40

Annual carrying cost of inventory, 20% of inventory value

Solution: Here, R = 2,000

O = 40

Unit Price = 20

C = 20% of Unit Price = 20% of 20 = 4

$EOQ = \sqrt{2RO / C}$

$= \sqrt{2(2000)(40) / (4)}$

= 200 units

Problem: 2.

Compute EOQ and the total variable cost from the following information:

Annual demand = 4,000 units

Units Price = Rs. 40

Order Cost = Rs. 20

Storage Rate = 7% Per annum

Interest Rate = 3% Per annum

Solution:

Here, R = 4,000

O = 20

Unit Price = 40

C = 10% of Unit Price

= 10% of 40 = 4

$EOQ = \sqrt{2RO / C} = \sqrt{2(4000)(20) / (4)} = 200$ units

Total Variable Cost = Carrying Cost + Order Cost

= (EOQ/2 x C) + (R/EOQ x O)

= (200/2 x 4) + (4000/200 x 20)

= 400 + 400 = Rs. 800

Total Cost = Purchase Cost + Carrying Cost + Order Cost

= (R x Unit Price) + (EOQ/2 x C) + (R/EOQ x O)

= (4000 x 40) + (200/2 x 4) + (4000/200 x 20)

= 1, 60,000 + 400 + 400 = Rs. 1, 60,800

Assignment:

Two components P and Q are used as follow: Normal usage 600 units per week each. Maximum usage 900 units per week each Minimum usage 300 units per week each Re-order quantity- P = 4,000 units; Q = 7,000 units Re-order period- P = 4 to 6 weeks; Q = 2 to 4 weeks a. Re-order level b. Minimum Level c. Maximum Level d. Average stock level

Meaning of Inventory Cost

Maintaining varied types of inventories involve different costs associated with them. Some inventory items are low priced, some are medium priced and some are very expensive.

Thus, inventory costs has to be looked into first before deciding the type of control to be exercised on it.

The costs associated with inventory include the **purchase cost, ordering cost and the holding cost**.

In case of selective inventory control technique – **ABC analysis**, inventory cost plays a very **significant role as the category classification** and the kind of control exercised, completely depend upon the cost of inventory.

Meaning and purpose of ABC Analysis

Inventory ABC Classification, known as ABC Analysis, is a term used to define an inventory categorization method used in materials management to **exercise selective inventory control**.

The ABC Classification **provides a mechanism for identifying the inventory items that captures the significant portion of the overall inventory cost**.

It also provides a mechanism for identifying different categories of stock on which different inventory policy and inventory control practices can be used.

ABC analysis divides the inventory items into **three categories namely A, B and C**. The classification is based on their cost.

Costly items are categorized 'A' and **highest control is exercised** on these items. **Least valuable** items are categorized **'C'** and least control is exercised on them and **remaining items are categorized as 'B'** on **which moderate control** is exercised

The basic purpose of ABC Analysis

Provide basis for material management processes and helps to define how stock is to be managed.

It form the basis for various activities comprising plans on alternative stock arrangements and reorder calculations.

It also helps to determine at what intervals inventory checks should be carried out. For instance – 'A' class items are to be checked more frequently than 'C' class items. Thus, ABC analysis forms the basis of many such activities and policy frameworks. There fore it helps in

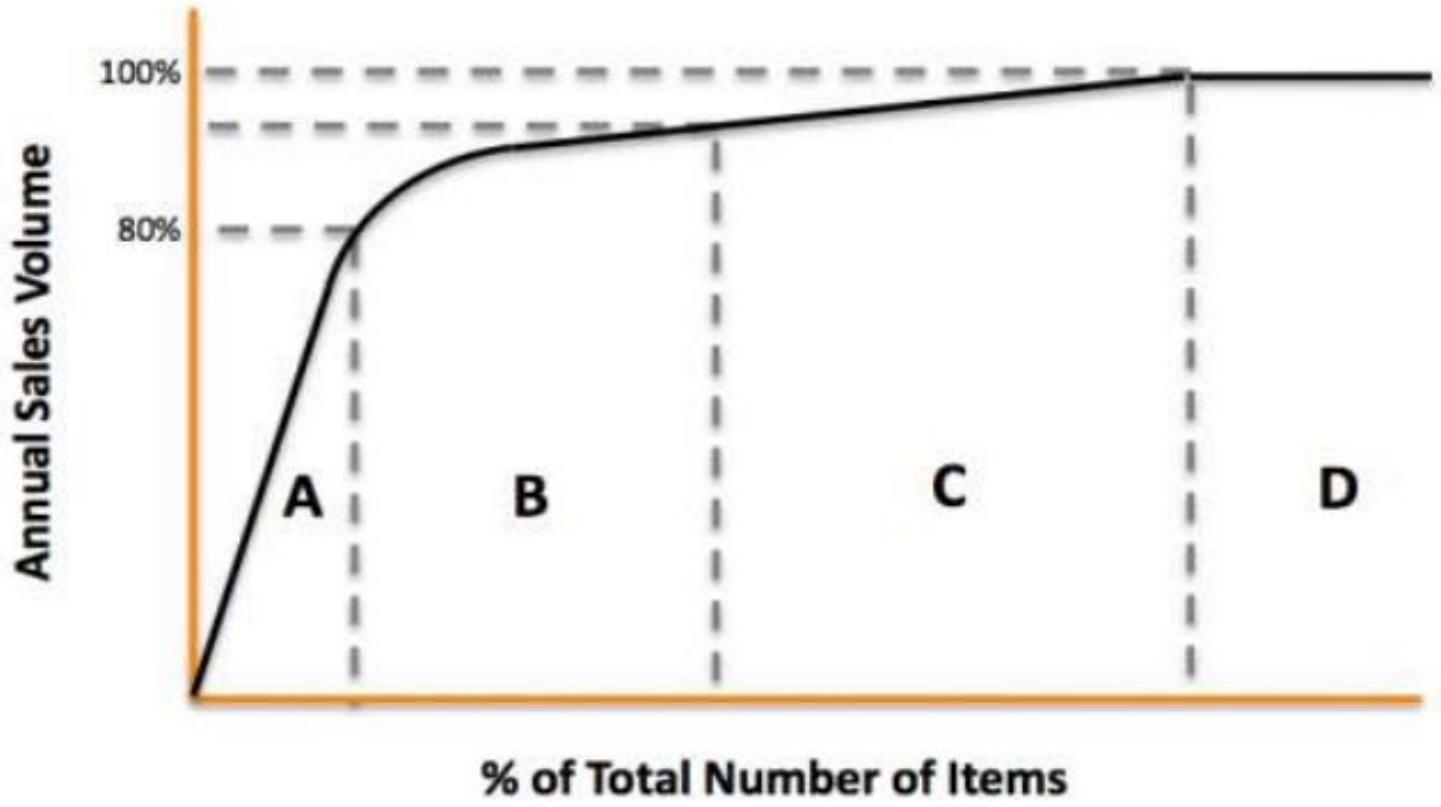
- Significant reduction in investment in inventory.

Protection against stock outs.

- Reducing the work load involved in different activities such as ordering, procuring, receiving, inspecting, handling and storage of inventory items.
- Reduction in obsolescence losses.
- Increase in profits.

The Pareto Principle developed by Vilfredo Pareto (1848 - 1923).
Critical few is separated from the trivial many ,also known as the 80/20 rule.
It is based upon the theory
that 20% of the population owns 80% of the nation's wealth, most of the businesses get 80% of their sales revenue from 20% of the customers,
80% of the problems are caused because of 80% of the employees and 20% of the items accounts for 80% of the firms expenditure.
Therefore, the classification of the inventory is done on the basis of the Pareto principle, in which 20% of the impactful items should fall into 'A' classification category.
It emphasizes on working out the rupee value of each individual inventory item on annual consumption basis. Then the ratio between the number of items and the currency value of the items is calculated and the following categorization is done:

- 10-20% of the items ('A' class) account for 70-80% of the consumption
- the next 15-25% ('B' class) account for 10-20% of the consumption
- the balance 65-75% ('C' class) account for 5-10% of the consumption



ABC Classification & The Pareto Rule for Inventory Management

The above figure depicts the classification according to the Pareto principle. All the items are divided into three broad categories – A, B and C, according to the calculation of the above mentioned ratio.

Criteria for ABC classification The ABC analysis suggests that inventories of an organization are not of equal value. It specifies that the company should rate the inventory items from A to C, based upon their quantity and value. The three categories A, B and C possess the following characteristics:

"A" Category

- These items generally represent approximately 15%-20% of an overall inventory by quantity, but represent 80% of the value of an inventory.
- These are high value items and are extremely important.
- By paying close attention to the optimization of these items in inventory, a significantly positive impact may be created with a nominal increase in the inventory management costs.
- Very strict control is kept on these items.
- Accurate records need to be maintained for these items.
- Because of the high value of these items, frequent value analysis is required.
- Appropriate order pattern should be chosen such as ‘Just- in- time’ to avoid excess capacity

"B" Category

- These items represent 30%-35% of inventory items by item type, and about 15% of the value.
- These are intermediary value items.
- These items can generally be managed through period inventory and should be managed with a formal inventory system.
- Comparatively less control than ‘A’ category items is needed.
- Proper records should be maintained for these items.

"C" Category

- These items represent 50% of actual items but only 5% of the inventory value.
- These are low value items and are marginally important.
- Most organizations can afford a relatively relaxed inventory process surrounding these items. Least amount of control is required.
- Minimum possible records should be maintained in the simplest form.

Steps for Classification of Items The inventory items are first classified, then their total cost is ascertained, thereafter ranking is done followed by the computation of ratio or percentages. Then finally the A, B and C categories are determined.

.Identify the objective for ABC analysis. An ABC analysis can accomplish one of two primary goals: to reduce procurement costs or to increase cash flow by having the right items available for production.

.Collect data related to the inventory under analysis. The data can be obtained from standard accounting if used in the organization. The data required is the raw material purchased or weighted cost including all ordering costs and carrying costs.

. Rank the inventory in decreasing order of their cost.

. Calculate the cumulative impact for all inventory items by dividing item annual cost by total inventory annual expenditure, then adding that amount to the cumulative total of percentage spent.

.Draw a curve of percentage items and percentage value. Take a holistic view taking into account the Pareto principle

6. Mark the limits bifurcating the three classes as A, B and C rationally. Analyze classes and make appropriate decisions.

The key to this step is follow-up and tracking. The periodic review should be done for monitoring the success or failure of the decisions and categorization done.

Basis	A class items	B class items	C class items
Control	Very strict control	Moderate control	Least control
Safety stock	No or very low safety stock	Low safety stock	High safety stock
Order delivery	weekly	Once in three months	Once in six months
Control report	Weekly Control report	Monthly Control report	Quarterly Control report
Follow up	Maximum follow up	Periodic follow up	Optional
Sources of supply	Should have as many sources as possible	Should have two or more reliable sources	Should have two reliable sources
Forecast	Accurate forecasts are needed	Estimates based on past data are sufficient	Rough estimate is required
Purchasing function	Should have centralised purchasing function	May have centralised or decentralised or a combination of both purchasing function	Should have decentralised purchasing function
Officers	Should be handled by senior officers	Should be handled by middle level officers	Can be delegated to lower level staff.

Following represent some applications of ABC analysis:
It highlights specific items on which efforts can be concentrated profitably.
It provides a sound basis on which the allocation of funds and time is done.
It helps in reviewing the stock levels especially minimum and maximum levels of the inventory items. ‘A’ items will generally have greater impact on projected investment and purchasing expenditure, and therefore should be managed more aggressively in terms of minimum and maximum inventory levels. The inactive items will fall at the bottom of the ‘C’ category. It is the best place to start when performing a periodic obsolescence review.

The frequency of usage can be worked out and accordingly the time gap between orders is decided. ‘A’ category items are very frequently used and their accurate record balances need to be kept. Thus, frequent stock taking is done for these items. Accordingly, the strategy is planned for B and C category items.

It helps in identifying the inventory items for potential consignment or vendor stocking.

Practice Problems

Q1. The following data is related to Paroma Ltd.:

Categorize the items according to ABC analysis

Item No.	11	12	13	14	15	16	17
Unit Cost	5	10	14	7	6	15	20
Annual Demand	47000	1500	200	700	4700	1100	17000

Solution:

Total Spending per year

Item No.	Unit Cost	Annual Demand	Total Cost per year
11	5	47000	235000
12	10	1500	15000
13	14	200	2800
14	7	700	4900
15	6	4700	28200
16	15	1100	16500
17	20	17000	340000

Usage of item in total usage

Item No.	**Unit Cost**	**Annual Demand**	**Total Cost per year**	**% of Total Usage**
11	5	47000	235000	36.58%
12	10	1500	15000	2.33%
13	14	200	2800	0.43%
14	7	700	4900	0.76%
15	6	4700	28200	4.38%
16	15	1100	16500	2.56%
17	20	17000	340000	52.92%
			642400	**100%**

Sort the items by usage

Item No.	Unit Cost	Annual Demand	Total Cost per year	% of Total Usage	Cumulative % of total
17	20	17000	340000	52.92%	52.92%
11	5	47000	235000	36.58%	89.50%
15	6	4700	28200	4.38%	93.88%
16	15	1100	16500	2.56%	96.44%
12	10	1500	15000	2.33%	98.77%
14	7	700	4900	0.76%	99.53%
13	14	200	2800	0.47%	100%
			642400	**100%**	

ABC Classification

Category	Items	% usage	Action Needed
A	17, 11	89.5%	Close control
B	15,16,12	9.27%	Regular review
C	14, 13	1.23%	Infrequent review

Assignment:

The following data is related to a manufacturing company. Categorize the items according to ABC analysis.

Item No.	1	2	3	4	5	6	7
Unit Cost	80	9	28	20	29	10	3
Annual Demand	75	145000	500	17500	2900	19000	9500

A breakeven analysis is used to determine how much sales volume your business needs to **start making a profit**.

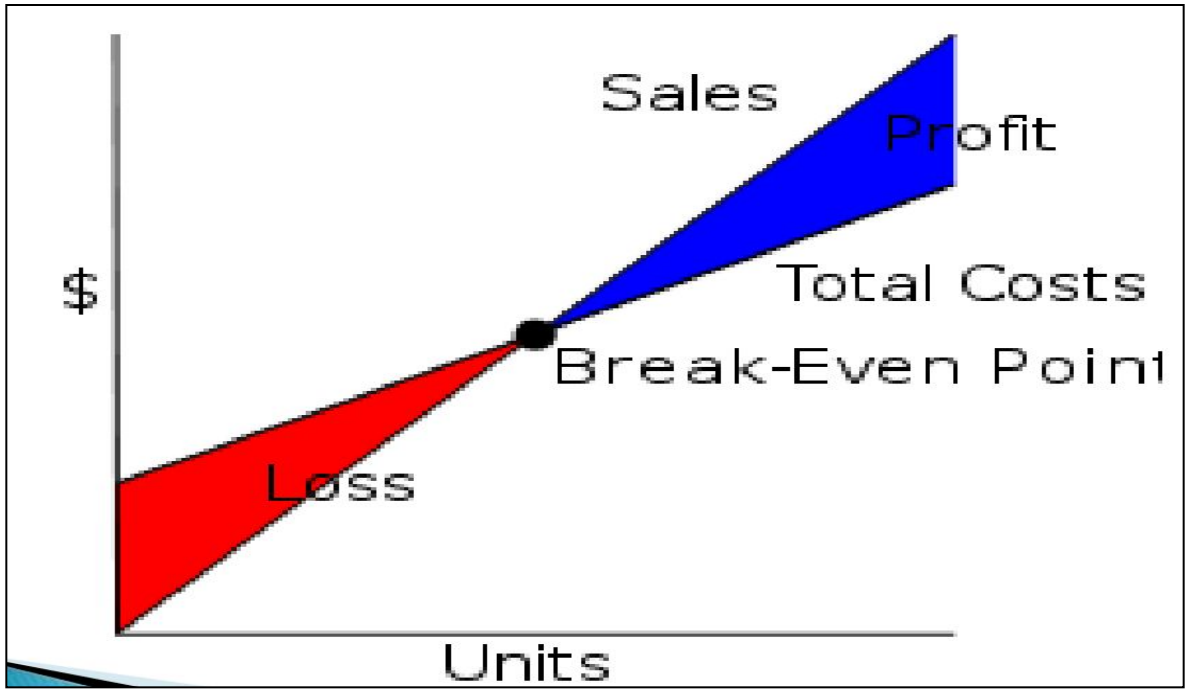
The breakeven analysis is especially useful when you're developing a pricing strategy, either as part of a marketing plan or a business plan.

In economics & business, specifically **cost accounting**,

the break-even point (BEP) is the **point at which cost or expenses and revenue are equal**:

there is no net loss or gain, and one has "broken even".

Total cost = Total revenue = B.E.P.



In order to calculate how profitable a product will be, we must firstly look at the Costs Price and Revenue involved.
There are two basic types of costs a company incurs. • Variable Costs • Fixed Costs

Variable costs are costs that change with changes in production levels or sales.
Examples include: Costs of materials used in the production of the goods.

Fixed costs remain roughly the same regardless of sales/output levels.
Examples include: Rent, Insurance and Wages.

Unit Price: The amount of money charged to the customer for each unit of a product or service.
Total Cost: The sum of the fixed cost and total variable cost for any given level of production. (Fixed Cost + Total Variable Cost)
Total Variable Cost: The product of expected unit sales and variable unit cost. (Expected Unit Sales * Variable Unit Cost)

Total Revenue:
The product of expected unit sales and unit price.
(Expected Unit Sales * Unit Price)

Profit/ loss The monetary gain or loss resulting from revenues after subtracting all associated costs. (Total Revenue - Total Costs)

The break-even point (in terms of Unit Sales (X)) can be directly computed in terms of Total Revenue (TR) and Total Costs (TC) as:

$$
\begin{aligned}
TR &= TC \\
P \times X &= TFC + V \times X \\
P \times X - V \times X &= TFC \\
(P - V) \times X &= TFC \\
X &= \frac{TFC}{P - V}
\end{aligned}
$$

where:
TFC is Total Fixed Costs,
P is Unit Sale Price, and
V is Unit Variable Cost

The quantity (P – V) is of interest in its own right, and is called the Unit Contribution Margin (C): it is the marginal profit per unit, or alternatively the portion of each sale that contributes to Fixed Costs.

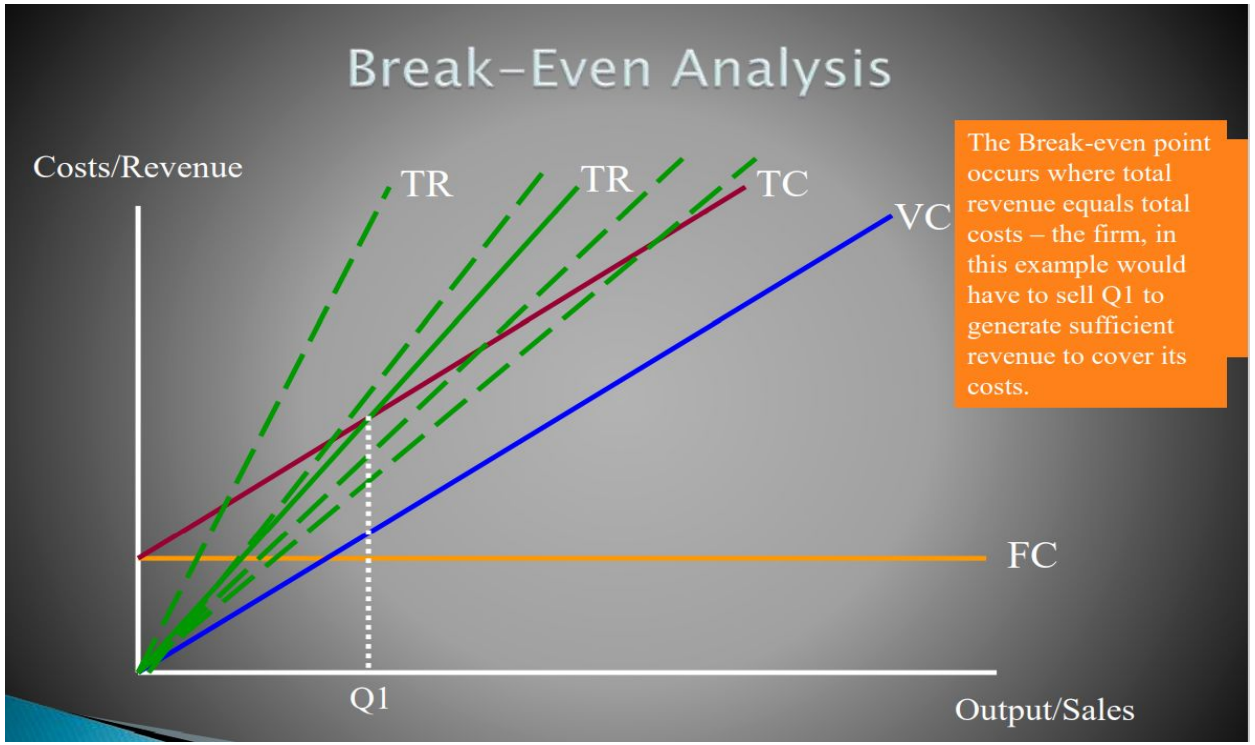
For example, suppose that your fixed costs for producing 100,000 product were 30,000 Rs a year. Your variable costs are 2.20 R.s materials, 4.00 R.s labor, and 0.80 Rs overhead, for a total of 7.00 R.s per unit.
If you choose a selling price of 12.00 Rs for each product, then:
BEP= TFC/P-V
30,000(TFC) divided by [12.00(P) - 7.00(V)] equals 6000 units.
This is the number of products that have to be sold at a selling price of 12.00 Rs before your business will start to make a profit.

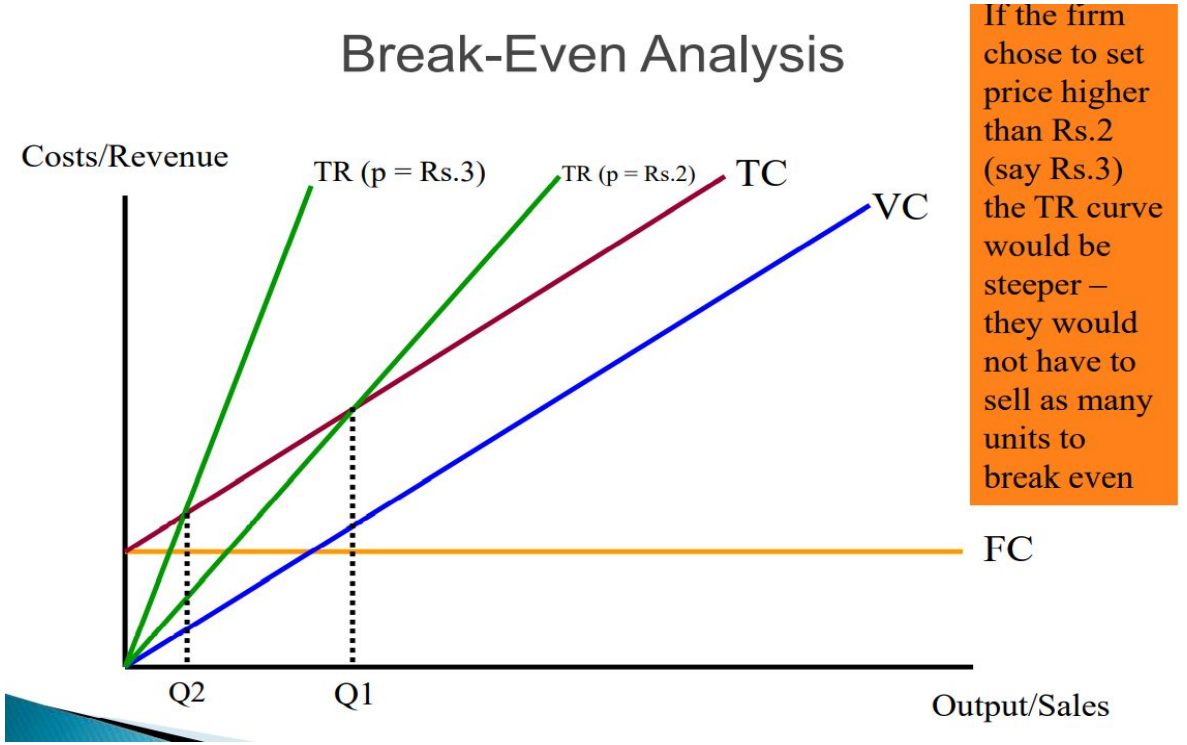
For example, if it costs R.s. 50 to produce a pen, and there are fixed costs of R.s.1,000, the break-even point for selling the widgets would be:

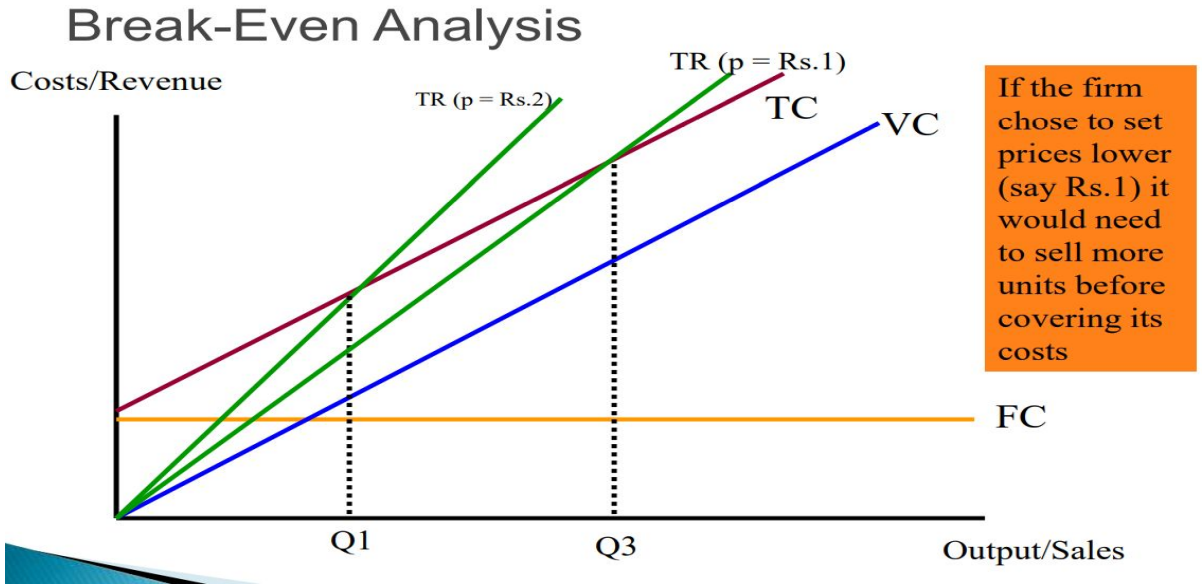
If selling for R.s. 100: 20 Widgets
(Calculated as 1000/(100-50)=20)

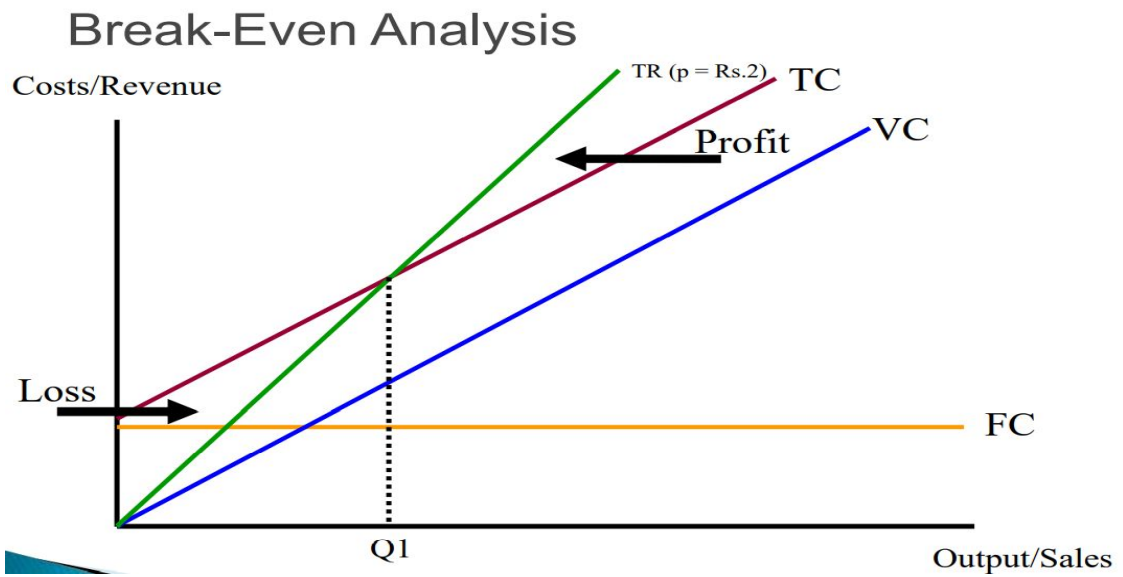
If selling for $200: 20 Widgets
(Calculated as 1000/(200-50)=6.7)

From this we can make out that the company should sell products at higher price to reach BEP faster.


Break-Even Analysis
Costs/Revenue
TR
TR
TC
VC
FC
Q1
Output/Sales
The Break-even point occurs where total revenue equals total costs – the firm, in this example would have to sell Q1 to generate sufficient revenue to cover its costs.


Break-Even Analysis
Costs/Revenue
TR (p = Rs.3)
TR (p = Rs.2)
TC
VC
FC
Q2
Q1
Output/Sales
If the firm chose to set price higher than Rs.2 (say Rs.3) the TR curve would be steeper – they would not have to sell as many units to break even


Break-Even Analysis
Costs/Revenue
TR (p = Rs.1)
TR (p = Rs.2)
TC
VC
FC
Q1
Q3
Output/Sales
If the firm chose to set prices lower (say Rs.1) it would need to sell more units before covering its costs


Break-Even Analysis
Costs/Revenue
TR (p = Rs.2)
TC
Profit
VC
Loss
FC
Q1
Output/Sales

Margin of safety represents the strength of the business.

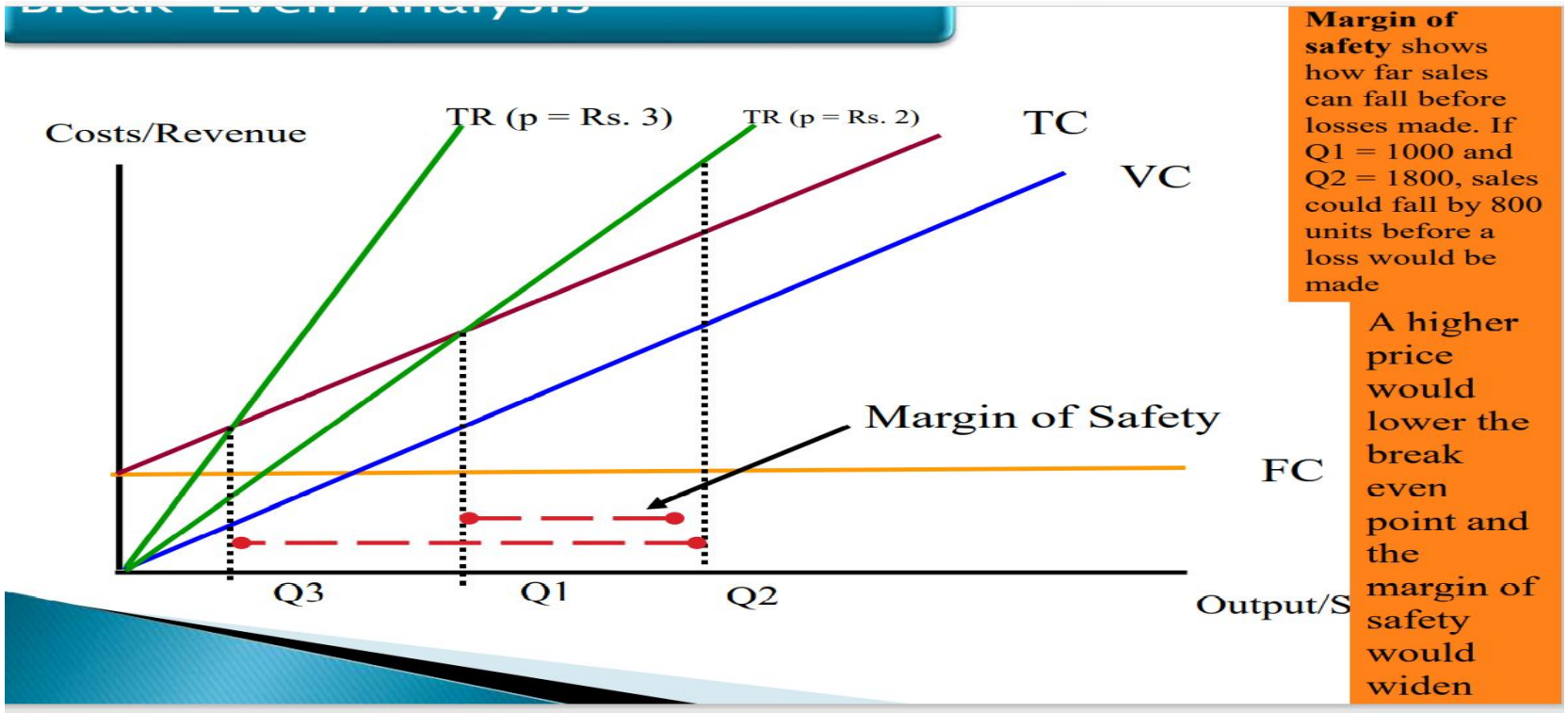
It enables a business to know what is the exact amount it has gained or lost and whether they are over or below the break even point.

Margin of safety = (current output - breakeven output)

OR

Margin of safety = actual sales – BEP sales

Margin of safety% = (current output - breakeven output)/current output × 100



Production Planning and Control

Production is done by manufacturing different things with various processes.

Planning looks ahead, anticipates possible difficulties, and decides in advance about the production.

The control phase makes sure that the programmed production is constantly maintained.

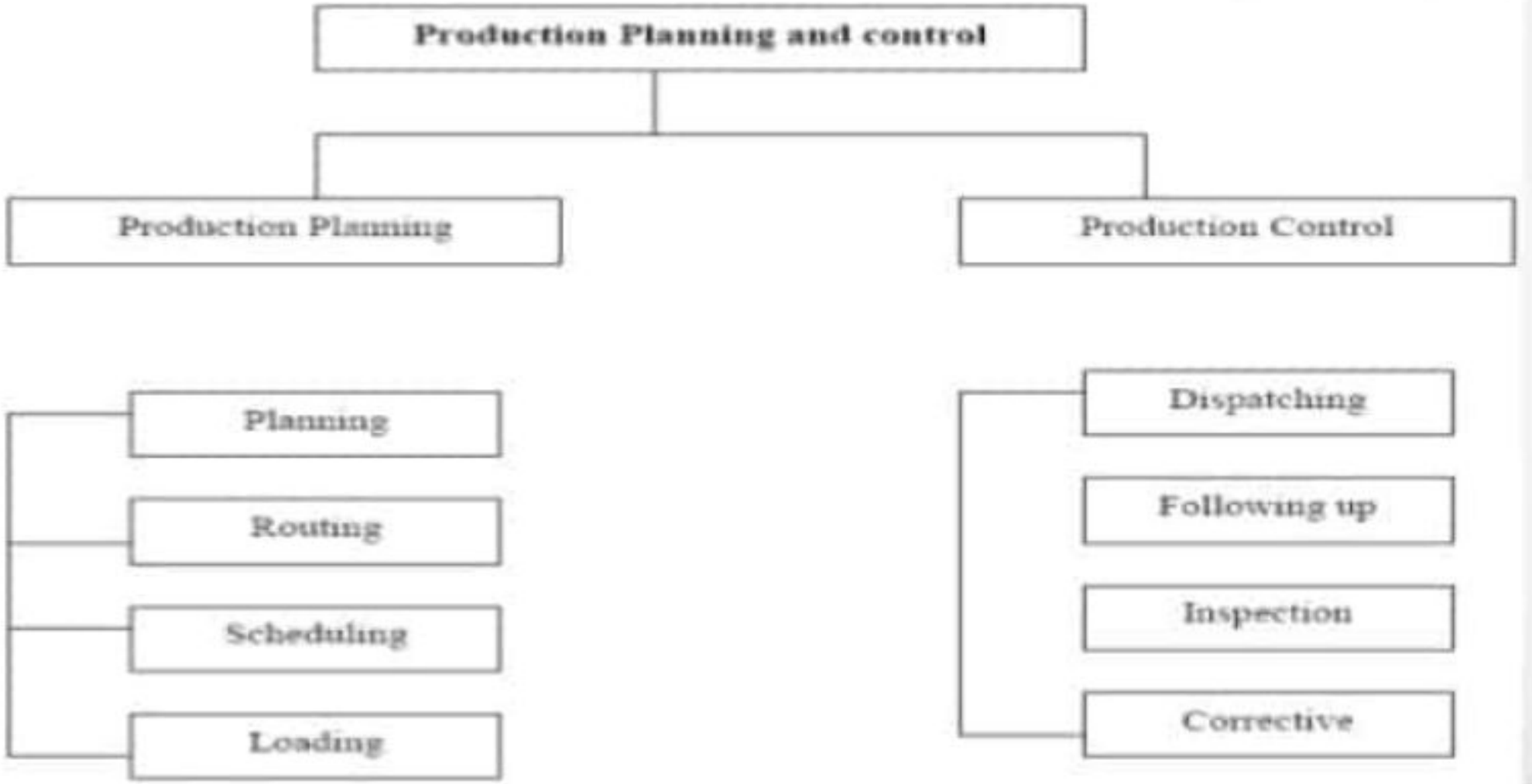
A production planning and control (PPC) system has many functions to perform like:-

.**Planning phase:-** Forecasting, order writing, product, product design, material control, tool control, loading, etc.

.**Action phase:-** Dispatching

.**Control phase:-** Data processing, expediting and replanning

PPC : PROCESS



production planning and control

What is PPC?

- Production planning and control may be defined as the direction and coordination of the firm's material and physical facilities towards the attainment of pre-specified production goals, most efficiently and economically.
- **According to Samuel Elion: "The highest efficiency in production is obtained by manufacturing the required quantity of the product, of the required quality, at the required time, by the best and cheapest method."**
- To attain this target, management employs production planning and control, the tool that co-ordinates all manufacturing activities.
- The four factors mentioned above—namely: quantity, quality, time and price encompass the production system, of which production planning and control is the brain.
- Production control will be in action when production activity begins.

Objectives of PPC are discussed below:

1. To design a system and plan, by which production may be carried out to meet the promised delivery date consistent with minimum cost and quality standard.
2. To ensure efficient utilization of production facilities.
3. To coordinate the production activities of different departments.
4. To maintain adequate but not excessive stock of raw materials, work in process, and of finished goods to meet production requirements and delivery schedules at the most economical level.
5. To ensure the production of the right product in the right quality at the right time.
6. To maintain flexibility in manufacturing operations, to accommodate rush jobs or to meet contingencies.
7. To co-ordinate labor, machines, and equipment most effectively and economically.
8. Ensuring smooth flow of materials by eliminating bottlenecks if any, in production.
9. Establishing targets and checking it against performance.

Functions of PPC

Three main phases of PPC:

1. Planning phase
2. Action phase
3. Follow up or control phase

- These three phases as mentioned above make up the main body of functions of PPC. There are other secondary functions that are essential contributors to the efficient performance of production, planning, and control.

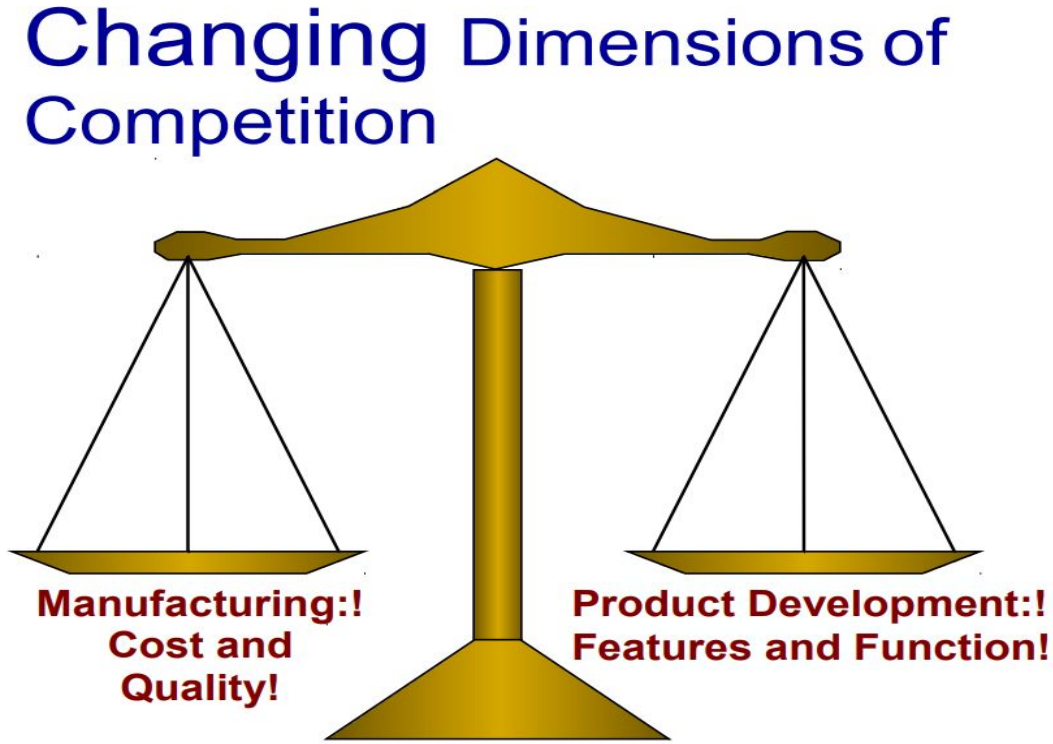
- Also there are other functions that are supported by these three phases which are not generally considered to be direct functions of production planning and control.

- These include quality control- cost control and so on.

function of ppc

Product Design & Development (PDD)

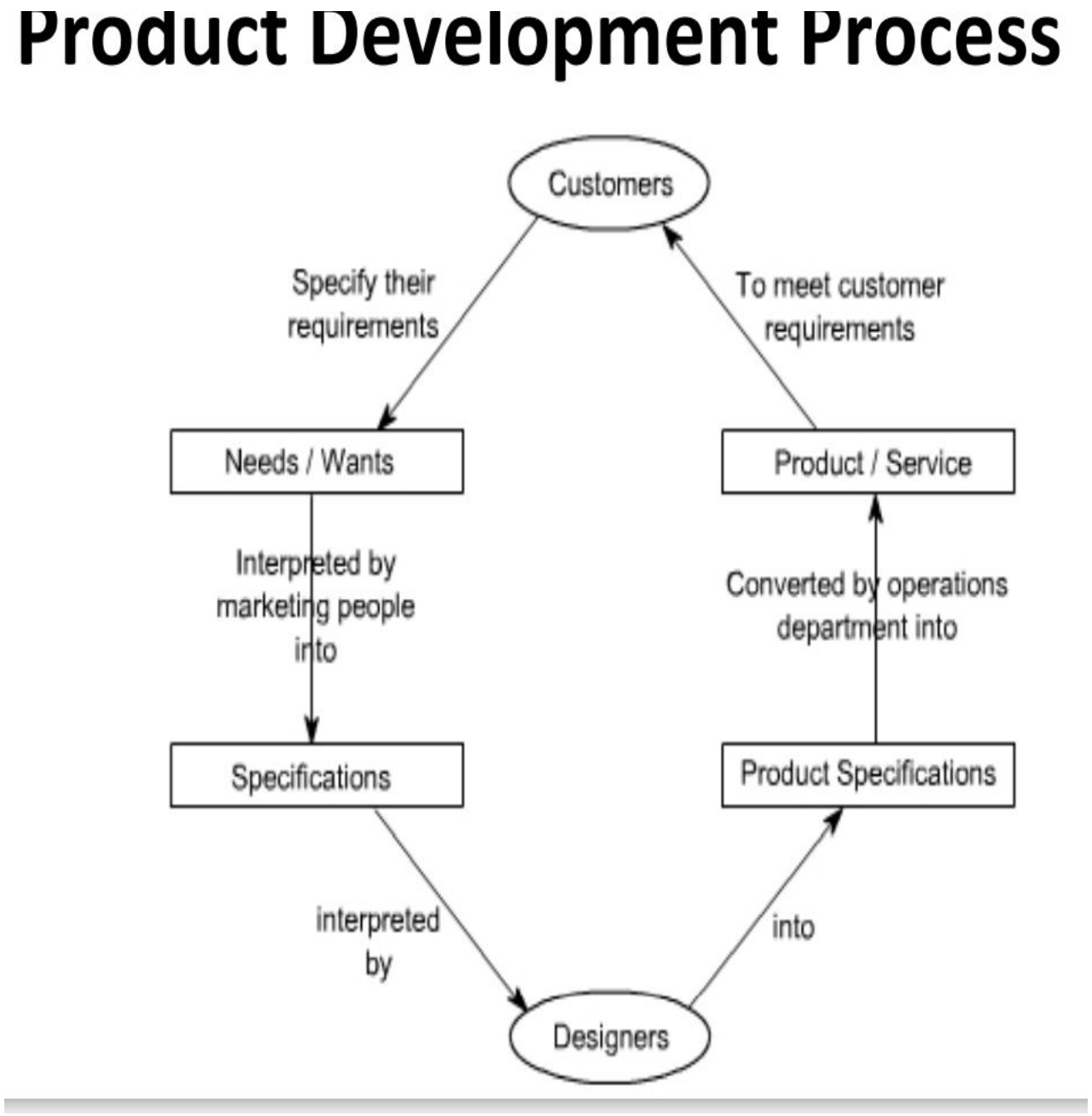
- Basic need of every manufacturing company
  - Consumers want and expect new and better products
  - Not to innovate approach is becoming increasingly risky
- Innovating new product is expensive and risky.



What is product development ?

Product Development is the set of activities ,beginning with the perception of a market opportunity and ending in the production , sales and delivery of a product.

The goal of the subject is to present a clear and detailed way a set of product development methods while focusing together the marketing, Design and manufacturing functions of the organization.



Product development is an interdisciplinary activity requiring contribution from the following three functions.

.**Marketing**

. **Design**

. **Manufacturing**

Marketing: The marketing function mediates the interactions between the firm and its customers. It arranges for communication between the firm and its customers.

Design: plays the lead role in defining the physical form of the product to best meet customer needs. It includes engineering design (mechanical, electrical, software etc.) and industrial design (aesthetics, ergonomics, user interfaces).

Manufacturing: This is primarily responsible for designing and operating the production system in order to produce the product. Broadly defined, the manufacturing function also often includes purchasing, distribution and installation.

This collection of activities is sometimes called the supply chain

Elements of a Product Development Team

Project team

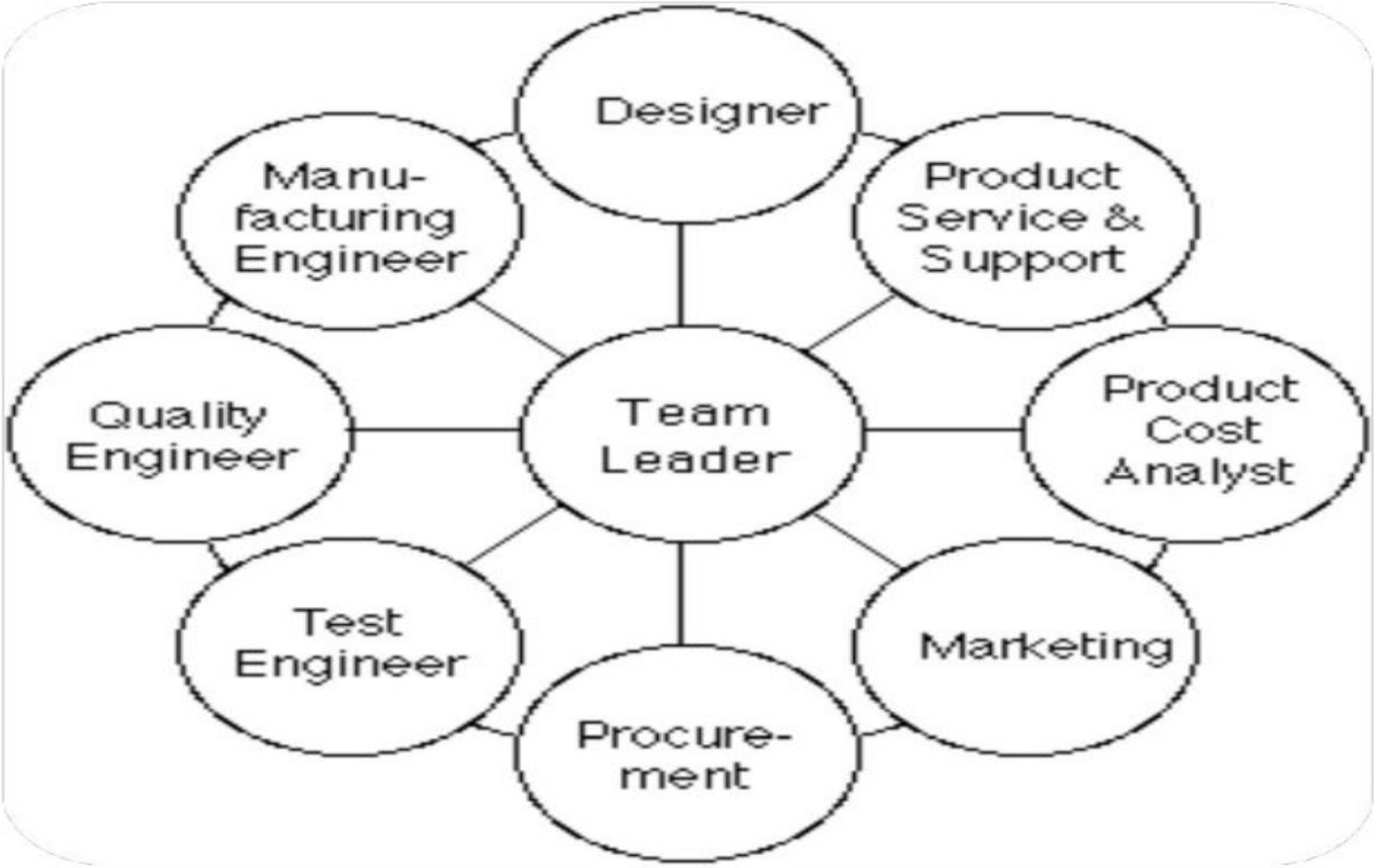
Few products are developed by a single individual. The collection of individuals developing a product forms the project team. This team usually has a single team leader who could be drawn from any of functions of the firm. The team can be thought of as consisting of a core team and an extended team.

Core team In order to work together effectively, the core team usually remains small enough to meet in a conference room.

Extended team

While the extended team may consist of dozens, hundreds or even thousands of other members

Development Team



Process Planning

A process is described as a set of steps that result in a specific outcome. It converts input into output.

Process planning is also called manufacturing planning, material processing, process engineering, and machine routing.

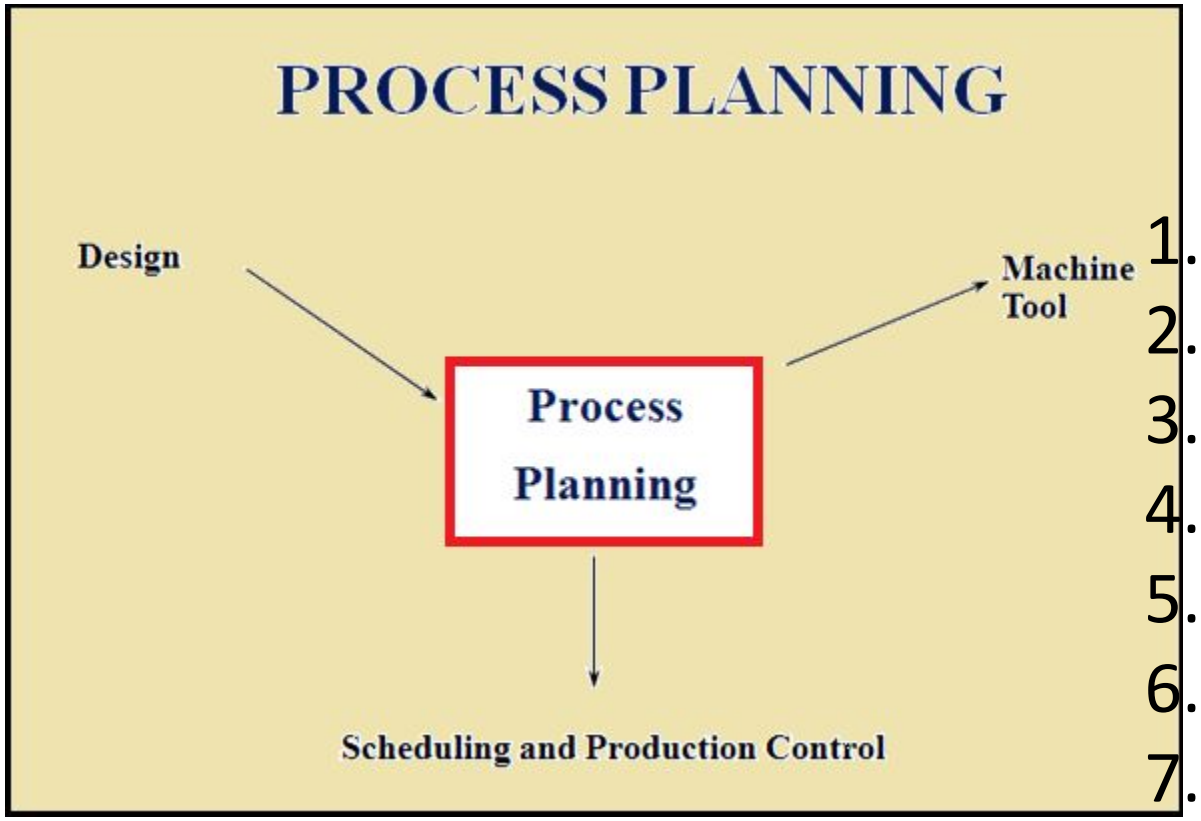
It is the act of preparing detailed work instructions to produce a part.

It is a complete description of specific stages in the production process.

Process planning determines how the product will be produced or service will be provided.

Process planning converts design information into the process steps and instructions to powerfully and effectively manufacture products.

As the design process is supported by many computer-aided tools, computer-aided process planning (CAPP) has evolved to make simpler and improve process planning and realize more effectual use of manufacturing resources.



Process planning in manufacturing may include the following activities:

1. Selection of raw-stock,
2. Determination of machining methods,
3. Selection of machine tools,
4. Selection of cutting tools,
5. Selection or design of fixtures and jigs,
6. Determination of set-up,
7. Determination of machining sequences,
8. Calculations or determination of cutting conditions,
9. Calculation and planning of tool paths,
10. Processing the process plan

Computer Aided Process Planning

Manufacturers have been following an evolutionary step to improve and computerize process planning in the following five stages:

Stage I - Manual classification; standardized process plans

Stage II - Computer maintained process plans

Stage III - Variant CAPP

Stage IV - Generative CAPP

Stage V - Dynamic, generative CAPP

Group Technology

is manufacturing philosophy in which similar parts are identified and grouped together to take advantage of **their similarities in design and production**.

Similar parts are arranged into part families, where each part family possesses similar design and / or manufacturing characteristics.

Objectives of Group technology

- Reduce MLT
- Reduce WIP
- Improve scheduling
- Reduce tooling
- Increase equipment utilization

Two tasks of GT

.Identifying the part families:

If the plant makes 10000 different parts reviewing all of the part drawings and grouping the parts into families is a substantial task that consumes a significant amount of time.

.Rearranging production machines into machine cells:

It is the time consuming and costly to plan and accomplish this rearrangement and the machines are not producing during the changeover.

Types of GT.

.Visual inspection

.Parts classification and coding

. Production flow analysis

VISUAL INSPECTION

• This method is the least sophisticated and least expensive method.

• It involves the classification of parts into families by looking at either the physical parts or their photographs and arranging them into groups having similar features.

• This method is generally considered to be the least accurate of the three, one of the first major success stories of GT in the United States made the change over using the visual inspection.

• This method is fast and simple and is useful when the part mix is not complex.

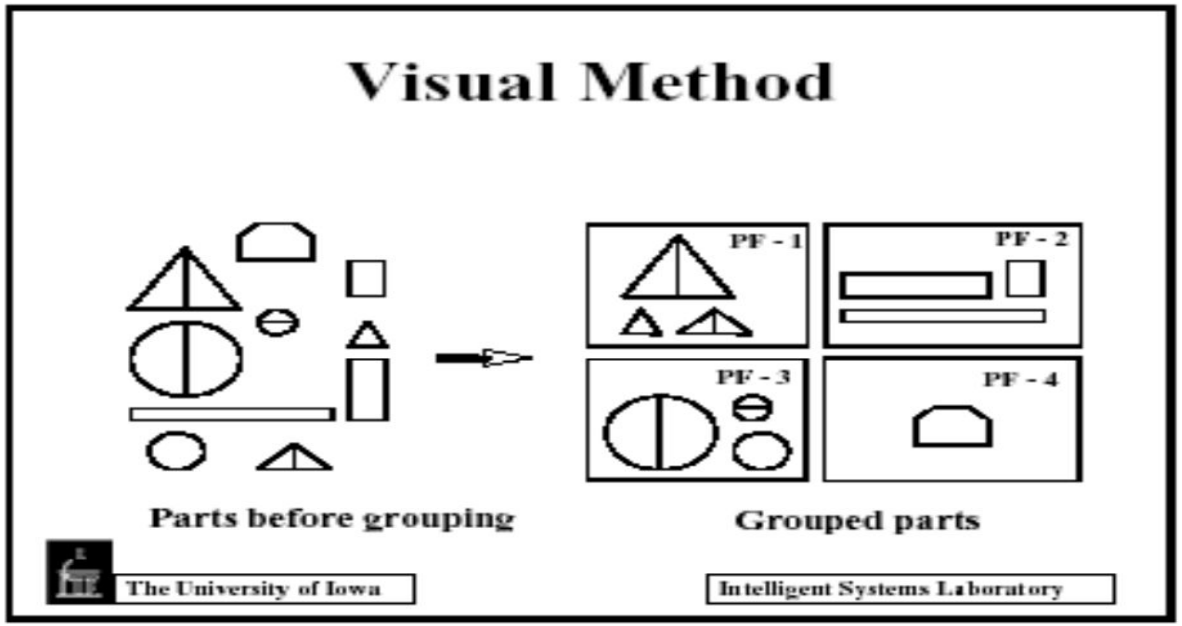


Fig.5 Visual inspection method

PARTS CLASSIFICATION AND CODING

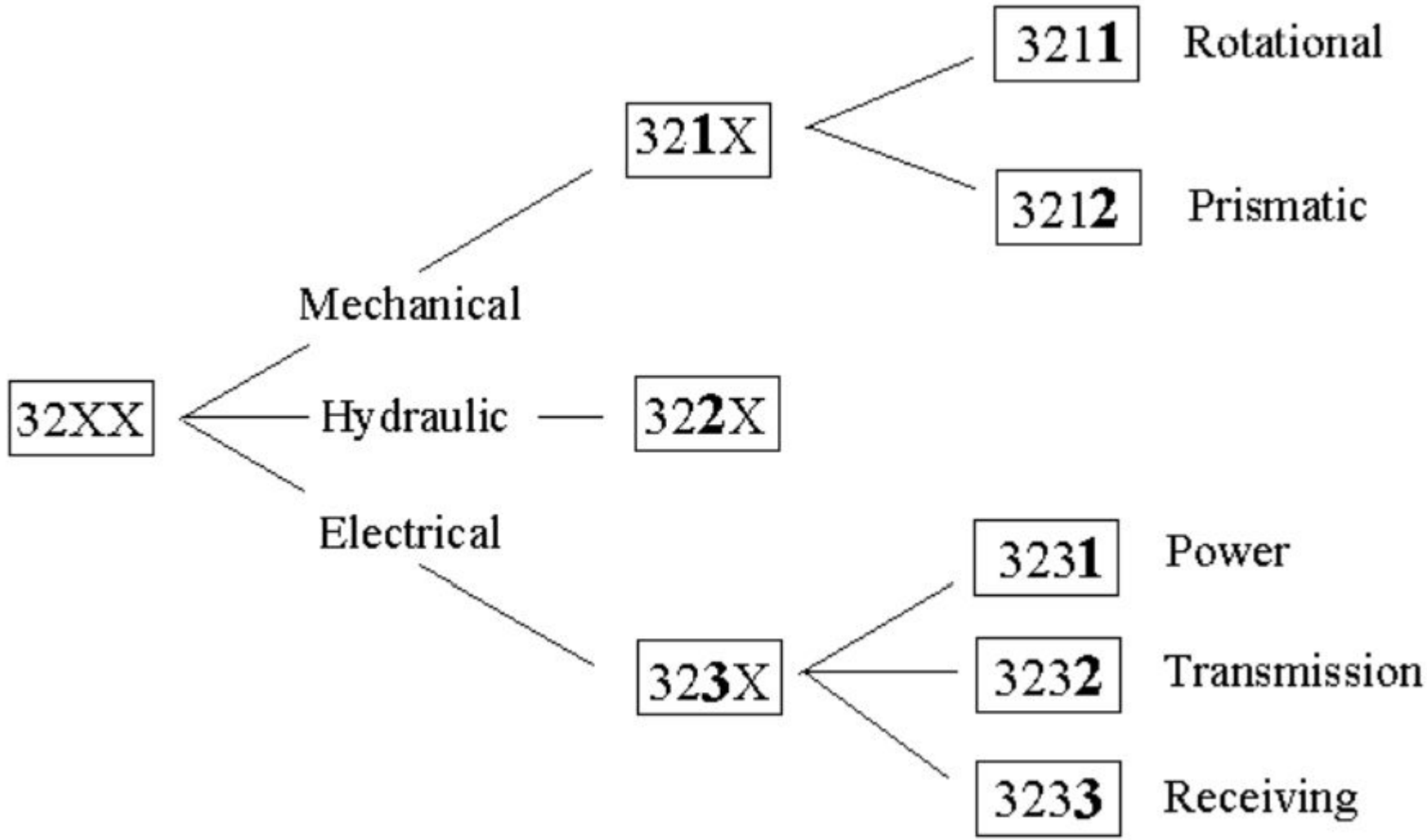
- This method is the most time consuming of the three methods.
- In parts classification and coding, similarities among parts are identified and these similarities are related in a coding system.

Part design attributes

- Basic external shape
- Basic internal shape
- Rotational or rectangular shape
- Length–to–diameter ratio (rotational parts)
- Aspect ratio (rectangular parts)
- Material type
- Part function
- Major dimensions
- Minor dimensions
- Tolerances
- Surface finish

Part manufacturing attributes

- Major processes
- Minor operations
- Operation sequence
- Major dimension
- Surface finish
- Machine tool
- Production cycle time
- Batch size
- Annual production
- Fixtures required
- Cutting tools used in manufacture


32XX
Mechanical
321X
3211
Rotational
3212
Prismatic
Hydraulic
322X
Electrical
323X
3231
Power
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Transmission
3233
Receiving

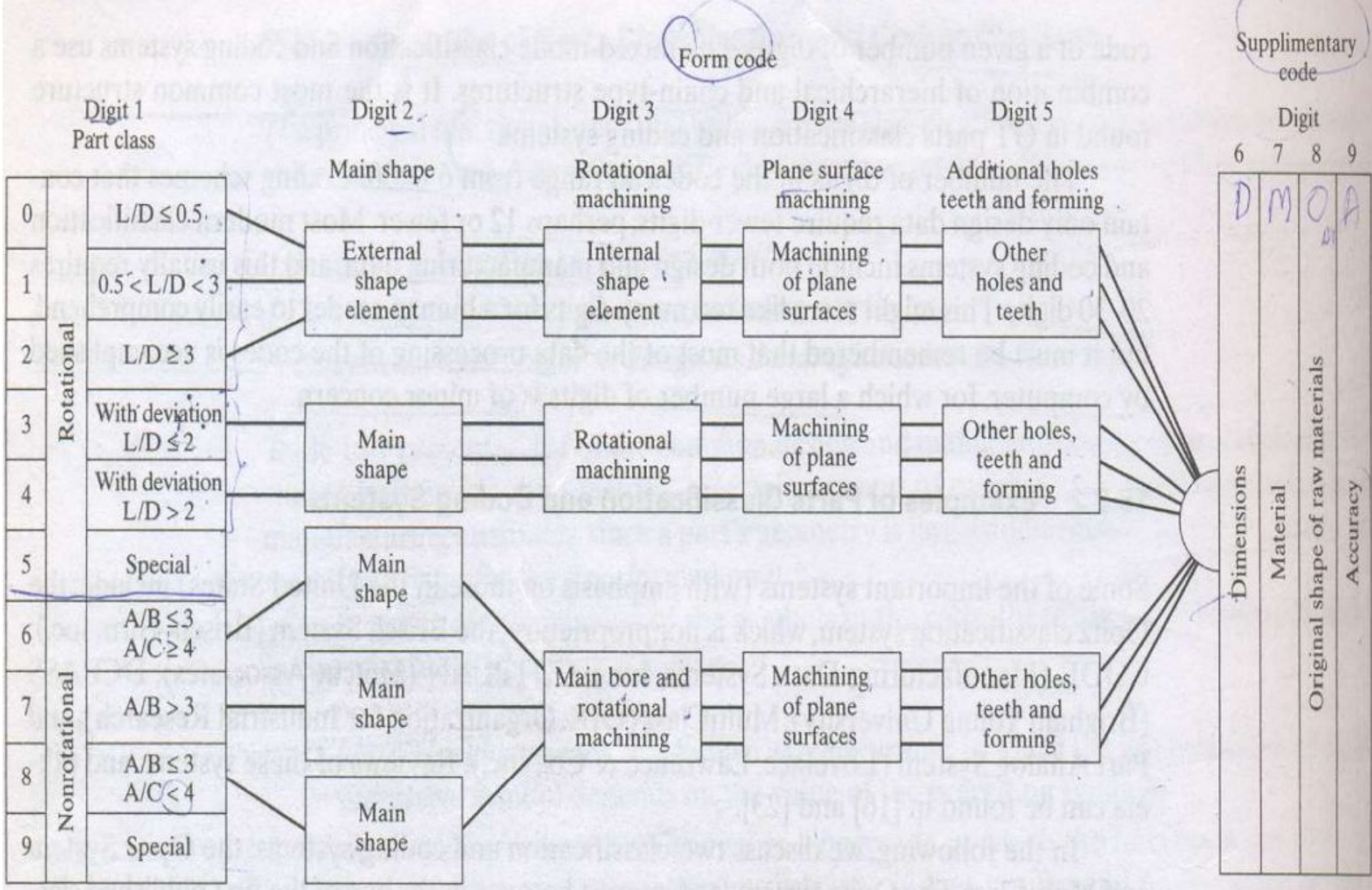


Figure 15.5 Basic structure of the Opitz system of parts classification and coding.

Value engineering

is a systematic method to improve the "value" of a product or service that the project produces.

It is an integral component of project quality.

Value is defined as containing two components, function and cost.

Value = Function / Cost

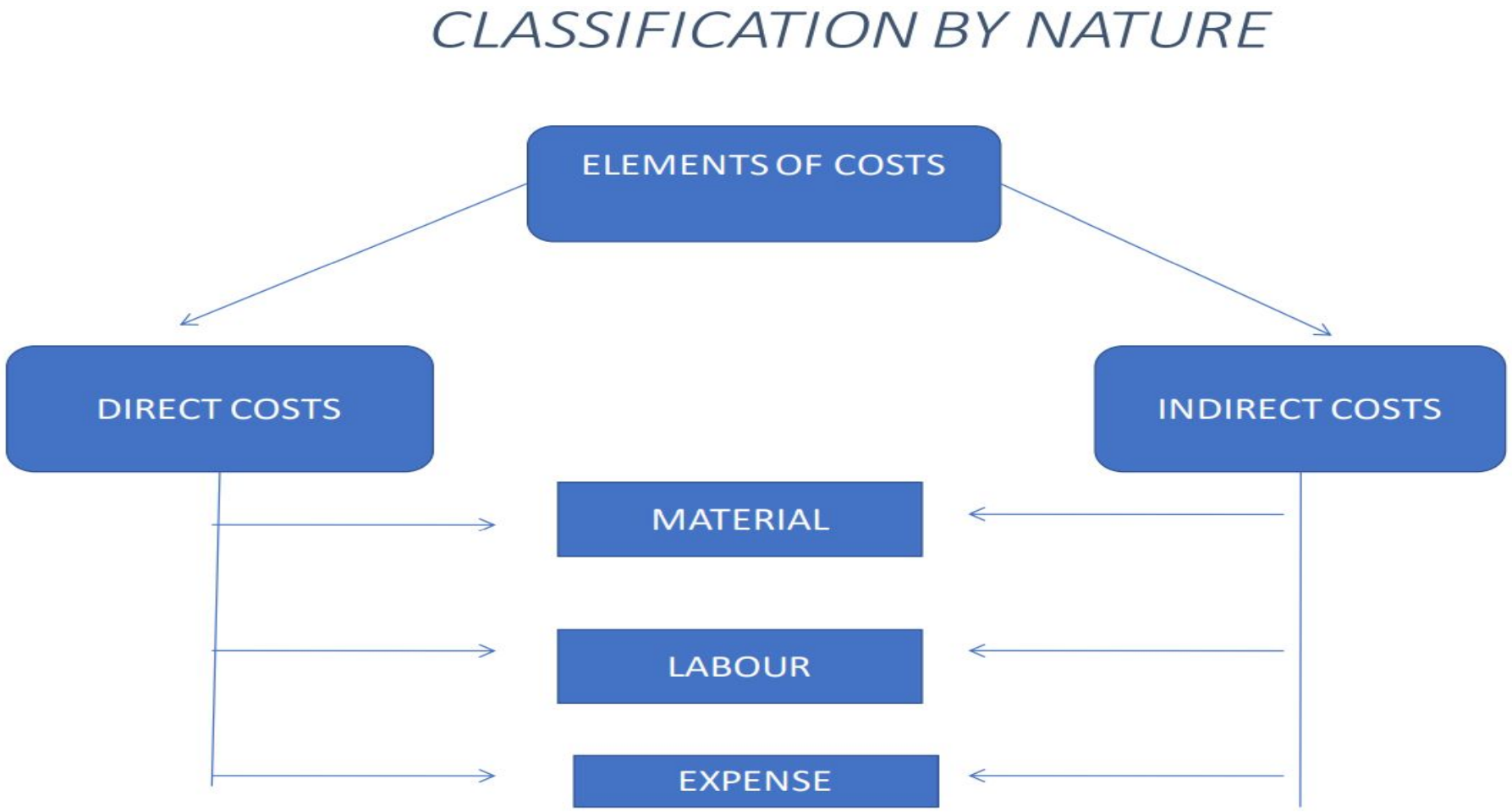
- ***Function:*** a measure of the the performance capabilities of the product, service, or project. A function might be to "achieve traffic flow across the river." In practice value engineers look at many different functions that the bridge serves, like accommodating floods, passengers, bicycles, endangered turtles, emergency vehicles, the sun on the horizon, and anything else that serves in a functionary capacity.
- ***Cost:*** The resources required to achieve the function. This can include materials, tools, price, time, or anything that is required to achieve the functional specifications.

COST :“the amount of expenditure incurred on or attributable to a given thing”.

COSTING

Costing is the technique and process of ascertaining costs.

In simple words costing is a systematic procedure of determining the unit cost of product/service.



Direct Cost:- These are costs directly attributable to producing a product.

The following comes under the Direct Cost:-

• Direct Material Cost:- It is the cost of material which can be directly allocated to a cost centre. Example:- Raw material consumed for production of a product.

• Direct Labour Cost:- It is the cost of wages of those workers who are readily identified or link with cost centre.

• Direct Expense:- These are the expenses other than direct material or direct labour which can be identified with cost centre

➢Indirect Costs:- These are the costs which can not be assign to any particular cost unit, i.e job product or process.

•Indirect Material:- Material which cannot be directly allocated to a particular cost centre.

•Indirect Labour:- These are the wages of employees which are not directly allocable to a particular cost centre.

•Indirect Expense:- These are the expense other than the nature of material or labour and cannot be directly attributable to a particular cost centre.