OPERATIONS MANAGEMENT

UNIT-I:

Systems Concept of Production, Types of Production System, Productivity, World Class Manufacturing.

Process Planning & Design, selection of process, Value Analysis/Value Engineering, Make or Buy Decision.

Capacity Planning, forecasting: Nature and use of Forecast, Sources of data, Demand Patterns, Forecasting Models, selection of a Forecasting Technique, Simple Moving Average Method, Weighted Moving Average, Simple(single) Exponential Smoothing, Linear Regression, Delphi Method.

Definition

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

Production/Operations function, therefore, is that part of an organization which is concerned with the transformation of a range of inputs into the required outputs (products/services) having the requisite quality level.

SYSTEMS CONCEPT OF PRODUCTION

System is a collection of interrelated entities. As stated earlier, operations management is the management of transformation systems which convert inputs into goods and /or services.

The inputs to the system are

materials,
labour,
equipments and
capital.

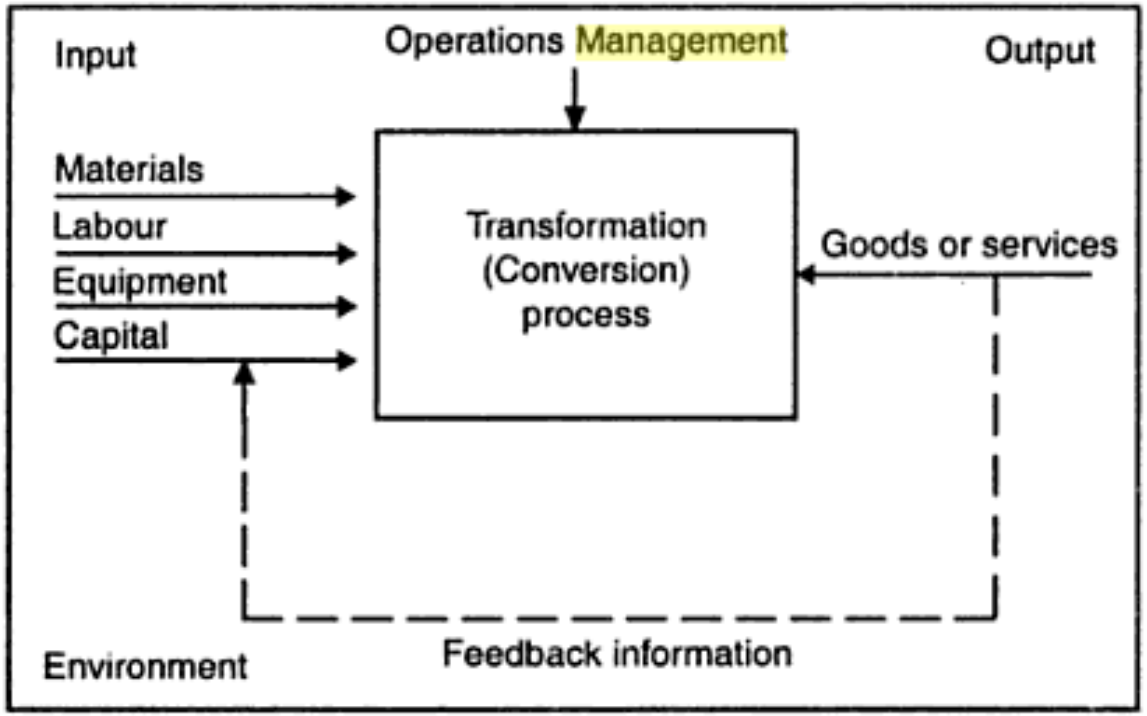


Fig. 1.3 Systems aspect of production/operations function.

These inputs are combined and converted into goods and/or services by suitable process technology.

The type of inputs used vary from one industries to another.

In product manufacturing, the major inputs are

- capital,
- machineries,
- equipments and tools,
- labour

is required to operate and maintain the equipments.

The materials input is the basis for the conversion process.

Feedback for making necessary corrections.

- Tight quality check on the incoming raw materials
- Adjustment of machine settings
- Change tools
- Proper allocation of operators to machines with matching skills
- Change in the production plans, like increase in volume of production
- Rigid in-process quality programme to avoid rework

Based on the feedback, the system once again tries to produce the product/service with modified parameters, in order to meet the specifications.

The feedback mechanism is a continuous exercise to monitor the status of the system.

ENVIRONMENT

The system operates in an environment. So, the system has to take feedback from its environment and adjust its parameters accordingly. The environment can be classified into

- internal environment and
- external environment.

The top management may be treated as the internal environment and its instructions and expectations will form internal feedback.

The system must respond to these modifications for achieving better results.

The environment outside the firm may change in terms of legal, political, social or economical conditions, thereby necessitating the corresponding change in the environment of production/operations.

So, the production/Operations system must consider these changes as feedback from external environment and adjust its parameters accordingly.

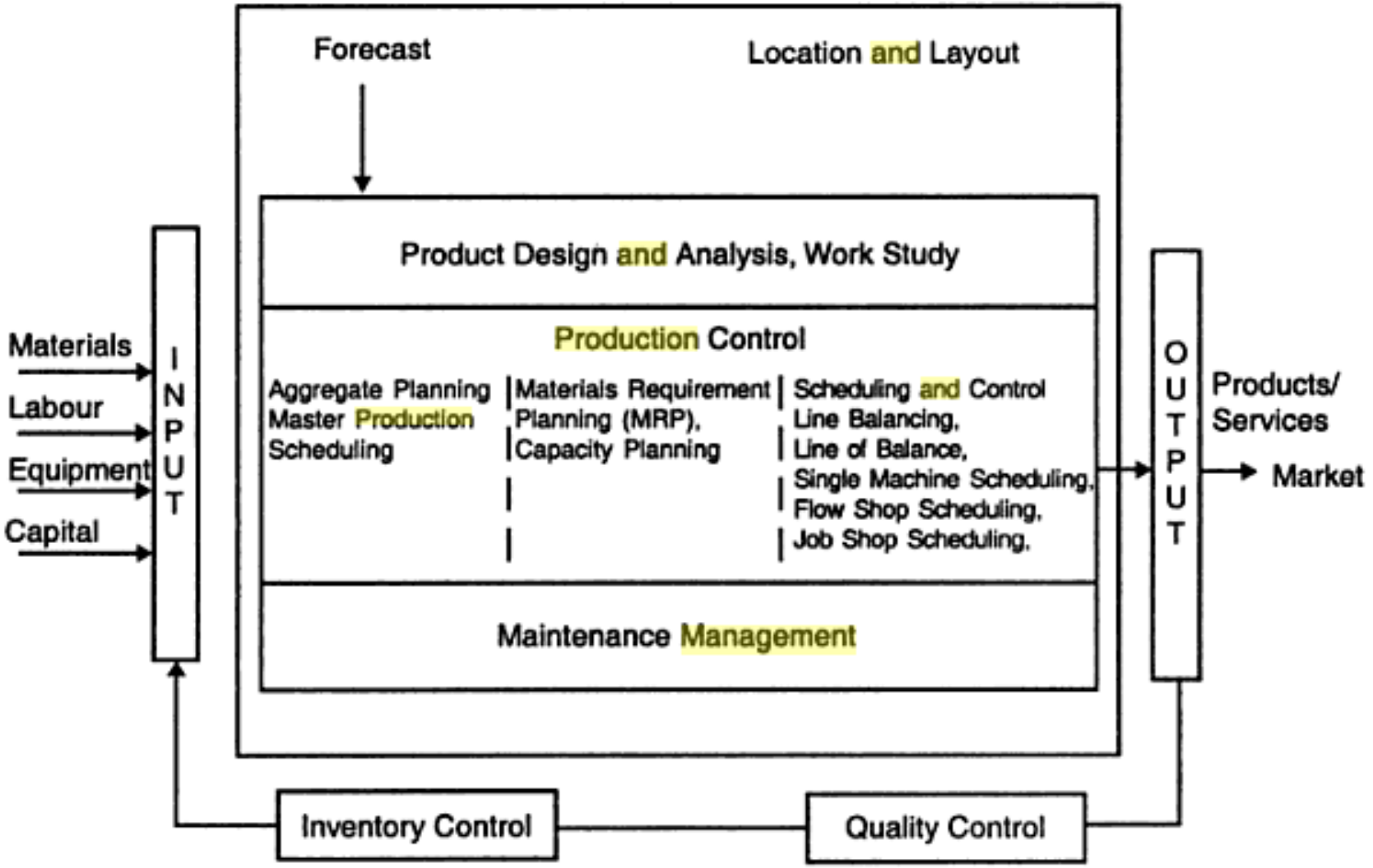


Fig. 1.4 Schematic representation of production/operations subsystem.

This feedback mechanism is a continuous process, but the degree of corrections required depends on the materials quality, equipments condition, employees skills and their commitments.

TYPES OF PRODUCTION SYSTEM

The production system of a company mainly used facilities, equipments and operating methods (called the production system) to produce goods that satisfy customers demand.

Table 1.2 Classification of Production System

Basis	Classifications	Examples
Type of output	Products	Consumer goods like furniture, TV, radio, etc. Producer goods like, lathe, milling machine, etc.
	Services	Transportation, health, entertainment, banking services, education system, etc.
Type of flow	Projects	Construction of bridge, dam, road, etc.
	Job Shop	Hospital, auto repair, machine shop, furniture company, etc.
	Flow shop	High volume TV factory, auto factory, etc.
	Continuous process	Postal services, telephone company, power corporation, oil refinery, chemical plant
Type of specification under service type	Customized	Medical care, legal services
	Standardized	Insurance, wholesale stores

Flow shop

This is a conversion process in which successive units of output undergo the same sequence of operations, using specialized equipments usually positioned along a production line.

Ex. Auto assembly, assemble of television sets.

Continuous flow shop (cigarettes, cement)

Intermittent flow shop (bottling factories, television sets)

Job shop

This is a conversion process in which units of different types of products follow different sequences through different shops.

This type of system has more flexibility. But this system results into more set-up time, more in-process inventory, complex scheduling and varying quality.

Ex. Auto repair and furniture company.

Batch Manufacturing

A batch manufacturing facility produces some intermediate varieties of products with intermediate volumes.

Production equipments in batch manufacturing must be capable of performing a variety of tasks, but the range of possible operations is much narrower than a job shop.

The Projects

A project refers to the process of creating a complex one-of-a-kind product or service with a set of well defined tasks in terms of resources required and time phasing.

Some examples of projects are dam construction, starting new industries.

PRODUCTIVITY

Productivity is a relationship between the output (products/services) and the input (resources consumed in providing them) of a business system.

Productivity = Output/Input

For the survival of any organization, this productivity ratio must be at least 1.

If it is more than one, the organization is in a comfortable position.

So, the objective of the organization should be to identify ways and means to improve productivity to the highest possible level.

There are several strategies for improving the productivity which are:

1.Increased output for the same input
(layout)

2. Decreased input for the same output
(raw materials)

3. Proportionate increase in the output is more than the proportionate increase in the input
(new products)

4. Proportionate decrease in the input is more than the proportionate decrease in the output
(uneconomical product)

5. Simultaneous increase in the output with decrease in the input.
(advanced automated technologies)

World Class Manufacturing

The concern for improving performance continuously and rapidly in line with the increasing global competition is gathering momentum.

World Class Manufacturing concept is of a recent origin.

The attributes of the World Class Manufacturing are aimed to fulfill the customer demands:

1. Products with high quality
2. Products at competitive price
3. Products with several enhanced features
4. Products in a wider variety
5. Products delivered with shorter lead times
6. Flexibility in fulfilling products demand

All these performance measures are external to the manufacturing systems but higher essential for the success of the company.

PRODUCT DESIGN AND ANALYSIS

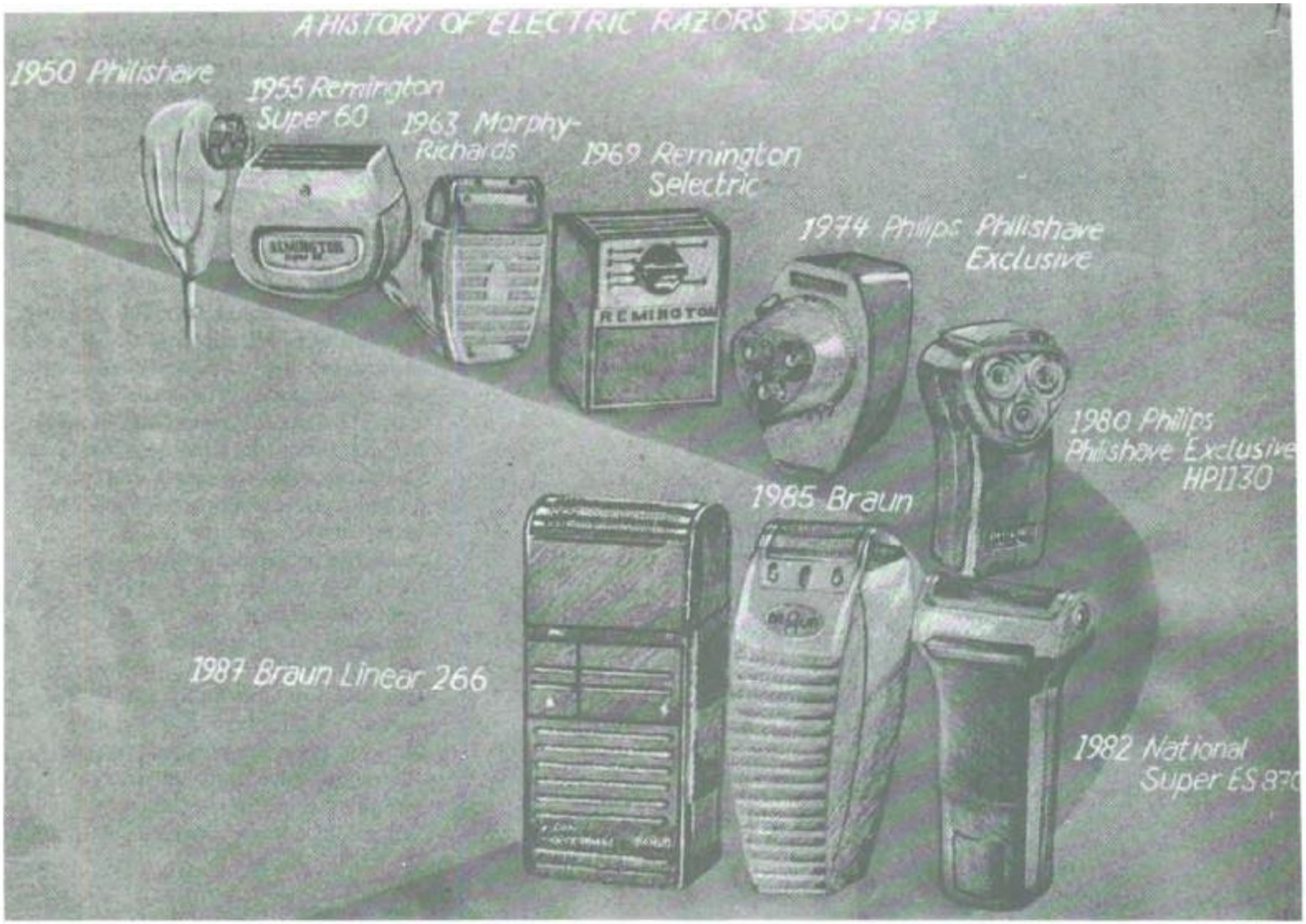
What is product design and analysis

- In any business venture, product design is the first step immediately after accepting the concept of a product.

- Product design has direct bearing on plant layout and in-process materials flow.

- In the process of product design, one has to critically analyze different design features with manufacturing the product.

- Therefore the purpose of product design and analysis is to determine and specify products that will be profitable to manufacturer and distributors and will give human satisfaction.


A HISTORY OF ELECTRIC RAZORS 1950-1987
1950 Philishave
1955 Remington Super 60
1963 Morphy-Richards
1969 Remington Selectric
1974 Philips Philishave Exclusive
1980 Philips Philishave Exclusive HP1130
1985 Braun
1987 Braun Linear 266
1982 National Super ES 87

The various aspects in product design are:

1. Design for Function

(Customer expects)

2. Design for Making

(solves the functional problem)

3. Design for Selling

(has to sell)

So, engineers, designers and psychologists should work together to design a better product for selling.

NEW PRODUCT DEVELOPMENT

Innovation is a process of converting an invention(s) into some useful product which can satisfy human wants either directly, or indirectly.

Maturity stage

-Technology

-Level of competition

-Culture

-Taste of customers, etc.

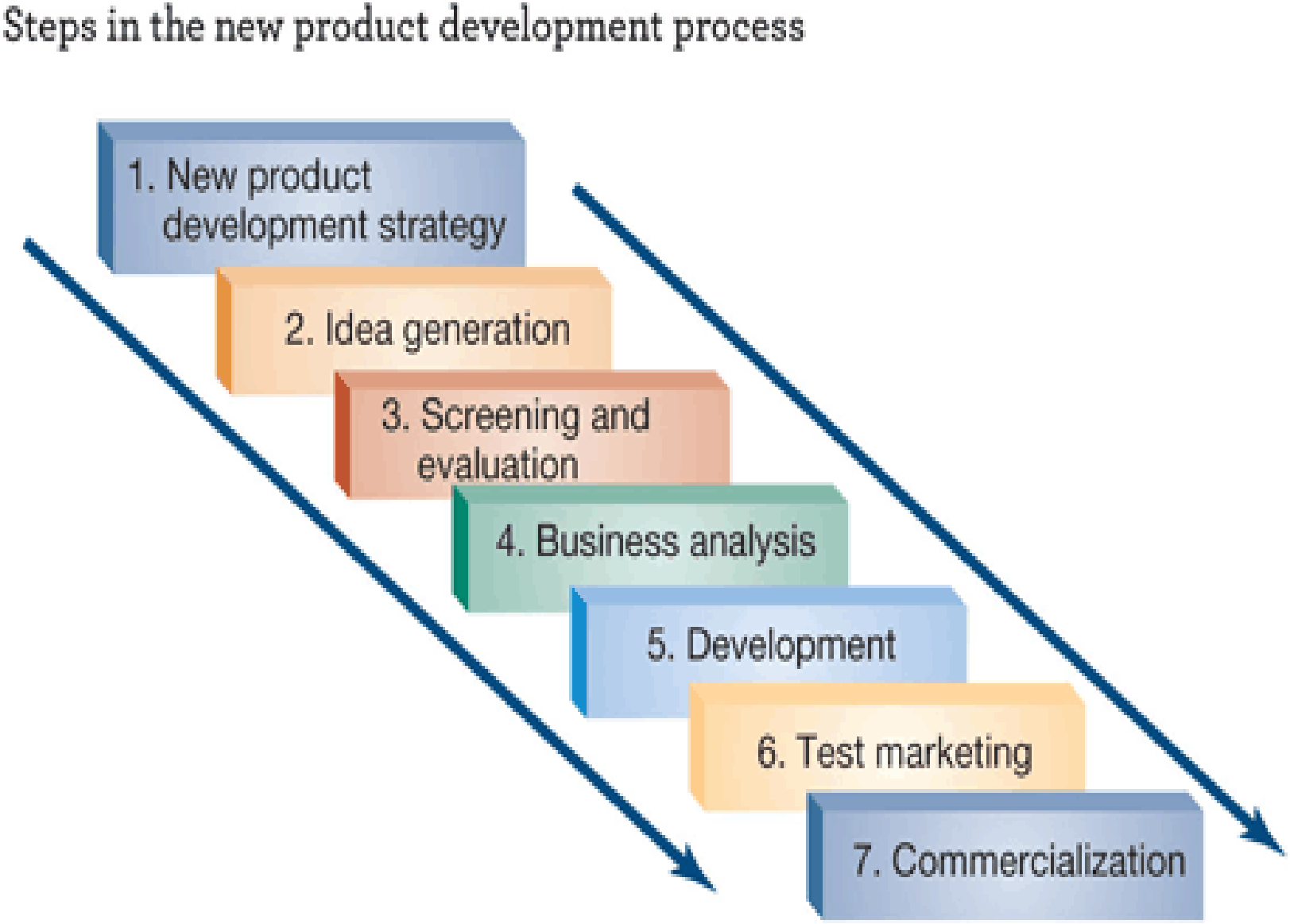
Some of the factors which are to be taken into the account while designing a product
are as listed below:

- **External appearance of the product**

- **Internal components of a products**
  (performance, reliability, durability and long term satisfaction)

Sometimes Designs affects many aspects of operations
-Pricing
-Sales
-Revenues
-Costs

STEPS IN NEW PRODUCT DEVELOPMENT



STEPS IN NEW PRODUCT DEVELOPMENT

1. **New product strategy developed**
   -provides guidelines internal experience and external opportunities
2. **Idea generation**
   -various idea sources and identify new ways
3. **Screening and evaluation**
   -to evaluate the potential of new products
4. **Business analysis**
   -in-depth study
5. **Development**
   -for customers, manufacturing, packaging and distribution cost etc.
6. **Testing**
   -market research
7. **Commercialization**
   -actual introduction

PROCESS SELECTION DECISIONS

Process can be classified and selected according to product flow and the type of customer order.

The customer order is generally of two types

- **Make-to-stock**
- **Make-to-order**

Table 2.1 Process Characteristics Matrix

	Make-to-Stock	Make-to-Order
Line flow	Soap, Paste, Fertilizer, Cement	Automobile assembly line, Dumpers, Railway coaches.
Intermittent flow	Medicines, Fasteners, Furniture	Automobile assembly line, Hospital, Custom jewelry
Project	Real estate development, Commercial paintings.	Buildings, Dams, Bridges, Boilers.

The followings six factors influence process selection

- **Market conditions**
- **Capital requirements**
- **Labour**
- **Management skills**
- **Raw materials**
- **Technology**

Process Planning Design

It is a complete determination of the specific technological process steps

- Determine the method of manufacturing
- Establish the sequence and the type of operations involved
- Select the tools and equipments required
- Analyze how the manufacturing of the product will fit into the facilities.

The effects of process planning on manufacturing parts and end products have direct effect on all departments

- Costs
- Methods of manufacturing
- Quality and production rates

The basic inputs of process planning

- Production information
  - -Product design
  - -Production volume
  - -Market environment
  - -Quality requirement
  - -Major technology selection

- Production System information
  - -Resource availability
  - -Technology capabilities

Steps in Process Planning

The steps in process planning are

- Analyze the part print to get an overall picture of what is wanted

- Make recommendation to or consult with product engineering on product design changes

- List the basic operations required to produce the part to the drawing or specifications.

- Determine the most practical and economical manufacturing methods and the form of tooling required for each operation.

- Devise the best way to combine the operations and put them in sequence.

Value Analysis/Value Engineering

Value analysis is one of the major techniques of cost reduction and cost prevention.

It is a disciplined approach that ensures the necessary function at minimum cost without compromising on quality, reliability, performance and appearance.

When to Apply Value Analysis

- Company's products show decline in sales
- Company's price are higher than those of its competitors
- Raw materials cost has gone up suddenly
- New design are being introduced
- The cost of manufacturing is rising disproportionate to the volume of production
- Rate of return on investment has a falling trend
- The firm in unable to meet its delivery commitments.

Value analysis versus value Engineering

The philosophy underlying the two is the same

-Value Analysis is the application of a set of techniques to an existing product

-Value Engineering is the application of exactly the same set of techniques to a new product at the designing stage

Value can be divided into four types

- **Cost value** (labour, material)
- **Exchange value** (for money)
- **Use value** (buyers view)
- **Esteem value** (appearance)

Performance

The performance of a product is the measure of its functional features and properties that make it suitable for a specific purpose.

Appropriate performance should fulfill the following criteria:

- Functional requirements
  -intend use of work or service requirement
- Safety requirements
- Reliability requirements
  -trouble free
- Maintainability requirements
- Appearance requirements

Performance and cost must be interwoven. Desired performance at the least cost must be achieved by selecting appropriate materials and manufacturing operations.

Therefore, the value of the product is the ratio of performance (utility) to cost.

Value= Performance (utility)/Cost

-Value can be increased either by increasing the utility for the same cost or
-by decreasing the cost for the same utility.

Satisfactory performance at lesser cost through identification and development of low cost alternatives is the philosophy of Value Analysis

Function

Function identifies the characteristics which make the product/component/part/item/device work or sell.

In that

- **Work functions** lend performance value
- **Sell function** provide esteem value

Identification of the basic function and determination of the cost currently being incurred on them are the two major considerations of Value Analysis.

Classification of Functions

-Rarely all function are of equal importance.
-Usually, some functions are more important than others.

Functions can be classified into the following three categories:

- **Primary function**
  (most essential -it makes product worthless –chair support weight, fluorescent tube gives light)

- **Secondary function**
  (it would not prevent from the performance –chair provides support for hands)

- **Tertiary function** (esteem appearance)

Aims

The aims of Value Engineering are listed below:

- Simplify the product
- Modify and improve product design
- Use (new) cheaper and better materials
- Use efficient process
- Reduce the product cost
- Increase the utility of the product by economical means
- Save money or increase the profits.

MAKE OR BUY DECISION

-within the company

-from a subcontractor

- Low volume of usage favors buying

- If the total cost of buying an item is more than or equal to total cost of making that item, then company can manufacture the item within the company.

- Otherwise the item can be bought from a vendor

Possible Alternatives while Starting for New Products

When a company plans for new products, the following alternatives can be considered

- Purchase the complete product from a contracted supplier

- Purchase some components and materials and manufacturing and assemble the balance in its own plants.

- Manufacturing the product completely in its own plants, stating with the extractions of the basic raw materials.

Criteria for Make or Buy

- **Criteria for make**

1. Cheaper
2. Limited number of suppliers
3. Strict quality
4. Existing facilities

➢Criteria for buy

1. High investments on facilities which are already available at the suppliers plant

2. The company does not have facilities to make it, and there are more profitable opportunities for investing the company's capital.

3. Existing facilities can be used more economically to make other parts.

4. The skill of personnel employed by the company can not be readily utilized to make the part.

5. Patent or other legal barriers prevent the company from making the parts.

6. Demand for the part is either temporary or seasonal.

Approaches for Make or Buy decision

The types of approach followed in make or buy decision are as follows:

- **Simple cost analysis**
- **Economic analysis**
- **Break even analysis**

Simple cost analysis

In this analysis, cost of making a product and that of buying a product are calculated.

Then, the alternative which involves the minimum cost is suggested for implementation.

Example 2.1. An automobile company has extra capacity that can be used to produce gears that the company has been buying for Rs. 300 each. If the company makes the gears, it will incur materials cost of Rs. 90 per unit, labour cost of Rs. 120 per unit and variable overhead cost of Rs. 30 per unit. The annual fixed cost associated with the unused capacity is Rs. 240,000. Demand over the next year is estimated at 4000 units.

1. Would it be profitable for the company to make the gears?

➢ Economic analysis

The following inventory models are considered to illustrate the concept of economic analysis:

- **Purchase model**
- **Manufacturing model**

The formulae for calculating economic order quantity and total cost for each model are given below:

Purchase Model	Manufacturing Model
$Q_1 = \sqrt{\frac{2C_o D}{C_c}}$	$Q_2 = \sqrt{\frac{2SD}{C_c(1 - D/R)}}$
$TC = D * P + \frac{DC_o}{Q_1} + \frac{Q_1 \times C_c}{2}$	$TC = D * P + \frac{D \times S}{Q_2} + C_c(R - D)\frac{Q_2}{2 * R}$

where

D – demand/year

P – purchase price/unit

C_c – carrying cost/unit/year

C_o – ordering cost/order

S – setup cost/setup

EOQ – economic order quantity (size)

R – production rate (units/year)

Q_1 – economic order size

Q_2 – economic production size

Example 2.2 An item has yearly demand of 1000 units. The different costs with regard to make and buy options, are as follows:

	Buy	Make
Item cost/unit (Rs.)	6.00	5.90
Procurement cost/order (Rs.)	10.00	—
Setup cost/setup	—	50.00
Annual carrying cost/item/year (22% of item cost)	1.32	1.30
Production rate/year	—	6000 units

Break Even Analysis

- Actually in any business organization, for manufacturing a product, there are two major costs, namely, fixed costs and variable cost.

- The sum of these two cost is known as the total cost of the product.

- The fixed cost is constant irrespective of production volume of a product which is manufactured by the organization. But the variable cost is a function of the production volume of the product.

- For low volume of production, the sales revenue of the product will be less than the total cost and after reaching a certain level of production volume, it will be more than the total cost.

- The point at which the sales revenue becomes equal to the total cost is known as the breakeven point.

- At this point, there is no loss or gain to the organization.

TC represents the Total Cost and
FC represents the Fixed Cost.

Total Cost (TC) = FC + Variable Cost

B – Intersection point of TC and sales curves (no loss or no gain situation)

A – Break even sales point

C – Break even quantity/Break even point (B.E.P.)

The formula for the break even point (B.E.P.) is given below. Application of this formula to arrive at the make or buy decision is illustrated with some examples.

$$\text{B.E.P.} = \frac{\text{FC}}{\text{Selling price} - \text{Variable cost}}$$

Example 2.3, a manufacturing of motor cycles buys side box at Rs. 240 each. In case he makes it himself, the fixed and variable costs would be Rs. 3,00,000 and Rs. 90 per side box, respectively. Should the manufacturer make or buy the side box if there is a demand for 2500 side boxes?

Example 2.4. There are three alternatives available to meet the demand of a particular product. They are as follows:

1. Making the product using process *A*.
2. Making the product using process *B*.
3. Buying the product.

The details are as follows:

Cost Elements	Making using Process *A*	Making using Process *B*	Buy
Fixed cost/year (Rs.)	100,000	300,000	—
Variable cost/unit (Rs.)	75	70	—
Purchase price/unit (Rs.)	—	—	80

The annual demand for the product is 10,000 units.

(a) Should the company make the product using process *A* or process *B*, or buy it?

(b) At what annual volume should the company switch from buying to making using process *A*?

(c) At what annual volume should the company switch from process *A* to *B*?

CAPACITY PLANNING

DETERMINATION OF PLANT CAPACITY PLANNING

Production system design is the first level planning for the inputs, conversion activities and outputs of a production operation.

Design capacity

Preliminary estimate of capacity is done based on long range forecast extending 5 to 10 years into the future.

The design capacity of a system is the rate of output of goods or services under full scale operating conditions.

System capacity

In practice, it may not be possible to achieve production to the extent of design capacity mainly because of mismatch between required resources and available resources.

The maximum output of a specific product or product mix that the system of workers and equipments is capable of producing as an integrated whole is called system capacity.

System Efficiency = Actual Output/System Capacity

Capacity Planning Strategies

Capacity is a measure of the ability to produce goods or services or, it may be called as the rate of output.

Long-term capacity strategies

Top management may have the following strategies to cope up with major changes in products and services that it can provide to customers in the long run which will significant impact on the capacity.

-develop new product lines

-expand existing facilities

-Construct or phase out production plants

Short-term capacity strategies

In short term planning horizon, capacity decision are taken by considering the fluctuation in demand caused by seasonal and economic factors.

-overtime

-subcontracting

-hiring

FORECASTING

FORECASTING

NATURE AND USE OF FORECAST

A forecast is an estimation of an event which will happen in future.

The event may be

-demand of a product

-rainfall

-population of a country

-growth of a technology

It is estimate based on the past data related to a particular event.

In any industrial enterprise, forecasting is the first level decision activity.

Demand for a particular product

-Material planning

-Scheduling

-Type of production system

Classification of business forecasts

Technology forecast

-hardware and software
-level of technical performance
-rate of technology advances

Economic forecasts

Government agencies and other organization involved in collecting data and prediction of estimate on the general business environment.

-future tax revenue
-level of business growth
-level of employment
-level of inflation

Demand forecast

The demand forecast gives the expected level of demand for goods or services.

This is the basic input for business planning and control.

Factors affecting forecast (Demand)

- Business cycle
- Random variation
- Customer plan
- Products life cycle
- Competition efforts and prices
- Customers confidence and attitude
- Quality
- Credit policy
- Design of goods and services
- Reputation for service
- Advertising

Types of Forecasting in Decision Making

Forecasting in different functional areas of management such as

Marketing

-demand forecasting of product
-forecast of market share
-forecast trend in price

Production

Forecast of
-materials requirements
-trend in material and labour
-maintenance requirement
-plant capacity

Finance

Forecast of

-cash flows

-rates of expenses

-revenues

Personnel

Forecast of

-number of workers in each category

-labour turn over

-absenteeism

SOURCE OF DATA

The data for forecast is very much vital.
-company records
-published records
-journals
-surveys
-government publication
-newspapers

DEMAND PATTERNS

Forecasting is based on the pattern of events in the past.
A pattern may solely exist as a function of time.
Such a pattern can be identified directly from historical data.

Historical pattern (Stationary pattern)

This exists when there is no trend in data and when the ,mean value does not change over time.

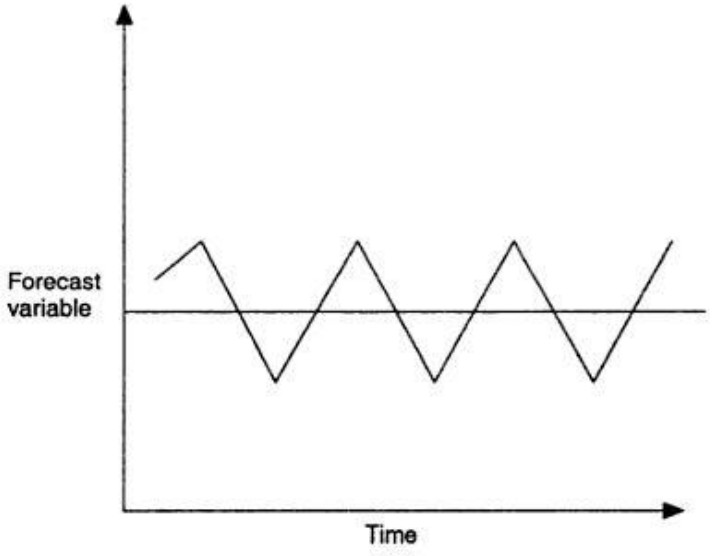


Fig. 4.1 Historical pattern (Stationary pattern).

Products with stable sales, number of defective items from a stable production process are same of the examples.

Seasonal demand patterns

This demand pattern exist when the series fluctuation according to some seasonal factors.

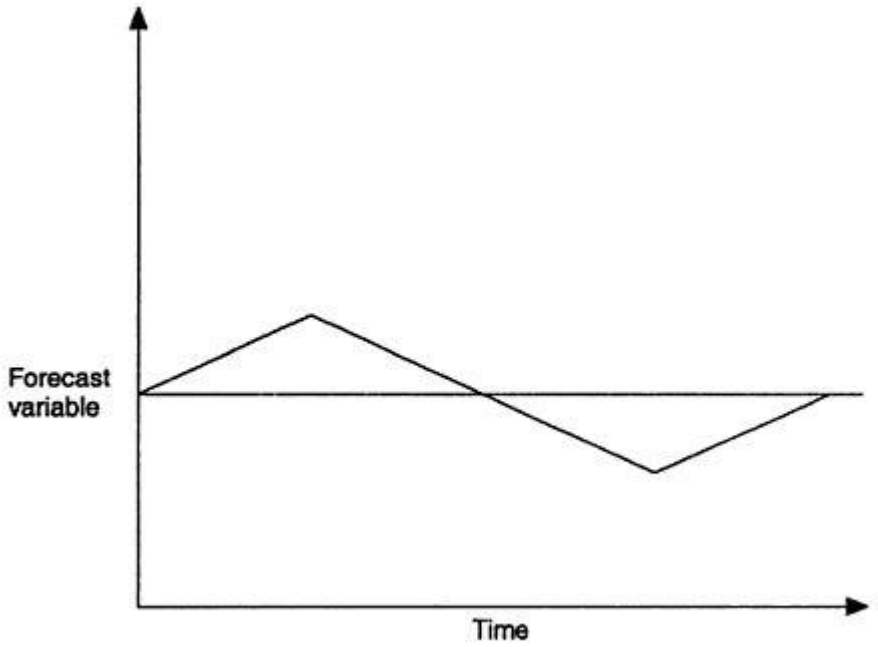


Fig. 4.2 Seasonal demand pattern.

Cyclical pattern

In this type of pattern, the length of single cycle is longer than a year. The cycle does not repeat at constant intervals of time. Ex- prices of some metals

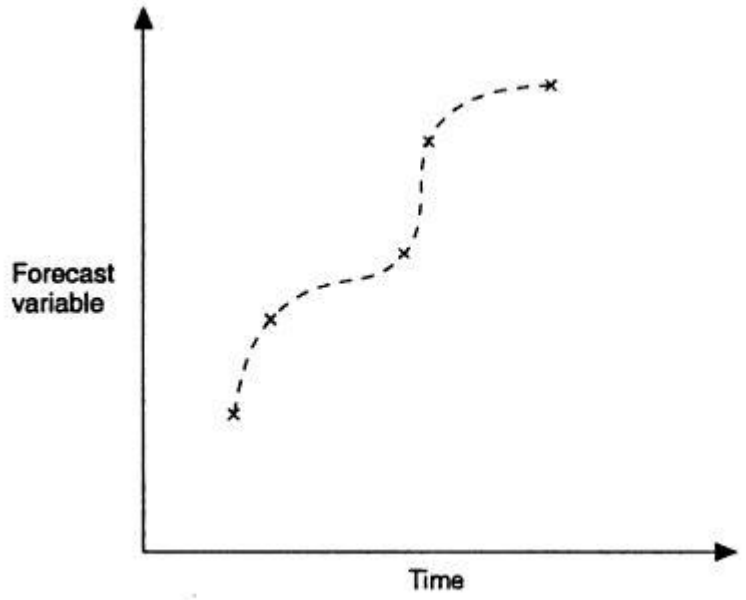


Fig. 4.3 Cyclical pattern.

Trend patterns

This type of pattern exists when there is an increase or decrease in the value of variable over time. The examples are sales of many products, stock prices, business economic indicators.

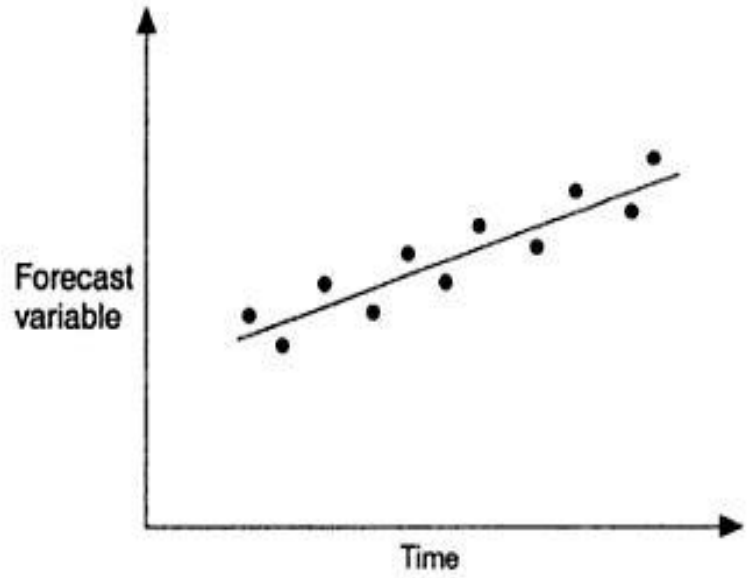


Fig. 4.4 Trend pattern.

Forecasting models

The forecasting techniques can be classified into

1.Qualitative Techniques

Qualitative techniques are subjective approaches.

There are useful where no data is available and are useful for new products.

2. Quantitative Techniques

Quantitative techniques are historical data. There are more accurate and computers can be used to speed up the process.

Quantitative forecasting techniques

- Simple moving average
- Weighted moving average
- Simple(single) Exponential Smoothing
- Linear Regression

Qualitative forecasting techniques

- Delphi Method

Simple Moving Average Methods

A simple moving average is a method of computing the average of a specified number of the most recent data value in a serious.

$$M_t = \frac{1}{n}\{D_{t-(n-1)} + D_{t-(n-2)} + \cdots + D_{t-2} + D_{t-1} + D_t\}$$

where

M_t – simple moving average at the end of period t (It is to be used as a forecast for period $t + 1$).

D_t – actual demand in period t.

n – number of periods included in each average.

Calculate the demand for the 13 month for following data using 3 years moving average.

Month	1	2	3	4	5	6	7	8	9	10	11	12
Demand	95	100	87	123	90	96	75	78	106	104	89	83

Weighted moving average

Equal weights were assigned to all periods in the computation of the simple moving average.

The weighted moving average assigns more weight to some demand values (usually the more recent ones) than to others.

$$\text{Weight } MA_t = \frac{\sum_{i=1}^{n} W_i D_i}{\sum_{i=1}^{n} W_i}$$

Calculate 3 months weighted moving average and estimate the demand for 7th month with a weight of 0.5 assigned to the most recent demand value, a weight of 0.30 assigned to the next most recent value and a weight of 0.20 assigned to the oldest of the demand value included in the average.

The data are as follows:

Month	1	2	3	4	5	6
Demand	120	130	110	140	110	130

Delphi Method

1. Choose the experts to participate representing a variety of knowledgeable people in different areas

2. Through a questionnaire (or E-mail), obtain forecasts (and any premises or qualifications for the forecasts) from all participants

3. Summarize the results and redistribute them to the participants along with appropriate new questions

4. Summarize again, refining forecasts and conditions, and again develop new questions

5. Repeat Step 4 as necessary and distribute the final results to all participants

Test

1. Briefly explain the steps in new product development.

Example 2.4. There are three alternatives available to meet the demand of a particular product. They are as follows:

1. Making the product using process *A*.
2. Making the product using process *B*.
3. Buying the product.

The details are as follows:

Cost Elements	Making using Process *A*	Making using Process *B*	Buy
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(b) At what annual volume should the company switch from buying to making using process *A*?

(c) At what annual volume should the company switch from process *A* to *B*?

UNIT-II:

Facility Location: Factors influencing Plant Location, Break Even Analysis, Plant Layout & Materials Handling: Classification of Layout, Advantages and Limitations of Process Layout, Advantages and Limitations of Product Layout, Advantages and Limitations of Group Technology Layout. Layout Design Procedures: Systematic Layout Design Procedure, Introduction to CRAFT, ALDEP & CORELAP, Material Handling System, Unit Load Concept, Material Handling Principles, Classification of Materials Handling Equipments.

Line Balancing: Concept of Mass Production System, Objective of Assembly Line Balancing, Rank Positional Weight Method.

Inventory Control: Review of Basic Models of Inventory, Quantity Discount Model, Implementation of Inventory Systems, P & Q system of Inventory.

Facility Location

Business systems utilize facilities like, plant and machineries, warehouses, etc., while performing the task of producing products/services. A proper planning of these facilities would definitely reduce their cost of operation and maintenance.

Plant location decisions are important because they have direct bearing on factors like,

-financial

-employment

-distribution patterns

Reasons for plant location study

The following events are quite common in any business venture.

- **Establishment of a new venture**
- **Expansion of existing business**
- **Significant change in existing demand, supply and marketing locations**
- **Significant change in the cost structure**
- **Government policies**

Factors Influencing Plant Location

The factors which influence plant location can be classified into

- General factors
- Specific factors

General factors

- Availability of land for present and future needs and cost of land and land development and building etc.

- Availability of inputs such as labour, raw materials, etc.

- Closeness to the market places.

- Stability of demand

- Availability of communication facilities

- Availability of necessary modes of transportation like road, rail, airport and water ways.

- Availability of infrastructure facilities such as power, water, financial institution, bank, etc.

- Disposal of waste and their impact on the environment

- Government support, grant, subsidy, tax structure.

- Availability of housing facilities and recreational facilities

- Demographic factors like population, trained man power, academic institutions, standard of living, income level, etc.

- Security, culture of society

- Fuel cost

Specific factors

The multinational company, desiring to set up plant considers the following aspects in addition to the normal factors.

- The economic stability of the country and the country towards outside investments are to be considered.

- The success of operation of the factory depends on the cultural factors, language and cultural differences which can present operating, control and even policy problems.

- Analysis must be based on the factors like wage rate, policy, duties, etc.

- The company can set up joint ventures with any leading local giants that will solve many operational problems.

Plant Layout and Materials Handling

Plant layout is a floor plan of the physical facilities which are used in production.

Layout planning refers to generation of several possible plans for the spatial arrangement of physical facilities and selects the one which minimizes the distance between the departments.

The objective of the plant layout are:

- Minimize the investment in equipment
- Minimize overall production time
- Utilize existing space most effectively
- Provide for employee convenience, safety and comfort
- Maintain flexibility of arrangement and operation
- Minimize materials handling cost
- Facilitate the manufacturing process
- Facilitate the organizational structure

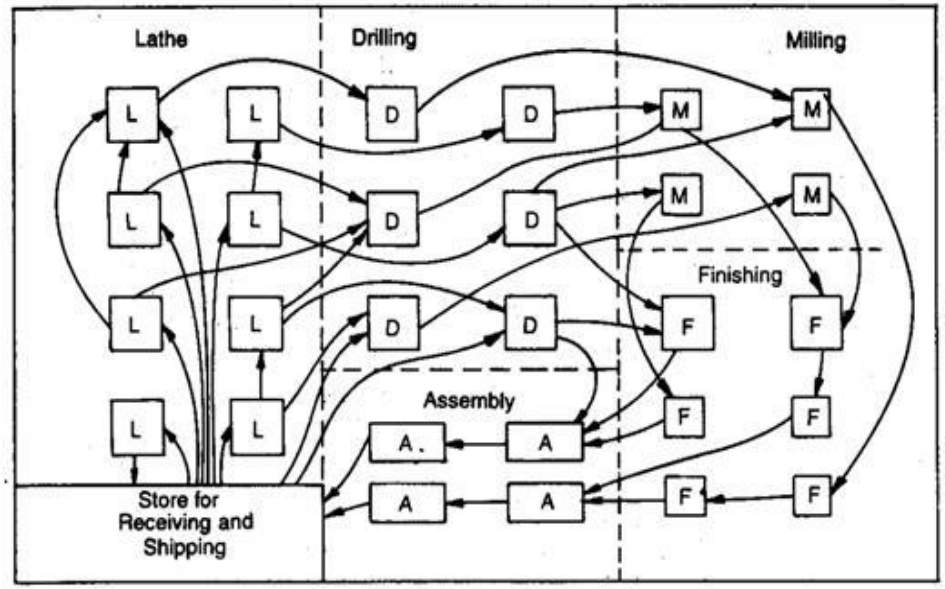
CLASSIFICATION OF LAYOUT

Layout can be classified into the following four categories.

1. Process layout
2. Product layout
3. Group layout (Combination layout)
4. Fixed position layout

Process layout

-similar machines and
services are located together.
-job shops
-variety of products manufactured
-low production volumes



Product layout

Product layout is used when machines and auxiliary services are located according to the processing sequence of the product.

The product layout is selected when the volume of production of a product is high such that a separate production line to manufacture it can be justified.

In a strict product layout, machines are shared by different products.

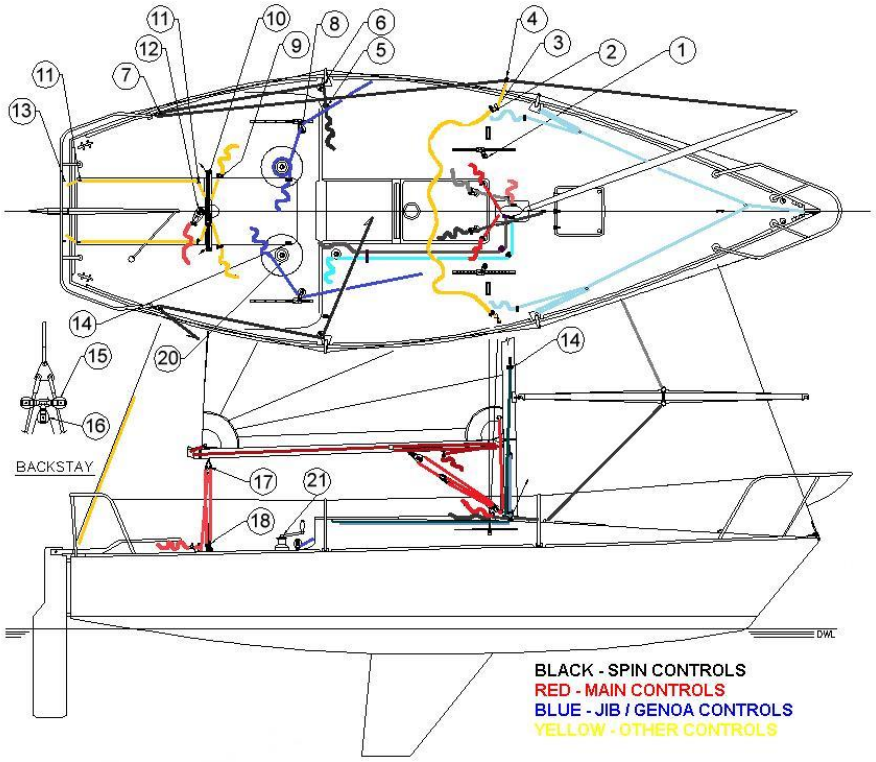
Group layout

A group layout is a combination of the product layout and process layout. It combines the advantage of both layout systems.

Fixed position layout

-in which the physical characteristics of the product dictate as to which type of machines and men are to be brought to the product.

The ship building industry commonly employs a static product layout.



Advantages and Limitation of Process Layout

Advantages

1. Machines are better utilized; fewer machines are required.

2. A high degree of flexibility in terms of task allocation to machines exists.

3. Comparatively low investment in machines is required.

4. The diversity of tasks offers a more interesting and satisfying occupation for the operator.

Limitation of Process Layout

1. Material handling cost will be high
2. Production planning and control systems are more involved.
3. Throughput time is longer.
4. Large amounts of in-process inventory will result.
5. Space and capital are tied up by work in process.
6. Higher grades of skill are required.

Advantages and limitations of product layout

Advantages

1. The flow of product will be smooth and logical in flow lines.

2. In-process inventory is less.
3. Throughput time is less.
4. Material handling cost is minimum.
5. Operators need not be skilled.
6. Simple production planning and control systems are possible.
7. Less space is occupied by work in transit and for temporary storage.

Limitations of product layout

1. A breakdown of one machine in a product line may cause stoppage of machines in the downstream of the line.

2. A change in product design may require major alterations in the layout.

3. The line output is decided by the bottleneck machine.

4. Comparatively high investment in equipment is required.

Advantages and Limitation of Group Technology Layout

Advantages

Group technology layout can increase the items given in **List A**

List A

1. Component standardization and rationalization
2. Reliability of estimates
3. Effective machine operation
4. Productivity
5. Costing accuracy
6. Customer service
7. Order potential

Advantages of Group Technology Layout

Group technology layout can decrease the items given in List B.

List B

1. Planning effort
2. Paper work
3. Setting time
4. Down time
5. Work in progress
6. Work movement
7. Overall production times
8. Overall cost

Limitations of Group Technology Layout

This type of layout may not be feasible for all situations.

If the product mix is completely dissimilar, then we may not have meaningful cell formation.

LAYOUT DESIGN PROCEDURES

Layout design procedures can be classified in to manual methods and computerized methods.

Manual methods

Under this category, there are some conventional methods like, travel chart and Systematic Layout Planning (SLP)

Computerized methods

Under this method, again the layout design procedures can be classified into constructive type algorithms and improvement type algorithms.

Construction type algorithms

- Automated Layout Design Program (ALDEP)
- Computerized Relationship Layout Planning (CORELAP)

Improvement type algorithms

- Computerized Relative Allocation of Facilities Technique (CRAFT)

Systematic Layout Design Procedure

• An organized approach to layout planning has been developed by Muther and has received considerable publicity due to the success derived from its application in solving a large variety of layout problems.

• Once the appropriate information is gathered, a flow analysis can be combined with an activity analysis to develop the relationship diagram.

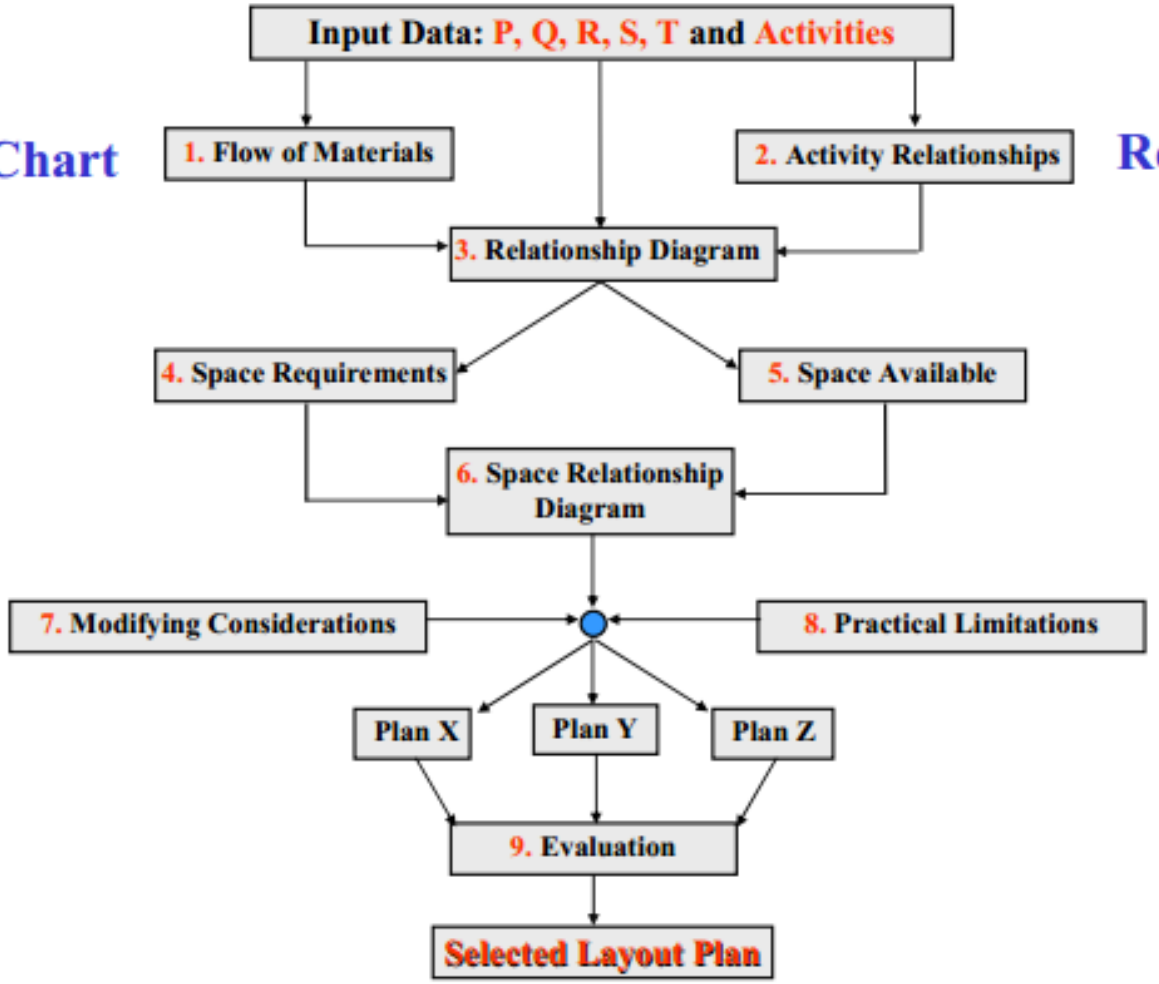
• The space relationship diagram is constructed by combining space considerations with the relationship diagram.

• Based on the space relationship diagram, modifying considerations and practical limitations, a number of alternative layout are designed and evaluated.

Systematic Layout Planning

From-To-Chart

Relationship Chart



Automated Layout Design Program (ALDEP)

- ALDEP is a construction type algorithm.

- This algorithm used basic data on facilities and builds a design by successively placing the departments in the layout.

- After placing all the department in the layout, a score is computed.

- This is nothing but the sum of the closeness rating value of different neighboring department in the layout.

- This algorithm is repeated for a pre specified number of times and the best layout is selected based on the maximum layout score.

The basic data required for this algorithm are listed below.

1. Total number of department
2. Area of each department
3. Length and width of layout
4. Closeness ratings of various pairs of departments in the form of relationship chart.
5. Minimum department preference (MDP) value.
6. Number of iterations to be performed.
7. Location and size of each restricted area in the layout if present.

Computerized Relationship Layout Planning (CORELAP)

This algorithm is based on Muther's procedure given in Systematic Layout Planning. A computer algorithm was developed by R.C. Lee.

Interactive version was developed by James Moore.

Input requirements

1. Number of department and their area

2. Closeness relationship as given by Relationship-Chart

3. Weighted rating for Relationship chart entries.

- General approach is to select the most critical department first and place it at the center of the layout.

- After the first department is placed, then the department having closeness relationship with the department which are already placed is selected and placed in the best location adjacent to the previously placed departments.

- COREL AP builds the layout from the centre.

- The final layout will not have a regular rectangular shape.

- The user has to modify it slightly to suit the situation.

- Final score of the layout is developed by using the closeness value and rectilinear distances between all pairs of departments.

Computerized Relative Allocation of Facilities Technique (CRAFT)

- CRAFT algorithm was originally developed by Armour and Buffa.

- CRAFT is more widely used than ALDEP and CORELAP.

- It is an improvement algorithm.

- It starts with an initial layout and improves the layout by interchanging the departments pair wise so the transportation cost is minimized.

- The algorithm continues until no further interchanges are possible to reduce the transportation cost.

CRAFT requirements

1. Initial layout

2. Flow data

3. Cost per unit distance

4. Total number of department

5. Fixed department

   - Number of such departments
   - Location of those departments

6. Area of departments

MATERIAL HANDLING SYSTEMS

- The development of material handling system to move materials from one stage of production to another is very important.
- Materials handling includes moving, packaging and storing all the materials used by a firm.
- The material handling system is judged by how well it serves the production process and how economical it is.
- With the development of technology, a variety of materials handling equipments has been developed to economize costs, lessen the monotony and effort of the workers, improve the safety for men and materials and improve the overall productivity.
- Such equipments range from hand trolleys to automatic devices for handling a variety of products and materials.
- The design of the plant layout and the materials handling system are clearly interlinked and the design of one affects the other.

Unit Load Concept

• The materials are shipped from a given source to a given destination in batches consisting of certain number of pieces or quantity of each trip.

• Again, for the purpose of handling within a given work area, loading to a material handling equipment and unloading from a material handling equipment, there must be a limit on the number of pieces in the case of discrete items or a limit on the quantity(weight) of materials in the case of continuous materials to be picked and placed simultaneously while loading and unloading the materials.

• In this process, the batch of materials which are placed at particular destination should retain its original shape and size before picking.

• The optimal shape and size of the bulk material which will retain its original shape and size even after unloading is called a unit load.

Material Handling Principles

Some of the important principles of materials handling are listed below.

1. All materials to be handled mechanically from the inbound raw materials stage to the outgoing finished goods stage.
2. Heavy loads must be handled mechanically
3. Avoid mixing materials which require future sorting
4. Transfer of materials from one container to another should be done mechanically.
5. Hot and hazardous materials must be handled mechanically.
6. Unit load concept must be followed. The larger the size of the unit load, the greater the economy.
7. Use of overhead space for conveyers and for stocking materials to be stored must be encouraged.
8. Materials are to be moved in a straight line to the extent possible. Minimum number of changes in the direction while moving materials is preferable.
9. Avoiding floor contact of materials is preferable.
10. Gravity feed must be taken into advantage where feasible.

Classification of Material Handling Equipments

The materials handling equipments can be classified into the following categories.

- Fixed path equipments
- Varied path equipments
- Auxiliary equipments

Fixed path equipments

Conveyers

1. Belt conveyer
2. Roller conveyer
3. Screw conveyer
4. Bucket conveyer
5. Pneumatic conveyer
6. Gravity conveyer

Cranes and hoists

1. Overhead travelling crane
2. Gantry crane
3. Jib crane
4. Hoist
5. Stacker crane
6. Monorail

Varied path equipments

1. Lift truck
2. Platform truck
3. Hand stacks
4. Tractors
5. Hand trolleys

Auxiliary equipments

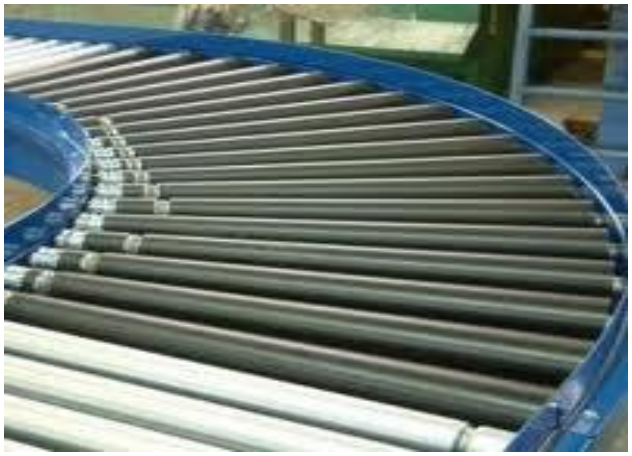
1. pallets, skids
2. containers
3. Lift truck attachments
4. Loaders and unloaders
5. Ramps

Fixed path equipments

Conveyers

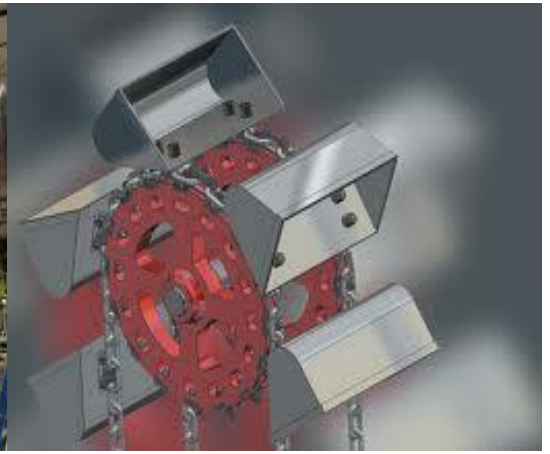
1. Belt conveyer

2. Roller conveyer



3. Screw conveyer

4. Bucket conveyer



5. Pneumatic conveyer

6. Gravity conveyer

Cranes and hoists

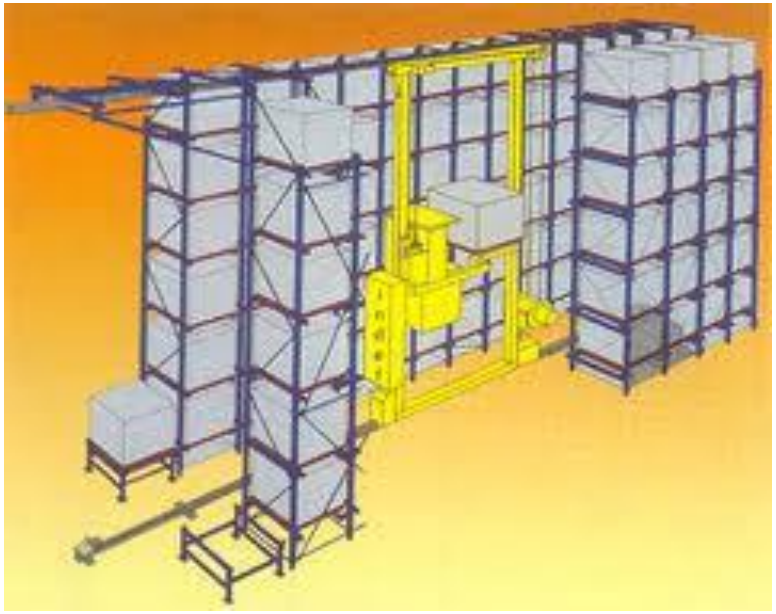
1. Overhead travelling crane

2. Gantry crane

3. Jib crane

4. Hoist

5. Stacker crane



6.Monorail

Varied path equipments

1. Lift truck

2. Platform truck

3. Hand stacks

4. Tractors

5.Hand trolleys

Auxiliary equipments

1. Pallets, skids

2. Containers

3. Lift truck attachments

4. Loaders and unloaders

5.Ramps

Line Balancing

- Line here means an assembly line composed of several work stations, at which specific operations are performed.
- Assembly line is a sequence of progressive assembly stations linked by some material handling devices.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Line Balancing

Concept of mass production System

- Many differences exist in the management of production activities in make-to-order and make-to-stock firms.
- In make-to-order situations, due dates are important.
- Make-to-stock products are generally high volume consumer goods such as, telephones, automobiles, wrist watches etc..

Flow shop

- A flow shop consists of a set of facilities through which work flows is a serial fashion.
- Thus the same operations are performed repeatedly, it requires lower-level skilled workers.
- The flow shop generally represents a mass production situation and hence the operations are carried out efficiently.
- E.g. When an operator has to install a gear box on an automotive assembly or assembling cooling system on a washing machine.

Flow control

- The production control system of continuous production is called flow control.
- The main objective of flow control in flow shop is to balance the assembly line.
- The assembly line is represented in the form of a precedence diagram.

- Cycle time is directly related to the production rate of the assembly line.

CT= productive time/Demand per period

Objective of assembly line balancing

- The objective of assembly line balancing is to subdivide the network into several sub networks (station) without violating the precedence relationships and allocating operations to each station without exceeding the cycle time.
- While allocating operations to each station, the precedence relationships must be maintained.

Inventory

What is Inventory?

- Definition--The stock of any item or resource used in an organization
  - Raw materials
  - Finished products
  - Component parts
  - Supplies
  - Work in process

Inventory System Purpose

- The set of policies and controls that determine what inventory levels should be maintained, when stock should be replenished, and how large orders should be

Why Inventory Control?

Control of inventory, which typically represents 45% to 90% of all expenses for business, is needed to ensure that the business has the right goods on hand to avoid stock-outs, to prevent spoilage/theft and to provide proper accounting.

Many businesses have too much of their limited resource, **capital,** tied up in their major asset, **inventory**.

Worse, they may have their capital tied up in the wrong kind of inventory. Inventory may be old, damaged, shopworn, outdated, or the wrong sizes or colors, or there may be an imbalance among different product lines that reduces the customer appeal of the total operation.

Models of Inventory

- Purchase model with instantaneous replenishment and without shortages.
- Manufacturing model without shortages.
- Purchase model with instantaneous replenishment and with shortages.
- Manufacturing model with shortages.

The **Economic Order Quantity** (EOQ) is the number of units that a company should add to inventory with each order to minimize the total costs of inventory—such as holding costs, order costs, and shortage costs.

Implementation of Purchase Inventory Model

The particular version of purchase model of inventory can be classified into

1. Fixed Order Quantity System (Q System) and

2. Fixed Period Quantity System (P System)

Fixed Order Quantity System (Q System)

In this system of inventory, whenever the stock level touches the reorder level, an order is placed for fixed quantity which is equal to EOQ.

The average demand during the lead time (average lead time) is known as the demand during lead time (D_{LT}).

The variation in demand during lead time (average lead time) is known as safety stock.

The average demand during delivery delay is called reserve stock.

The Reorder level is computed as the sum of the demand during lead time (D_{LT}), the variation in demand during lead time (safety stock) and the average demand during delivery delay (reserve stock).

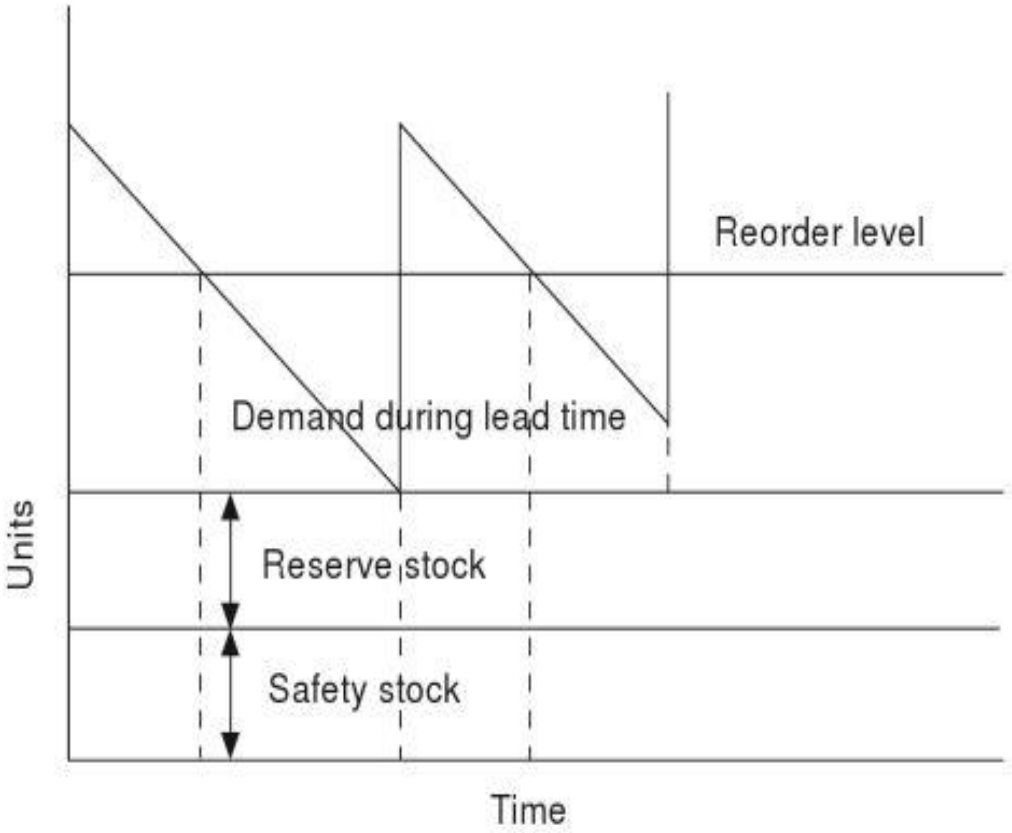


Fig. 9.9 Q system of inventory.

Reorder level = Demand during lead time (D_{LT})
+ Variation in demand during lead time (safety stock)
+ Average demand during delivery delays (reserve stock)

$$\text{Order quantity} = \sqrt{\frac{2C_oD}{p \times \%C_c}}$$

$$\text{Standard deviation in demand during lead time} = (\text{Lead Time})^{1/2} \times \text{Standard Deviation per week}$$

$$\text{Safety stock during lead time (SS)} = K \times \sigma$$

where $K = 1.64$ for the given service level of 0.95

$$\text{Average demand during delivery delays (reserve stock)} = \frac{D \times \text{Maximum delay}}{\text{No. of weeks/Yr}} \times \text{Probability of maximum delay}$$

Fixed Period Quantity System (P System)

UNIT-III:

Nature of Aggregate Planning Decisions, Aggregate Planning Strategies, Aggregate Planning Methods: Heuristic Method, Transportation Model for Aggregate Planning,

Material Requirement Planning: Product Structure/Bill of Materials(BOM), MRP Concept.

Single Machine Scheduling: Types of Scheduling, Concept of Single Machine Scheduling, SPT Rule to Minimize Mean Flow Time, Minimizing Weighted Mean Flow Time, EDD Rule to Minimize Maximum Lateness, Flow Shop Scheduling: Introduction, Johnson’s Problem, Extension of Johnson’s Rule.

Aggregate planning

- Demand forecast can be classified into long range, medium range and short range forecasting.
- Long rang forecast acts as the basis for capacity planning.
- A company may be manufacturing several products using a set of facilities.
- The association between the facilities and the products is generally, many to many, i.e. a given facility is used to manufacture more than one product.
- Similarly, a product may need more than one facility to manufacture it.
- This type of association introduces complexities in scheduling.

Aggregate planning is a process that follows capacity planning, and it uses medium range forecast.

- The plans do not necessarily have to be so detailed as to provide specific instructions for daily or weekly operations such as loading, sequencing, expediting and dispatching.

Nature of Aggregate Planning Decisions

Some time, the regular time production capacity may not be sufficient to cope with the demand of various products.

Under such situation , we can use other operational capacities in smoothing the impact of demand fluctuations.

Given the sales forecast, the factory capacity, aggregate inventory levels and the size of the work force, the manager must decide at what rate of production to operate the plant over the intermediate term. Intermediate-range planning is generally known as aggregate planning.

The different capacities which are generally used to manufacture.

- Regular time production capacity
- Subcontracting capacity
- Overtime capacity
- Hiring and firing capacity

Aggregate planning strategies

One can use any one or a combination of the followings strategies for smoothing fluctuations in demand.

Generally, a mixture of strategies is preferred.

- Building and utilizing inventory through constant work force.
- Varying the size of the work force
  -hiring and firing
- Overtime utilization
- Subcontracting

If a single strategy is used to meet the demand, then it is called as a pure strategy. Each of the above strategies is called as a pure strategy.

Pure strategies

a) Building and utilizing inventory through constant work force.
b) Varying the size of the work force
c) Subcontracting
d) Making changes in demand pattern

Mixed strategies

Instead of this, if the combination of the above pure strategies is used to meet the demand, then it is called a mixed strategy.

-all these mixed may not meaningful
-only limited combination is preferable
-most economical alternative for implementation.

Material Requirements Planning

Material requirements planning (MRP) is a production planning and inventory control system used to manage manufacturing processes.

An MRP system is intended to simultaneously meet three objectives:

1. Ensure materials are available for production and product are available for delivery to customers.
2. Maintain the lowest possible material and product levels in store
3. Plan manufacturing activities, delivery schedules and purchasing activities

MRP calculates and maintains an optimum manufacturing plan based on

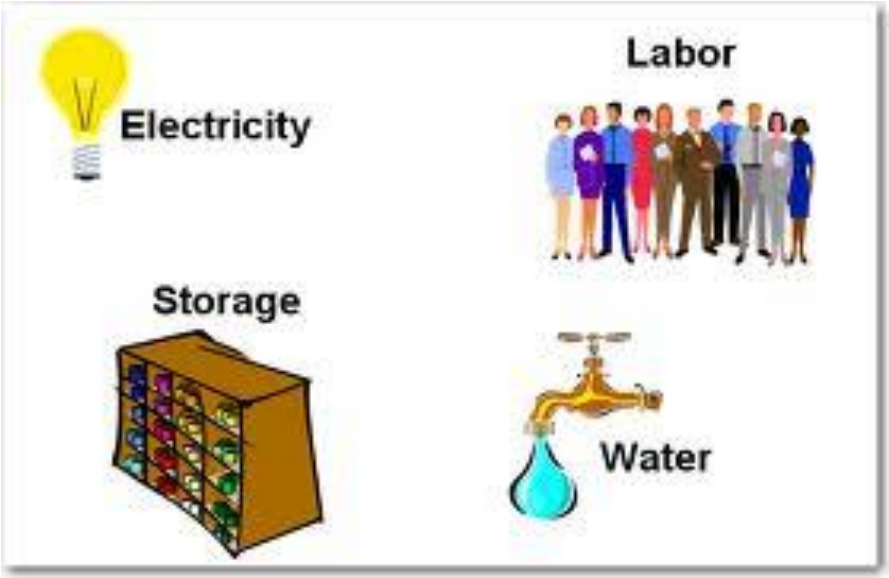
- master production schedules,
- sales forecasts,
- inventory status,
- open orders and bills of material.

If properly implemented, it will reduce cash flow and increase profitability.

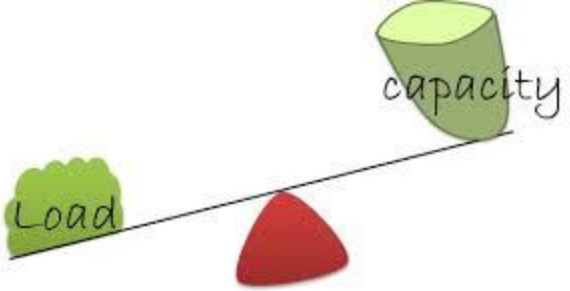
MRP will provide you with the ability to be pro-active rather than re-active in the management of your inventory levels and material flow.

Implementing or improving Material Requirements Planning can provide the following benefits for your company:

1. Reduced Inventory Levels
2. Reduced Component Shortages
3. Improved Shipping Performance
4. Improved Customer Service
5. Improved Productivity
6. Simplified and Accurate Scheduling
7. Reduced Purchasing Cost
8. Improve Production Schedules
9. Reduced Manufacturing Cost
10. Reduced Lead Times
11. Less Scrap and Rework
12. Higher Production Quality
13. Improved Communication



14. Improved Plant Efficiency
15. Reduced Freight Cost
16. Reduction in Excess Inventory
17. Reduced Overtime
18. Improved Supply Schedules
19. Improved Calculation of Material Requirements
20. Improved Competitive Position



MRP will plan production so that the right materials are at the right place at the right time.

MRP determines the latest possible time to product goods, buy materials and add manufacturing value.

Proper Material Requirements Planning can keep cash in the firm and still fulfill all production demands.

It is the single most powerful tool in guiding inventory planning, purchase management and production control.

MRP is easy to operate and adds dramatically to profits.

The scope of MRP in manufacturing

The basic functions of an MRP system include:

-inventory control,
-bill of material processing, and
-elementary scheduling.

MRP helps organizations to maintain low inventory levels.

It is used to plan manufacturing, purchasing and delivering activities.

"Manufacturing organizations, whatever their products, face the same daily practical problem - that customers want products to be available in a shorter time than it takes to make them. This means that some level of planning is required."

Companies need to control the types and quantities of materials they purchase, plan which products are to be produced and in what quantities and ensure that they are able to meet current and future customer demand, all at the lowest possible cost.

Making a bad decision in any of these areas will make the company lose money.

A few examples are given below:

- If a company purchases insufficient quantities (or the wrong item)
- If a company purchases excessive quantities
- Beginning production of an order at the wrong time can cause customer deadlines to be missed.

MRP is a tool to deal with these problems.
It provides answers for several questions:

- *What* items are required?
- *How many* are required?
- *When* are they required?...

MRP can be applied both to items that are purchased from outside suppliers and to sub-assemblies, produced internally, that are components of more complex items.

The data that must be considered include:

- The *end item* (or items) being created (Bill of materials).
- How much is required at a time.
- When the quantities are required to meet demand.
- Shelf life of stored materials.
- Inventory status records.
- Bills of materials. Details of the materials, components and sub-assemblies required to make each product.
- Planning Data. This includes all the restraints and directions to produce the end items. This includes such items as: Routing, Labor and Machine Standards, Quality and Testing Standards, Scrap Percentages, and other inputs.

Problems with MRP systems

First problem with MRP systems - the integrity of the data.

If there are any errors in the inventory data or the master production schedule, then the output data will also be incorrect (Garbage In, Garbage Out). Data integrity is also affected by inaccurate cycle count adjustments, mistakes in receiving input and shipping output, scrap not reported, waste, damage, box count errors, supplier container count errors, production reporting errors, and system issues. Many of these type of errors can be minimized by implementing pull systems and using bar code scanning. Most vendors in this type of system recommend at least 99% data integrity for the system to give useful results.

Second problem -A manufacturer may have factories in different cities or even countries.

UNIT-IV

Work Study: Method Study – Steps in Method Study, Recording, Examine Step, Principles of Motion Economy, Time Study.

Quality Control: Introduction, Need for Controlling Quality, Definition of a Quality System, Classification of Quality Control Techniques, Control Charts, Control Charts for Variable, Control Charts for Attributes, C-Chart, Acceptance Sampling: Operating Characteristic Curve (O.C. Curve), Single Sampling Plan.

What is Work Study?

Work Study is the systematic examination of the methods of carrying out activities such as to improve the effective use of resources and to set up standards of performance for the activities carried out.

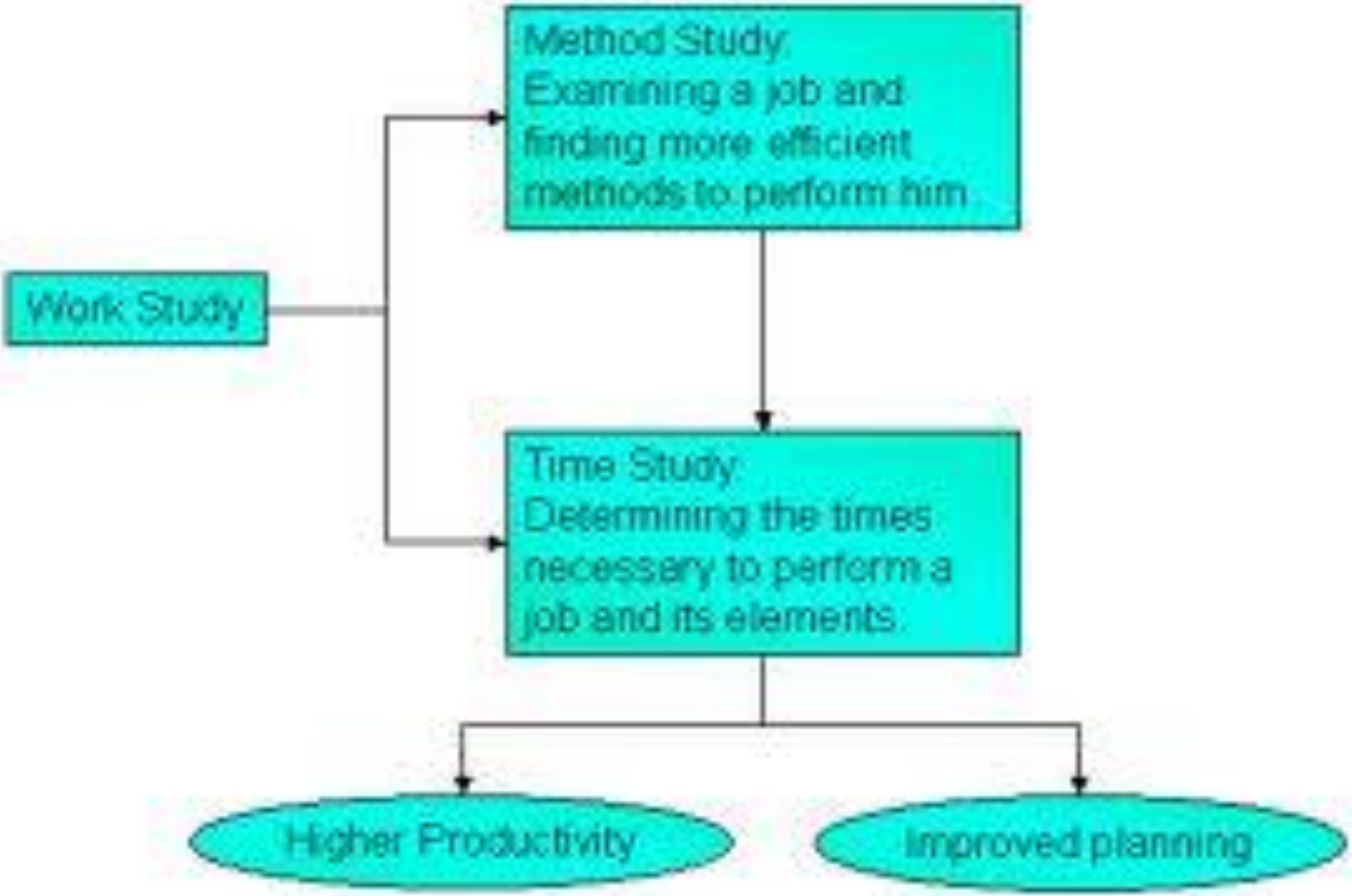
Definition of Work Study

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

Objective

Work study is concerned with finding better ways of doing work and avoiding waste in all its forms. As such the objective of work study is to assist management to obtain the optimum use of the human, machine and materials resources available to the organization for the accomplishment of the work upon which it is engaged.

- The most effective use of plant and equipment
- The most effective use of human effort
- The evaluation of human work.


Method Study
Examining a job and finding more efficient methods to perform him
Work Study
Time Study
Determining the times necessary to perform a job and its elements
Higher Productivity
Improved planning

Method study

It is the systematic recording, analyzing and critical examination of existing and proposed ways of doing work and the development and application of easier and new production methods.

Areas of applications of methods study

It can be applied in any field of work, but the most important areas where it plays a major role in improving productivity are as follows.

- Improved layout of office, working areas of factories
- Improved design of plant and equipment
- Improved use of materials, plant, equipment and manpower
- Most effective handling of materials
- Improved flow of work
- Standardization of methods and procedures
- Improved safety standards
- Better working conditions

Steps in Method Study

1. **Select:** Select the work to be studied

2. **Record:** Record all the relevant facts of the present (or proposed) method by direct observation.

3. **Examine:** Examine the facts critically in sequence, using special critical examination sheet.

4. **Develop:** Develop the best method the most practical, economic and effective method, under prevailing circumstances.

5. **Install:** install the methods as standard practice.

6. **Maintain**: maintain that standard practice by regular routine check.

Recording

In order to carry out any investigation, data or relevant facts pertaining to the existing method must be collected and recorded.

There are a number of recording techniques developed to simplify and standardize the work.

The recording may trace the movement of

-men,

-materials or

-details of various processes.

The principal is to use the simplest technique which will contain all relevant information needed for investigation.

The different recording techniques are

-charts,

-diagrams,

-models and

-photographic aids.

Examine steps

This is the most important step in method study.

This step aim to eliminate the activity altogether if it is unnecessary;

To combine it with other activities;

To change the sequence of activity so that work delay is reduced,

To simplify the activity to reduce the work content or time consumption.

Examine steps

In this step, we will have to ask a series of questions. The questions may be classified into primary questions and secondary questions.

Primary questions

Purpose- What is the purpose of the event? Why is it necessary?

Place- Where does the event take place? Why there?

Sequence- When does it occur? Why then?

Person-Who carries out the work? Why that person?

Means- How is the purpose achieved? Why that particular way?

Secondary questions

Purpose- What else could be done?

Place- Where else could it be done?

Sequence- When else could it be done?

Person – who else could do it?

Means- How else could it be done?

Alternatives

When each of the above question is applied to any event, number of alternatives would emerge.

Purpose- What should be done?

Place- Where should it be done?

Sequence- When should it be done?

Person – who should do it?

Means- How should it be done?

Principles of Motion Economy

The improvement of any methods is generally accomplished using the ideas chosen from the alternatives thrown up during the critical examination phase of the method study.

To aid critical examination, certain rules or principals may be used. These are called principal of motion economy.

These can be classified into the following three categories.

1. **Related to the use of the human body.**

2. **Related to the arrangement of the work place.**

3. **Related to the design of tools and equipment.**

Principles related to the use of the human body

1. The two hands should begin as well as complete their motion at the same time.
2. The two hands should not be idle at the same time except during rest periods.
3. Motions of the arms should be made in opposite and symmetrical directions and should be made simultaneously.
4. Momentum should be employed to assist the worker, wherever possible and it should be reduced to a minimum if it must be overcome by muscular effort.
5. Ballistic movements are faster, easier and more accurate than restricted or controlled movement.
6. Rhythm is essential to the smooth and automatic performance of an operation and the work should be arranged to permit any easy and natural rhythm wherever possible.

Principles related to the arrangement of work place

1. There should be a definite and fixed place for all tools and materials.
1. Tools, materials and controls should be located close to the operator and directly in front of the operator.
2. Gravity feed bind and containers should be used to deliver materials close to the point of use.
3. Drop deliveries should be used whenever possible.
4. Materials and tools should be located to permit the best sequence of motions.
5. The height of the work place and the chare should preferably be arranged so that alternate sitting and standing at work are easily possible.

Principles related to the design of tools and equipments

1. The hands should be relieved of all work that can be done more advantageously to a fixture or a foot operated device.
2. Two or more tools should be combined wherever possible.
3. Tools and materials should be pre-positioned wherever possible.
4. Where each finger performs some specific movements such as in typewriting, the load should be distributed in accordance with the inherent capacity of the finger.
5. Handles such as those used on cranks and large screw drivers should be designed to permit as much of the surface of the hand to come in contact with the handles as possible.




Quality control

In any business organization,

-profit is the ultimate goal.

To achieve this, there are several approaches.

- Profit may be maximized by cutting costs for the same selling price per unit.
- If it is a monopolistic business, without giving much of importance to the cost reduction programs, the price may be fixed suitably to earn sufficient profit.

But, to survive in a competitive business environment, goods and services produced by a firm should have minimum required quality.

Extra quality means extra cost.

So, the level of quality should be decided in relation to other factors such that the product is well absorbed in the market.

In all these cases, to have repeated sales and thereby increased sales revenue, no one will deny the fact that the basic quality is considered to be one of the supportive factors.

Quality is a measure of how closely a good or service conforms to specified standard.

Quality standard may be any one or a combination of attributes\variables.

The attributes will include performance, reliability, appearance, commitment to delivery time, etc.

Variables may be some measurement variables like, length, width, height, diameter, surface finish, etc.

Quality assurance is the system of policies, procedures and guidelines which help in building specified standard of product\service quality.

Need for controlling quality

In the absence of quality, the following will result:

1. No yardstick for comparing the quality of goods\services.

1. Difficulty in maintaining consistency in quality.

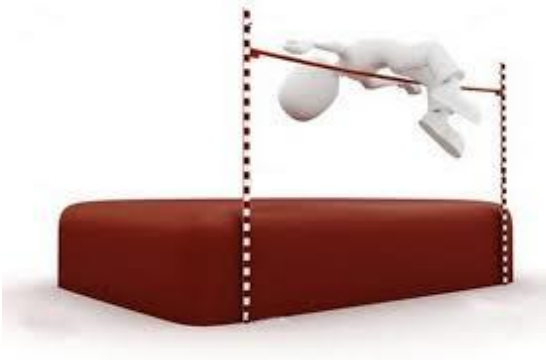
2. Dissatisfied customers due to increased maintenance and operating costs of products\services.

3. Increased rework cost while manufacturing products\providing services.

4. Reduced life time of the products/services.

5. Reduced flexibility with respect to usage of standard spare parts.

Definition of a quality system



There is no simple way to define a quality system.
In general, a quality system is a part of overhead.
The system does not add any value to the products.
It only ensure the product works and meets customer expectations.

Strategic areas of quality control program in manufacturing are as follows.

- Supplier quality
- Incoming raw materials quality
- Process quality
- Final inspection
- Customer quality

UNIT-V

MAINTENANCE PLANNING AND CONTROL

Introduction

The dictionary defines maintenance as “the work of keeping something in proper condition, upkeep.”

This would imply that maintenance should be actions taken to prevent a device or component from failing or to repair normal equipment degradation experienced with the operation of the device to keep it in proper working order.

Data obtained in many studies over the past decade indicates that most private and Government facilities do not expend the necessary resources to maintain equipment in proper working order.

They wait for equipment failure to occur and then take whatever actions are necessary to repair or replace the equipment.

Nothing lasts forever and all equipment has associated with it some predefined life expectancy or operational life.

OBJECTIVES OF MAINTENANCE

Equipments are an important resource which is constantly used for adding value to products.

So, it must be kept at the best operating condition.

Otherwise, there will be excessive downtime and also interruption of production if it is used in a mass production line.

Poor working of equipments will lead to quality related problems.

Hence, it is an absolute necessity to maintain the equipments in good operating conditions with economical cost.

Hence, we need an integrated approach to minimize the cost of maintenance.

In certain cases, the equipment will be outdated over a period of time.

If a firm wants to be in the same business competitively, it has to take decision on whether to replace the equipment or to retain the old equipment by taking the cost of maintenance and operation into account.

The objectives of maintenance are to maintain equipments and facilities in such conditions that:

- They give trouble free service and output at rated capacity.
- Safety is ensured.
- Down time is minimized.
- The cost of operations and maintenance is minimized.

TYPES OF MAINTENANCE

The design life of most equipment requires periodic maintenance.

- Belts need adjustment,
- alignment needs to be maintained,
- proper lubrication on rotating equipment is required, and so on.

In some cases, certain components need replacement, *e.g.*, a wheel bearing on a motor vehicle, to ensure the main piece of equipment (in this case a car) last for its design life.

Different approaches have been developed to know how maintenance can be performed to ensure equipment reaches or exceeds its design life.

In addition to waiting for a piece of equipment to fail (reactive maintenance) the other approaches are preventive maintenance and predictive maintenance.

Maintenance activity can be classified into three types;

- Break down (Reactive) Maintenance
- Preventive Maintenance
- Predictive Maintenance

1. Breakdown (Reactive) Maintenance

Breakdown maintenance is basically the ‘run it till it breaks’ maintenance mode.

No actions or efforts are taken to maintain the equipment as the designer originally intended to ensure design life is reached.

Studies as recent indicate that, this is still the predominant mode of maintenance.

Advantages

1. Involves low cost investment for maintenance.
2. Less staff is required.

Disadvantages

1. Increased cost due to unplanned downtime of equipment.
2. Increased labour cost, especially if overtime is needed.
3. Cost involved with repair or replacement of equipment.
4. Possible secondary equipment or process damage from equipment failure.
5. Inefficient use of staff resources.

2. Preventive Maintenance

Preventive maintenance can be defined as,

"Actions performed on a time or machine-run-based schedule that detect, preclude, or mitigate degradation of a component or system with the aim of sustaining or extending its useful life through controlling degradation to an acceptable level."

Preventive maintenance is a means to increase the reliability of their equipment.

By simply expending the necessary resources to conduct maintenance activities intended by the equipment designer, equipment life is extended and its reliability is increased.

In addition to an increase in reliability, lot of amount will be saved over that of a program just using reactive maintenance.

Studies indicate that this savings can amount to as much as 12% to 18% on the average.

Advantages

1. Cost effective in many capital intensive processes.
2. Flexibility allows for the adjustment of maintenance periodicity.
3. Increased component life cycle.
4. Energy savings.
5. Reduced equipment or process failure.
6. Estimated 12% to 18% cost savings over reactive maintenance program.

Disadvantages

1. Catastrophic failures still likely to occur.
2. Labour intensive.
3. Includes performance of unneeded maintenance.
4. Potential for incidental damage to components in conducting unneeded maintenance.

Preventive maintenance (lubrication, filter change, etc.) will generally run the equipment more efficiently resulting in dollar savings. While we will not prevent equipment catastrophic failures, we will decrease the number of failures.

3. Predictive Maintenance

Predictive maintenance can be defined as

"Measurements that detect the onset of a degradation mechanism, thereby allowing causal stressors to be eliminated or controlled prior to any significant decline in the component physical state. Results indicate current and future functional capability".

Basically, predictive maintenance differs from preventive maintenance by basing maintenance need on the actual condition of the machine rather than on some preset schedule.

Preventive maintenance is time-based.

Predictive maintenance is need-based.

Advantages

1. Increased component operational life/availability.
2. Allows for pre-emptive corrective actions.
3. Decrease in equipment or process downtime.
4. Decrease in costs for parts and labour.
5. Better product quality.
6. Improved worker and environmental safety.
7. Improved worker moral.
8. Energy savings.
9. Estimated 8% to 12% cost savings over preventive maintenance program.

Disadvantages

1. Increased investment in diagnostic equipment.
2. Increased investment in staff training.
3. Savings potential not readily seen by management.

Replacement

Electronic items like bulbs, resistors, tube lights etc. generally fail all of a sudden, instead of gradual failure.

The sudden failure of the item results in complete breakdown of the system.

The system may contain a collection of such items or just an item like a single tube-light.

Hence we use some replacement policy for such items which would minimize the possibility of complete breakdown.

The following are the replacement policies which are applicable in these cases.

i) Individual replacement policy:

Under this policy, each item is replaced immediately after failure.

ii) Group replacement policy:

Under group replacement policy, a decision is made with regard the replacement at what equal internals, all the item are to be replaced simultaneously with a provision to replace the items individually which fail during the fixed group replacement period.

Among the two types of replacement polices, we have to decide which replacement policy we have to follow.

Whether individual replacement policy is better than group replacement policy.

With regard to economic point of view.

To decide this, each of the replacement policy is calculated and the most economic one is selected for implementation.

Concept of Reliability in Maintenance

Reliability is the probability of survival under a given operating environment.

For example, the time between consecutive failures of a refrigerator where continuous working is required is a measure of its reliability.

If this time is more, the product is said to have high reliability.

In a textile mill, generally the light is maintained at a minimum specified level.

To achieve this, let us assume that there are 100 bulbs in use and the guaranteed life time of these bulbs is 5000 hours.

If we collect statistics about the number of bulbs survived till 5000 hours, we can compute the reliability of the bulbs.

In this case,

$$\text{Reliability} = \text{Failure rate} = \frac{\text{Number of bulbs survived till the specified time limit}}{\text{Number of bulbs used}}$$

If the number of bulbs survived till 5000 hours is 80, then we can say that the reliability is 0.8 (*i.e.*, 80/100)

The reliability of railway signaling system, aircraft, and power plant are some of the interesting examples for demonstrating the reliability concept.

In these cases, a failure will lead to heavy penalty.

In Fig. 1, there will be large number of failures in the early period. This is mainly due to nonalignment while shipping the product, or misfit while manufacturing (assembling), or very high initial friction between moving parts, etc.

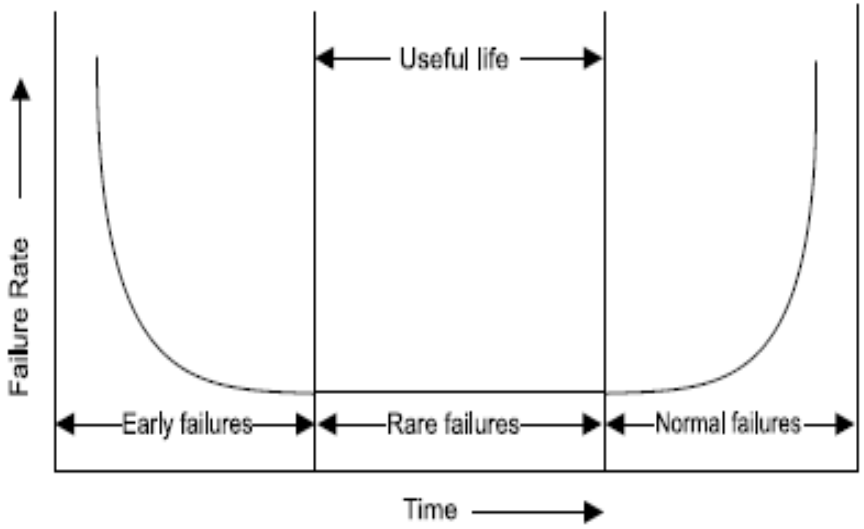


Fig. 1 *Product failure rate*

Reliability Improvement

The reliability of a system/product depends on many factors. So, we should concentrate at the grass root level to improve product's reliability.

Some of the ways of improving systems reliability are listed below:

- Improved design of components
- Simplification of product structure
- Usage of better production equipments
- Better quality standards
- Better testing standards
- Sufficient number of standby units
- Usage of preventive maintenance if necessary at appropriate time.

JUST-IN-TIME (JIT) MANUFACTURING

Just-In-Time (JIT) Manufacturing is a philosophy rather than a technique.

By eliminating all waste and seeking continuous improvement, it aims at creating manufacturing system that is response to the market needs.

Just-in-time manufacturing is a production and inventory control system in which materials are purchased and units are produced only as needed to meet actual customer demand.

The principle of just-in-time is to eliminate sources of manufacturing Waste by getting right quantity of raw materials and producing the right quantity of products in the right place at the right time.

According to Voss, JIT is viewed as a "*Production methodology which aims to improve overall productivity through elimination of waste and which leads to improved quality*".

JIT provides an efficient production in an organization and delivery of only the necessary parts in the right quantity, at the right time and place while using the minimum facilities.

BENEFITS OF JIT

- JIT manufacturing is a management philosophy that helps to reduce manufacturing costs.
- JIT allows manufacturers to perfectly meet customer demands in terms of time, quality, and quantity.
- Areas previously used, to store inventories can be used for other more productive uses.
- Defect rates are reduced, resulting in less waste and greater customer satisfaction.
- JIT helps to reduce in production cycle time or product throughput time.
- JIT helps to improve product quality and minimise scrap.

Benefits of JIT

The most significant benefit is to improve the responsiveness of the firm to the changes in the market place thus providing an advantage in competition.

Following are the benefits of JIT:

1. *Product cost*—is greatly reduced due to reduction of manufacturing cycle time, reduction of waste and inventories and elimination of non-value added operation.
2. *Quality*—is improved because of continuous quality improvement programmes.
3. *Design*—Due to fast response to engineering change, alternative designs can be quickly brought on the shop floor.
4. Productivity improvement.
5. Higher production system flexibility.
6. Administrative and ease and simplicity.

Kanban:

Literally, a" visual record;" a method of controlling materials flow through a JIT manufacturing systems by using cards to authorize a work station to transfer or produce materials.

Define kanban system?

Kanban system is a kind of production system which operates based on the information contained in cards called "kanbans". There are two types of kanbans namely, Withdrawal kanban and production order kanban.

Kanban is used in manufacturing to mean a visual signal that tells when it is time to get or make more of something.

A visual sign or signal that conveys a set of instructions to either withdraw parts or produce a given product is called a kanban.

- a Japanese manufacturing system in which the supply of components is regulated through the use of an instruction card sent along the production line.
- an instruction card used in a kanban system.

kan- card, ban - signal

TYPES OF KANBAN

A withdrawal kanban – it specifies the kind and quantity of product which a manufacturing process should withdraw from a preceding process.

A production-ordering Kanban – It specifies the kind and quantity of product which the preceding process must produce.

Raw material kanban – It tells suppliers when to send how much of a particular item to a particular place.

In-process kanban - It determines the amount of WIP that can be kept between any two operations in a process.

Finished goods kanban – It determines the amount of a product to be kept on hand at any given time.


Thank you.