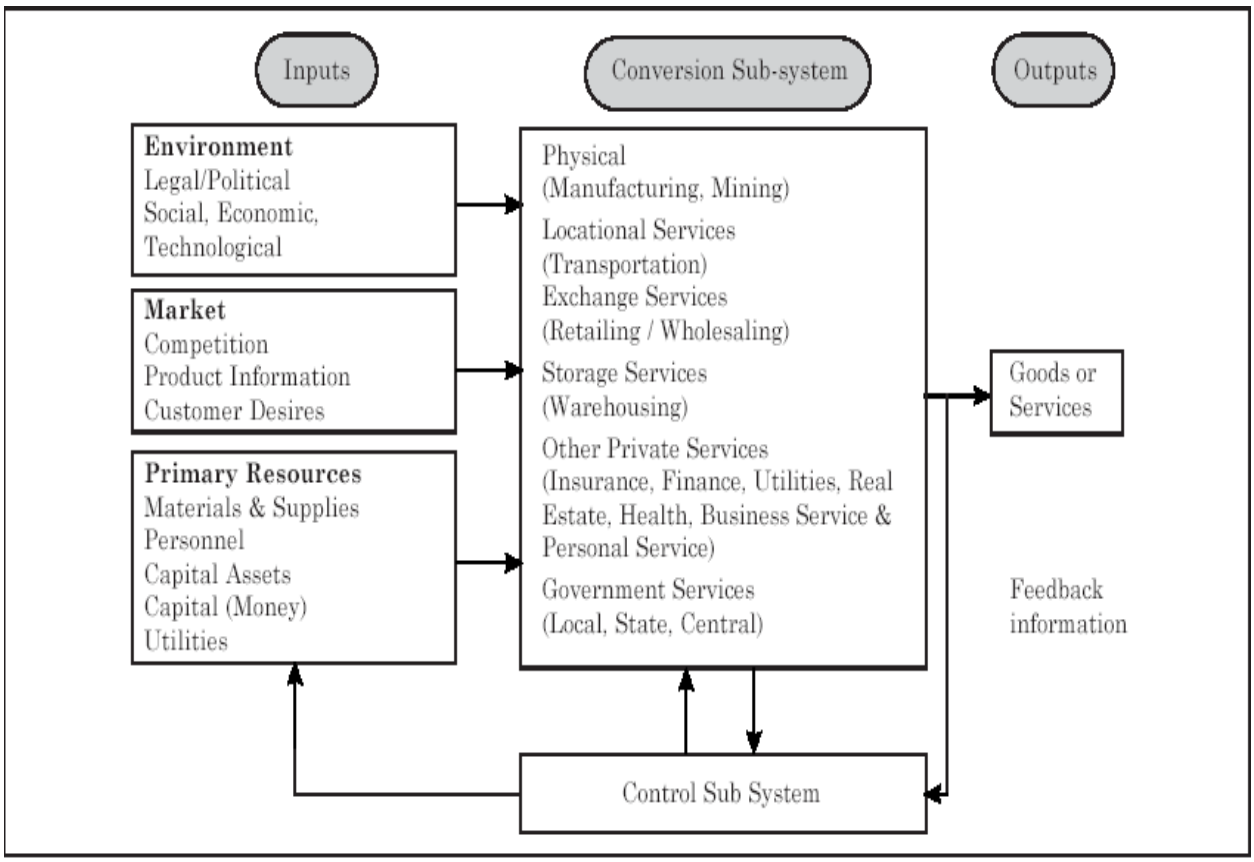
Unit-I

- Production is the process by which raw materials and other inputs are converted into finished products.
- Production management refers to the application of management principles to the production function in a factory. In other words, production management involves application of planning, organising, directing and controlling to the production process.
- Operations management is the process in which resorurces/inputs are converted into more useful products
- Production management and operations management are differentiated based on tangibilities of finished goods/services
- Production system model comprises:
-



- Operation managers are required to make a series of decisions in the production function.
- The decisions made by operation managers about the activities of production systems tend to fall into three general categories, viz.,

1. Strategic decisions
2. Operating decisions
3. Control decisions

Type of Decisions	Area of Involvement	Nature of Activities
I. **Strategic Decisions** (Planning Products) Processes and Facilities)	1. Production Processes	Developing long range production plans including process design.
	2. Production Technology	Selecting and managing production technology.
	3. Facility Layout	Planning the arrangement of facilities.
	4. Allocating Resources to Strategic Alternatives	Planning for the optimal distribution of scarce resources among product lines or business units.
	5. Long Range Capacity Planning and Facility Location	Answering the 'how much' and 'where' questions about long range production capacity.
II. **Operating Decisions** (Planning production to meet demand)	1. Production Planning Systems	Aggregate planning and master production scheduling
	2. Independent Demand Inventory Systems	Planning and controlling finished goods inventories
	3. Resource Requirements Planning Systems	Planning materials and capacity requirements.
	4. Shop Floor Planning and Control at each work centre.	Short range decisions about what to produce and when to produce
	5. Materials Management	Managing all facets of materials system.
III. **Control Decisions** (Planning and Operations)	1. Productivity and Employees	Planning for the effective and efficient use of human resources in operations.
	2. Total Quality Control	Planning and controlling the quality of products and services.
	3. Project Planning and Control Techniques	Planning and controlling projects.
	4. Maintenance Management and Reliability	Planning for maintaining the machines and facilities of production.

Importance of Production Function

Production function can offer competitive advantage to a firm in the following areas:

- Shorter new-product-lead time
- More inventory turns
- Shorter manufacturing lead time
- Higher quality
- Greater flexibility
- Better customer service
- Reduced wastage

Characteristics of Modern Production and Operations Function

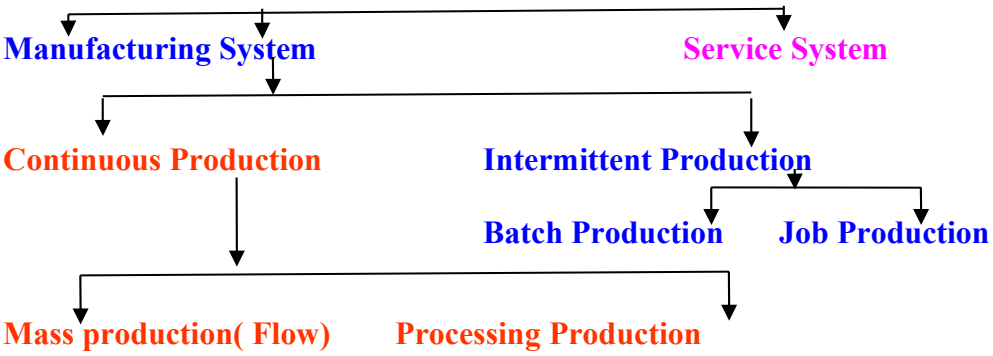
1. Manufacturing as Competitive Advantage

2. Services Orientation
3. Disappearance of Smokestacks
4. Small has Become Beautiful

Recent Trends in Production/Operations management

1. Global Market Place
2. Production/Operations Strategy
3. Total Quality Management (TQM)
4. Flexibility
5. Time Reduction
6. Technology
7. Worker Involvement
8. Re-engineering
9. Environmental Issues
10. Corporate Downsizing (or Right Sizing)
11. Supply-Chain Management
12. Lean Production

Types of Production system



Job-Shop Production

Job-shop production are characterised by manufacturing one or few quantity of products designed and produced as per the specification of customers within prefixed time and cost. The distinguishing feature of this is low volume and high variety of products.

Batch Production

American Production and Inventory Control Society (APICS) defines Batch Production as a form of manufacturing in which the job pass through the functional departments in lots or batches and each lot may have a different routing.

Mass Production

Manufacture of discrete parts or assemblies using a continuous process are called *Mass Production*. This production system is justified by very large volume of production. The machines are arranged in a line or product layout. Product and process standardisation exists and all outputs follow the same path.

Continuous Production

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

Elements of operation strategy

Operations strategy comprises six components :

1. **Positioning the production system,-** It involves selecting the product design, the production system and the inventory policy for the finished goods for each product line

A). Product Focused- Generally employed in mass production organizations, where there are groups of machine, tools and workers arranged according to their respective tasks in order to put together a product.

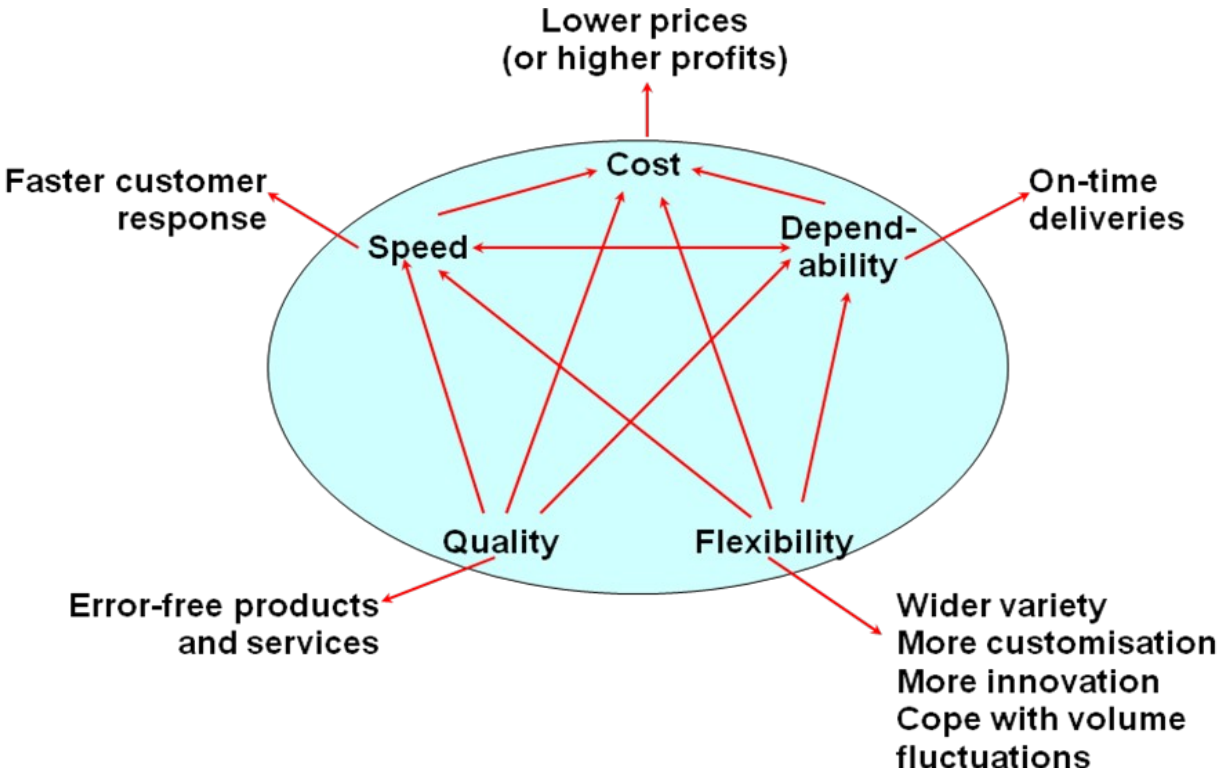
B).**Process Focused-**It is designed to support production departments that perform a single task like painting or packing. These system are highly flexible and can easily be modified to support other product design.

2. **Focus of factories and service facilities,**
3. **Product/Service design and development.**
4. **Technology selection and process development**,- Thorough analysis and planning of the production processes and facilities. Every step in the process of production is planned in detail. The technology to be used in the production process is selected from range of options
5. **Allocation of resources to strategic alternatives-** Production companies have to continuously deal with the problem of scarce resources like capital, machine and materials and so on. As these resource inputs are vital to production activities, their shortages can influence production performance significantly. Hence the operation manger have to plan the optimal use of resources, both in terms of minimizing wastage, and in terms of their allocation to the best strategic use.
6. **Facility planning.**
    - The location of the production facilities is one of the key decisions an operation manager has to make since it is critical to the competitiveness of the organization.

- Setting up production facilities with adequate capacity involves massive initial investment.
- Strategically right options should be carefully weighted against all available alternatives. These decisions also influence the future decisions on probable capacity expansions plans.
- Operation managers also make decisions, i.e. decision on internal arrangement of workers and department within the facility

Operations Competitive Priorities

1. Product and service design
2. Cost
3. Location
4. Quality
5. Quick response
6. Flexibility
7. Inventory management
8. Supply chain management
9. Service



Unit-2

Forecasting Defined : Forecasting is the first step in planning. It is defined as estimating the future demand for products and services and the resources necessary to produce these outputs.

Demand forcasting is needed for:

- New facility Planning
- Production Planning
- Work force scheduling
- Financial planning

Types of Forecasts

- **Technological forecasts:** Concerned with rates of technological progress
- **Economic forecasts:** Statements of expected future business conditions.
- **Demand forecasts:** Projections of demand for a company's products or services throughout some future period.

Objectives of Demand Forecasting

Short range objectives of demand forecasting:

i. Formulation of production strategy and policy
ii. Formulation of pricing policy
iii. Planning and control of sales
iv. Financial planning

Medium or Long-Range Objectives:

i. Long-range planning for production capacity
ii. Labour requirements (Employment levels)
iii. Restructuring the capital structure

Steps in the Forecasting Process

The seven basic steps

i. Determine the purpose (objectives) of the forecast
ii. Select the items for which forecasts are needed
iii. Determine the time horizon for the forecast
iv. Select the forecasting model (method or technique)
v. Gather and analyse the data needed for the forecast
vi. Prepare the forecast
vii. Monitor the forecast

Forecasting Approaches : The two general approaches to forecasting are :

(i) **Qualitative methods** consist mainly of subjective inputs, often of non-numerical description.

- **Jury of executive** opinion method involves taking opinion of a small group of high-level managers and results in a group estimate of demand.
- **Salesforce composite method** is based on estimate of expected sales by sales persons.
- **Market research method or consumer survey method** determines consumer interest in a product or service by means of a consumer survey.
- **Delphi method** is a judgemental method which uses a group process that allows experts to make forecasts.

(ii) **Quantitative methods** involve either projection of historical data or the development of association models which attempt to use *causal variables* to arrive at the forecasts.

1. Time series models use a series of past data to make a forecast for the future. Time series is a time-ordered sequence of observations taken at regular intervals over a period of time.

$Yc = T.\ S.\ C.\ R$ *multiplicative model*

$Yc = T + S + C + R$ *additive model*

where *T* is Trend, *S* is Seasonal, *C* is Cyclical, and *R* is Random components of a series.

Trend is a gradual long-term directional movement in the data (growth or decline).

Seasonal effects are similar variations occurring during corresponding periods, e.g., December retail sales. Seasonal can be quarterly, monthly, weekly, daily, or even hourly indexes.

Cyclical factors are the long-term swings about the trend line. They are often associated with business cycles and may extend out to several years in length.

Random component are sporadic (unpredictable) effects due to chance and unusual occurrences. They are the residual after the trend, cyclical, and seasonal variations are removed.

Trend: Three methods for describing trend are: (1) Moving average, (2) Hand fitting, and (3) Least squares.

1. MOVING AVERAGE

A centered moving average (MA) is obtained by summing and averaging the values from a given number of periods repetitively, each time deleting the oldest value and adding a new value.

$$\text{MA} = \frac{\sum x}{\text{Number of Period}}$$

A weighted moving average (MAw) allows some values to be emphasized by varying the weights assigned to each component of the average. Weights can be either percentages or a real number.

$$\text{MA}wt = \frac{\sum (Wt)X}{\sum Wt}$$

2. HAND FITTING

A hand fit or freehand curve is simply a plot of a representative line that (subjectively) seems to best fit the data points. For linear data, the forecasting equation will be of the form:

$Yc = a + b\ (X)$ (signature)

where *Yc* is the trend value, *a* is the intercept (where line crosses the vertical axis), *b* is the slope (the rise, Δy, divided by the run, Δx), and *X* is the time value (years, quarters, etc.). The "signature" identifies the point in time when $X = 0$, as well as the *X* and *Y* units.

3. LEAST SQUARES

Least squares are a mathematical technique of fitting a trend to data points. The resulting *line of best fit* has the following properties: (1) the summation of all vertical deviations about it is zero, (2) the summation of all vertical deviations squared is a minimum, and (3) the line goes through the means *X* and *Y*. For linear equations, the line of best fit is found by the simultaneous solution for *a* and *b* of the following two *normal equations:*

$\sum Y = na + b\sum X$

$\sum XY = a\sum X + b\sum X^2$

EXPONENTIAL SMOOTHING

Exponential smoothening is a moving-average forecasting technique that weights past data in an Exponential manner so that most recent data carry more weight in the moving average.

With simple Exponential smoothening, the forecast *F*t is made up of the last period forecast *Ft*–1 plus a portion, α, of the difference between the last periods actual demand *At*–1 and last period forecast *Ft*–1.

$Ft = Ft–1 + (At–1 – Ft–1)$.

Adjusted Exponential Smoothing

Adjusted exponential smoothing models have all the features of simple exponential smoothing models,

plus they project into the future (for example, to time period $t + 1$) by adding a trend correction increment, *Tt,* to the current period smoothed average, F*t*

$Ft+1 = FtTt$

The components of a trend-adjusted forecast that utilizes a second smoothing coefficient β. The βvalue determines the extent to which the trend adjustment relies on the latest difference in forecast amounts ($F t - F t-1$) versus the previous trend *Tt–1*

A low βgives more smoothing of the trend and may be useful if the trend is not well-established. A high βwill emphasize the latest trend and be more responsive to recent changes in trend. The initial trend adjustment *Tt*–1 is sometimes assumed to be zero.

REGRESSION AND CORRELATION METHODS

Regression and correlation techniques quantify the statistical association between two or more variables.

(*a*) ***Simple regression*** expresses the relationship between a dependent variable *Y* and a independent variable *X* in terms of the slope and intercept of the line of best fit relating the two variables.

(*b*) ***Simple correlation*** expresses the degree or closeness of the relationship between two variables in terms of a correlation coefficient that provides an indirect measure of the variability of points from the line of best fit. Neither regression nor correlation gives proof of a cause-effect relationship.

Capacity

Amount of output a system is capable of achieving over a specific period of time.

$$\text{Efficiency} = \frac{\text{Actual output}}{\text{Effective capacity}}$$

$$\text{Utilisation} = \frac{\text{Actual output}}{\text{Design capacity}}$$

Capacity planning

Capacity planning is central to the long-term success of an organisation. Capacity plans are made at two levels:

(i) **Long-term capacity plans** which deal with investments in new facilities and equipments covering the requirements for at least two years into the future.

(ii) **Short-term capacity plans** which focus on work-force size, overtime budgets, inventories etc.

Long-Range Capacity Planning

A long term strategic decision that establishes a firm's overall level resources.
Three major capacity decisions are:

i. How much capacity to be installed,
ii. When to increase capacity and
iii. How much to increase.

Types of Capacity

- **Production capacity:** Maximum rate of production or output of an organisation.
- **Design capacity:** The maximum output that can possibly be attained.
- **Effective capacity:** The maximum output given a product mix, scheduling difficulties, machine maintenance, quality factors, absenteeism etc.
- **Maximum capacity:** The maximum output that a facility can achieve under ideal conditions. Also known as peak capacity.

Developing Capacity Alternatives

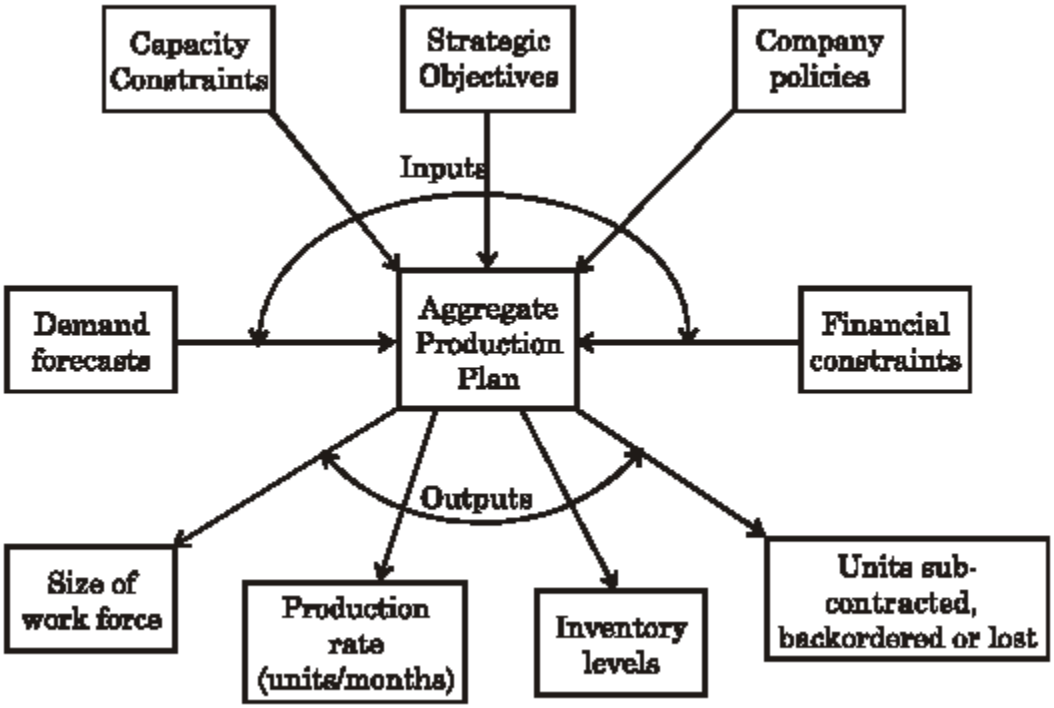
To enhance capacity management, the following approaches to capacity alternatives could be developed:

i. Designing flexibility into the system
ii. Differentiating between new and mature products or services
iii. Taking a "big-picture" approach to capacity changes
iv. Preparing to deal with "chunks" of capacity
v. Attempting to smooth out capacity requirements

Aggregate Planning

- Aggregate planning involves planning the best quality to produce in the intermediate-range horizon (3 months to one year)
- Aggregate production planning is the process of determining output levels of product groups over the next 6 to 18 months period.
- Objectives of Aggregate Planning
  i. The overall objective is to balance conflicting objectives involving customer service, work force stability, cost and profit.
  ii. To establish company-wide strategic plan for allocating resources.
  iii. To develop an economic strategy to meet customer demand.

Inputs to and Outputs from Aggregate Production Planning



Aggregate Planning or Aggregate Capacity Planning

- Need for Aggregate Capacity Planning
    1. It facilitates fully loaded facilities and minimizes overloading and underloading and keeps production costs low.
    2. Adequate production capacity is provided to meet expected aggregate demand.
    3. Orderly and systematic transition of production capacity to meet the peaks and valleys of expected customer demand is facilitated.
- **Steps in Aggregate Capacity Planning**
    1. Determine the demand (*i.e.,* sales forecast) for each product for each time period (*i.e.,* weeks or months or quarters) over the planning horizon (6 to 12 months).
    2. Determine the aggregate demand by summing up the demand for individual products.
    3. Transform the aggregate demand for each time period into workers, materials, machines required to satisfy aggregate demand.
    4. Identify company policies that are pertinent (*e.g.,* policy regarding safety stock maintenance, maintaining stable workforce etc.).
    5. Determine unit costs for regular time, overtime, subcontracting, holding inventories, back orders, layoffs etc.
    6. Develop alternative resource plans for providing necessary production capacity to support the cumulative aggregate demand and compute the cost of each alternative plan.
    7. Select the resource plan from among the alternatives considered that satisfies aggregate demand and best meets the objectives of the firm.

Approaches to Aggregate Planning

1. Top down approach

2. A bottom-up approach or subplan consolidation approach

- Rough-cut Capacity Planning

This is done in conjunction with the tentative master production schedule to test its feasibility in terms of capacity before the master production schedule (MPS) is finalised.

Capacity Planning and Capacity Requirement Planning (CRP)

- Production capacity is defined as the maximum production rate of a facility or a plant.
- Types of Capacity
    1. Fixed capacity
    2. Adjustable capacity
    3. Design capacity
    4. System capacity
    5. Potential capacity
    6. Immediate capacity
    7. Effective capacity
    8. Normal capacity or rated capacity
    9. Actual or utilised capacity

Capacity Planning

- Capacity planning involves activities such as:
    1. Assessing existing capacity
    2. Forecasting future capacity needs
    3. Identifying alternative ways to modify capacity
    4. Evaluating financial, economical and technological capacity alternatives

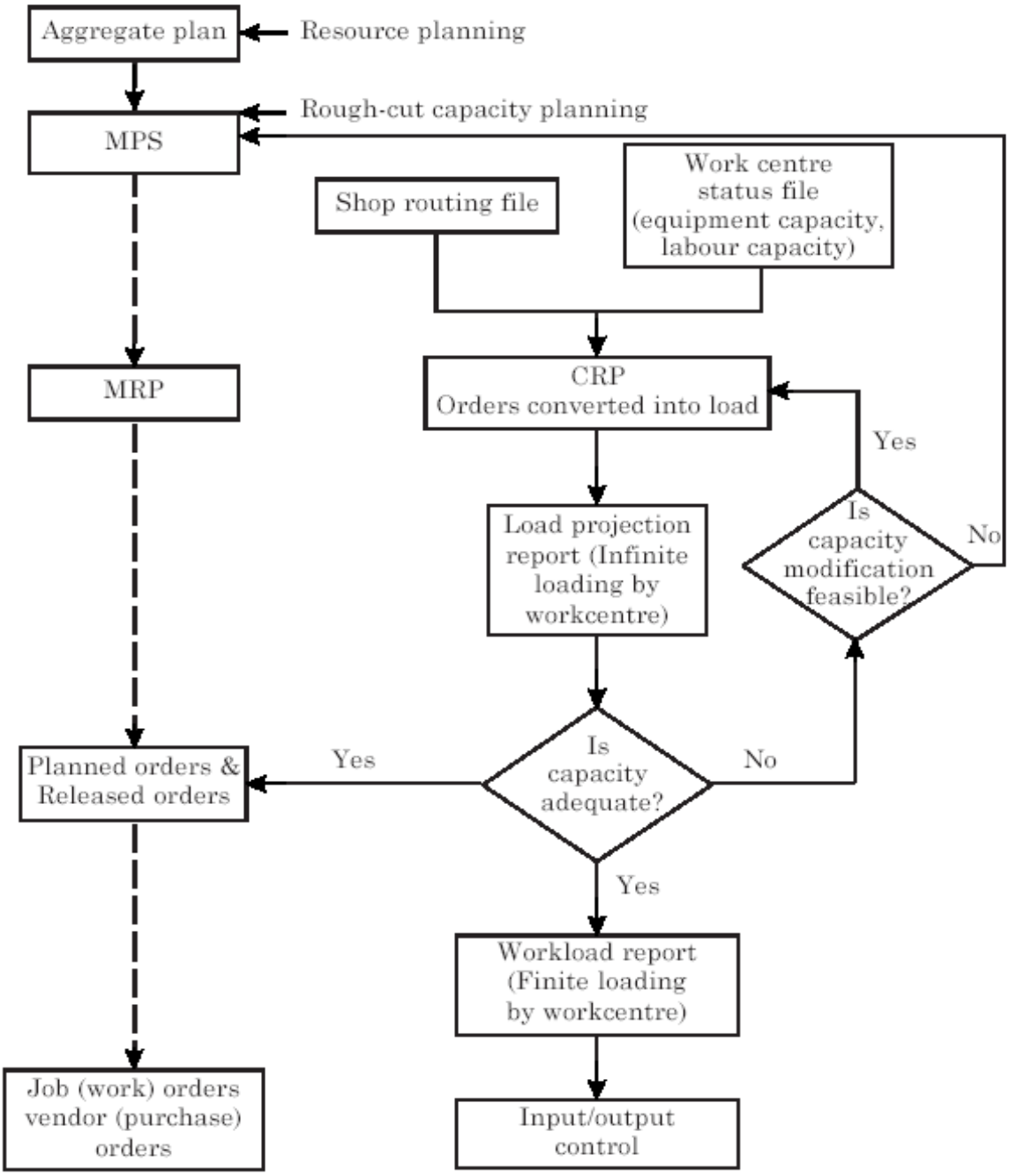
Selecting a capacity alternative most suited to achieve the strategic mission of the firm. Capacity planning involves capacity decisions that must merge consumer demands with human, material and financial resources of the organization

4 Types of Capacity Planning are:

- Long term Capacity Planning
- Short-term Capacity Planing
- Finite Capacity Planning
- Infinite Capacity Planning.

- Two catagories of factors affecting capacity planning are:
    - Controllable Factors
    - Less Controllable Factors.
- Capacity Requirement Planning (CRP): A technique to determine the labour and equipment capacities needed to meet the objectives.

Capacity Requirement Planning (CRP) Process



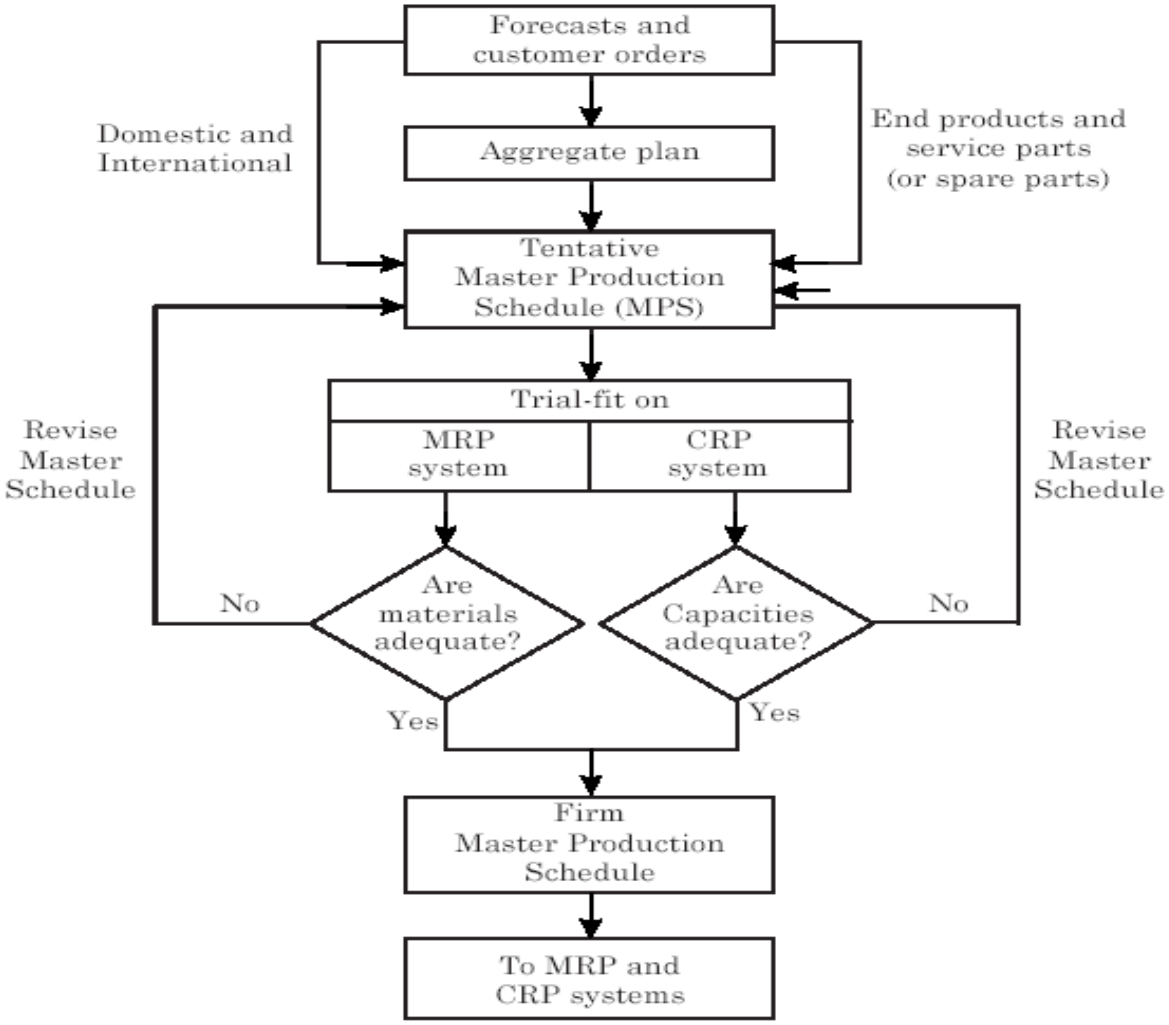
Master Production Scheduling

- Objectives of Master Production Scheduling
    1. To schedule end items to be completed promptly and when promised to customers.
    2. To avoid overloading or underloading the production facility so that production capacity is efficiently utilized and low production costs result.

Functions of MPS:

- Translating aggregate plans
- Evaluating alternative master schedules
- Generating material and capacity requirements
- Facilitating information processing
- Maintaining priorities
- Utilizing the capacity effectively.

Master Production Schedule - Flow Chart



Guidelines for Master Scheduling

1. Work from an aggregate production plan
2. Schedule common modules when possible
3. Load facilities realistically
4. Release orders on a timely basis
5. Monitor inventory levels closely
6. Reschedule as required

MPS in Produce-to-stock and Produce-to-order Firms

- The elements of the MPS that are affected by the type of production system are:
    a. Demand management
    b. Lot-sizing
    c. Number of products to be scheduled (product-mix).

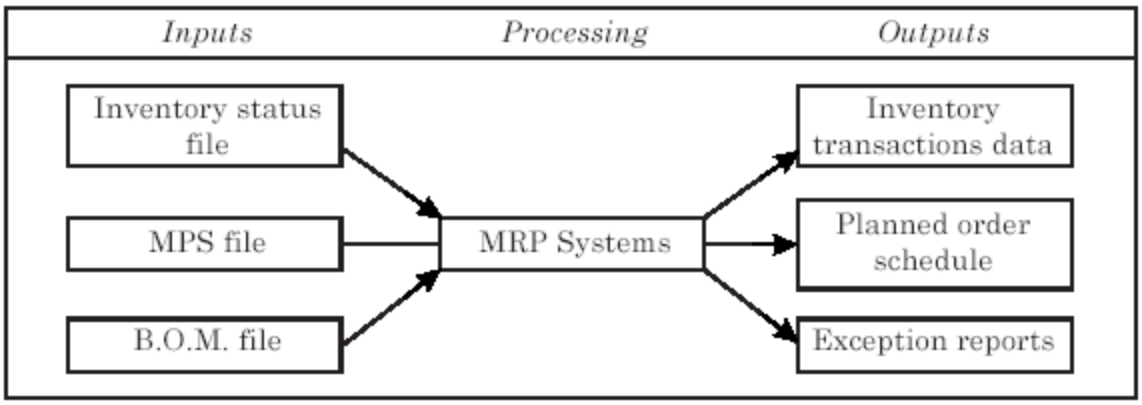
Materials Requirements planning (MRP-1 or mrp): Computer based information system for ordering and scheduling of dependent demand inventories.

Objectives of MRP

1. To improve customer service by meeting delivery schedules promised and shortening delivery lead times.
2. To reduce inventory costs by reducing inventory levels.
3.To improve plant operating efficiency by better use of productive resources.

Three main purposes of a basic MRP system are to:

- Control inventory levels
- Assign operating priorities
- Assign capacity to load production systems.



MRP System Inputs

Master Production Schedule: One of the three primary inputs in MRP, specifies what end products are to be produced, in what quantities and when.

Bill of Materials file: Provides the information regarding all the materials, parts and sub assemblies that go into the end product.

Inventory Status file: Gives complete and up-to-date information on the on-hand inventories, gross requirements, scheduled receipts and planned order releases for the item.

MRP System Outputs

Primary outputs of MRP Systems:

- Planned order schedule
- Changes in planned orders.

Secondary inputs of MRP system:

- Exception reports
- Performance reports
- Planning reports

Manufacturing Resource Planning (MRP II): Broad-based resource co-ordination system involving other areas of a firm in the planning process, such as marketing, finance and the human resource.

- Manufacturing Resource Planning (MRP II) addresses the planning and control of activities related to materials, capacity, finance, engineering, sales and marketing.
- Closed-loop MRP:

A system built around material requirement planning (MRP-I) and also including additional planning functions such as master production scheduling and capacity requirement planning

Enterprise Resource Planning

- **Enterprise Resource Planning (ERP):** A software package developed for optimum use of resources of an enterprise in a planned manner. It integrates the entire enterprise starting form the supplier to the customer, covering, logistics, financial and human resources.

Features of ERP

1. Accommodating variety
2. Integrated Management Information
3. Seamless integration
4. Supply chain management
5. Resource management
6. Integrated data model

Scope of ERP

a. Financials
b. Logistics
c. Human resources
d. Work flow

Application of ERP

ERP is gaining popularity in India at a rapid pace. This is mainly due to the need for reducing costs especially when the sales are sluggish in the sub-merging markets.

Unit-3

Product Design: Concerned with form and function of a product. It refers to the arrangement of elements or parts that collectively form a product.

Process Design: Concerned with the overall sequence of operations required to achieve the design specification of the product.

Production Design: Concept of designing products from the point of view of producibility.

Objectives of Product Design

(i) The overall objective is profit generation in the long run.
(ii) To achieve the desired product quality.
(iii) To reduce the development time and cost to the minimum.
(iv) To reduce the cost of the product.
(v) To ensure producibility or manufacturability (design for manufacturing and assembly).

Factors Influencing Product Design

i. Customer requirements
ii. Convenience of the operator or user
iii. Trade off between function and form

iv. Types of materials used
v. Work methods and equipments
vi. Cost/Price ratio
vii. Product quality
viii. Process capability
ix. Effect on existing products
x. Packaging

Approaches to Product Design

i. Designing for the customer
   - Industrial design
   - Voice of the customer
   - Quality function deployment (QFD)

ii. Designing for Manufacture and Assembly (DFMA)
   - "Over-the-wall approach"
   - Concurrent engineering
   - Design for Manufacturing (DFM) Design for Assembly (DFA)

iii. Designing for ease of production (or for producibility or manufacturability)
   - Specification
   - Standardisation
   - Simplification

iv. Designing for Quality
   a. Designing for robustness (or robust design)
   b. Designing for production
      i. Modular design
      ii. Designing for automation
   c. Designing for reliability

v. Designing for Ergonomics
vi. Designing for environmental protection
vii. Designing for recycling
viii. Designing of disassembly (DFD)
ix. Designing for mass customisation

Delayed differentiation and modular designs are two tactics used to make mass customisation possible.

x. Other issues in product design are (a) Computer aided design (CAD), (b) Value engineering or value analysis which
   - Computer aided design: Use of computer graphics for designing the product helps to generate a number of alternative designs and identify the best alternative which meets the designer's criteria.
   - Value engineering/Value analysis: Concerned with the improvement of design and specifications at various stages of product planning and development.

Legal Aspect of Product Design

(i) The imposition of rules and acts passed by State and Central Govt.
(ii) The standards related to code of practice for design, fabrication and testing of products prepared by standards organization.
(iii) The imposition of punitive damages by the courts in product liability cases.

(iv) The resistance of consumer protection forums to badly designed and manufacturing products.
(v) The resistance of public to damage of their environment.
(vi) The most important law to consider while dealing with the product liability is the Consumer Protection Act of 1986.
(vii) The sales of Goods Act of 1956.

Environmental Issues

Product Pollution

Designer should anticipate environmental trends and design products that are clean enough for future environmental standards.

Process Pollution

Product designer must avoid the process that causing pollution from solvents, combustible products, wastes etc. or he may change the processes at the early stages.

Ease of recycling product

Everyone has a moral obligation about the happens to the product after it's useful life is over? Can it be recycled into new even be able to profit in some manner from recycling of it's product.

Process Planning and Process Design

- After the final design of the product has been approved and released for production, the production planning and control department takes the responsibility of *process planning* and *process design* for converting the product design into a tangible product.

What is a Process?

A process is a sequence of activities that is intended to achieve some result, for example, to create added value for the customers

Process planning: Concerned with planning the conversion processes needed to convert the raw material into finished products.

Process design: Concerned with the overall sequences of operations required to achieve the product specifications

Operations design: Concerned with the design of the individual manufacturing operation.

Process Selection

Process selection refers to the **way** production of goods or services is organised.

Three primary questions to be addressed before deciding on process selection are:

(i) How much variety of products or services will the system need to handle?
(ii) What degree of equipment flexibility will be needed?
(iii) What is the expected volume of output?

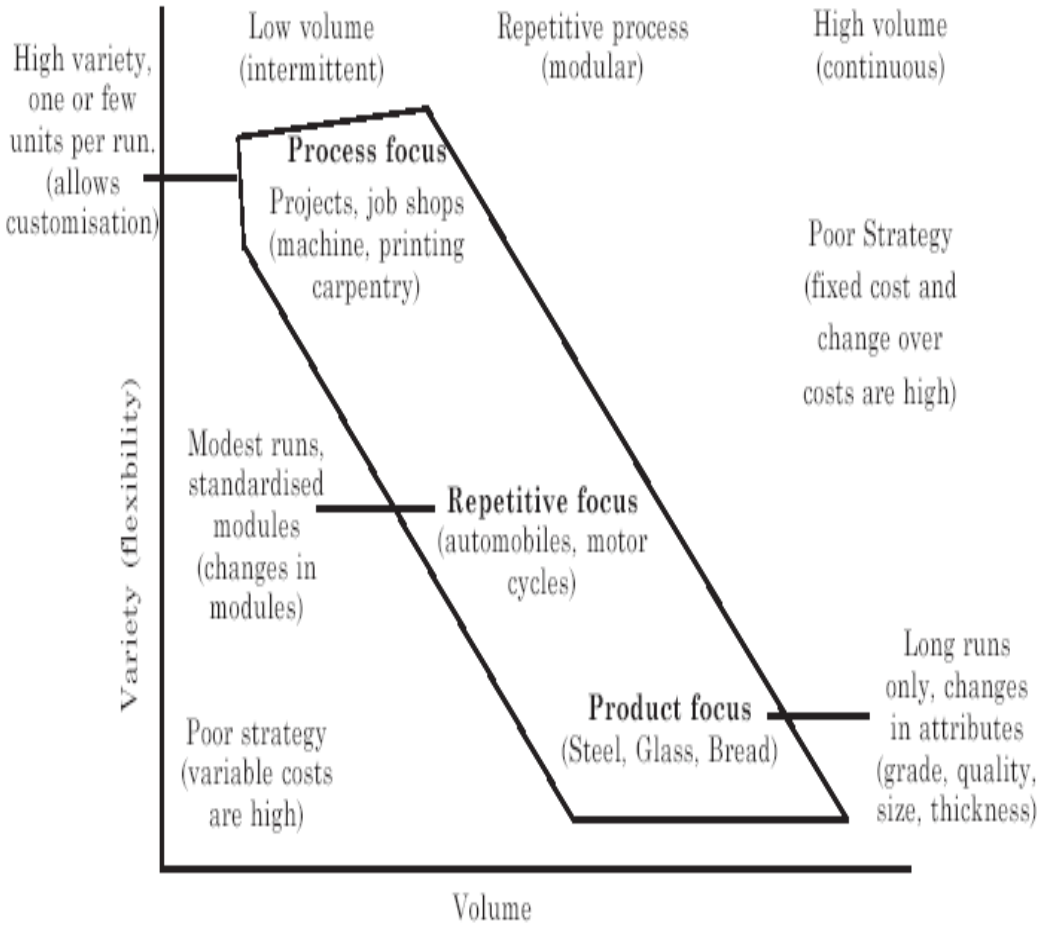
Process Strategy

An organisation's approach to selection of the process for the conversion of resource inputs into outputs.

Key aspects in process strategy include:

i. Make or buy decisions
ii. Capital intensity and
iii. Process flexibility

Process Selected Must Fit with Volume and Variety



SERVICE OPERATIONS

- Planning and Scheduling service systems is different from planning and scheduling manufacturing systems.
- Competitive priorities for service firm:
  - Low service product costs.
  - Fast and on time delivery
  - High quality services
  - Customer service
  - Flexibility.

Three types of service operations are:

- **Quasi manufacturing:** In quasi manufacturing physical goods are more dominant then service associated with the product. Here the stress is on cost of production, technology, products, product quality and prompt delivery. It may be either a standardized or customized product.
- **Customer-as-participants:** Here there is a high involvement of customer the physical goods may not be that must sufficient. Services can be either customized or standardized.
- **Customer- as-product:** Here the service is performed on customer. Service here is customized physical goods may or may not significant.

Scheduling Quasi-Manufacturing Operations

Two types of quasi-manufacturing operations are:

- Product-focussed operations
- Process focussed operations.

- Personnel Scheduling in Services

Three difficulties faced in scheduled personnel in services are:

- Demand variability
- Service time variability
- Availability of person when they are needed.

Scheduling "Customer-As-Participant" Service Operations

- "Customer-as-participant" service operations:
- Customer actually participates in service operations for eg. retailing, tourism etc.
- Has huge invovement of customer in service operations.

Scheduling "Customer-As-Product" Service Operations

- "Customer-as-product" service operations:
- Service is actually performed on the customer. for example, hair dressing,, medical treatment, surgery etc.
- Scheduling Multiple Resources

Two major characteristics of service operations are:

- Services are produced and delivered by people
- The pattern of demand for services is not uniform

- Scheduling of service system involve scheduling
  - Customers
  - Work force
  - Equipment

Scheduling Strategies for Services

- Two common strategies for scheduling services are:
  - Schedule for peak demand
  - Chase Demand. Other Possible Strategies
- Other possible strategies for services are:
  - Reservation strategy
  - Customer participation
  - Adjustable capacity
  - Cross-Training
  - Sharing capacity.

Scheduling Multiple Resources

In some service organization it is necessary to coordinate the uses of more than one resource. The complexity of scheduling the resources increases with multiple resources used by the service systems.

Cyclical Schedule or Rotating Schedule

Cyclical or rotating schedule rotates employees through a series of workdays or working hours.

Work Study-Method Study and Work Measurement

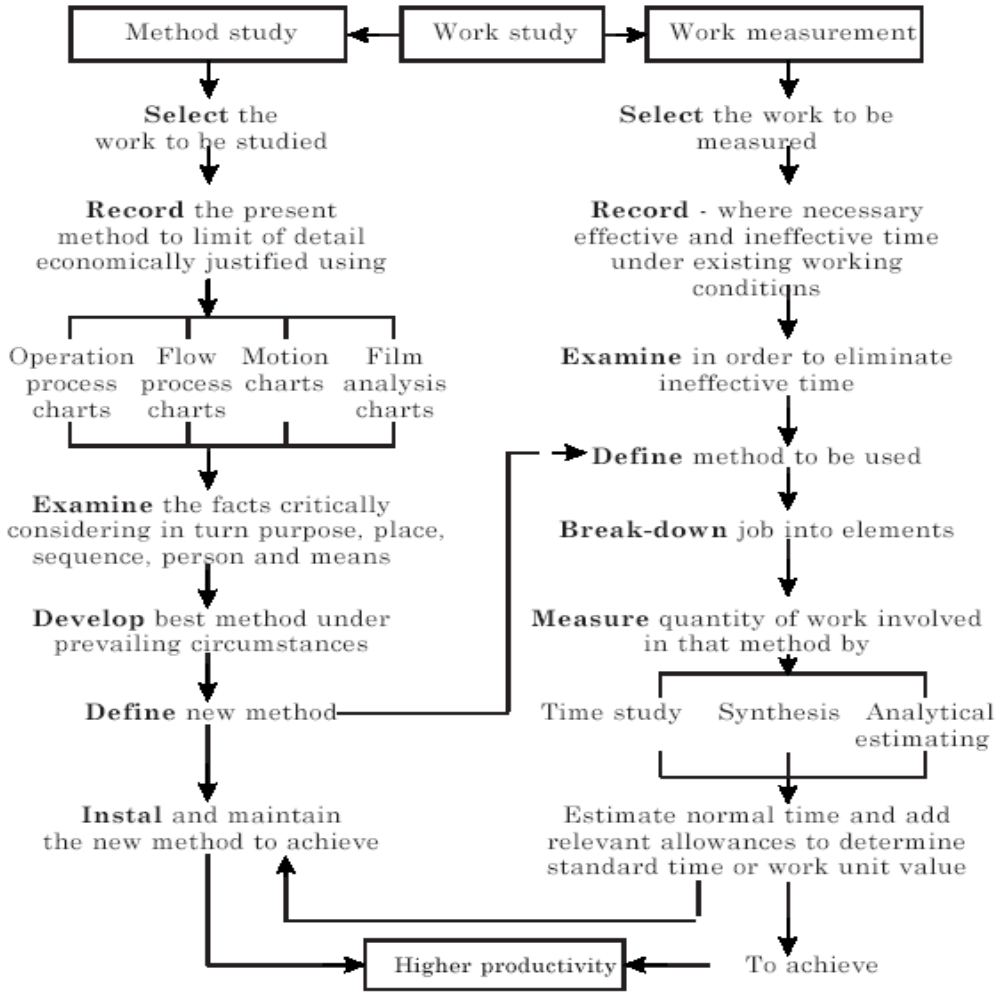
- Methods engineering includes work simplification, job design, value analysis and the like.
- Work study method was developed to improve performance of a given work.

- Work study is the body of knowledge concerned with analysis of the work methods, and the standard of proposed work methods.
- Objective of work study is to improve operational efficiency.
- The purpose of work study is to determine the best or most effective method of accomplishing a necessary operation.

Relationship of Time and Motion Study to Work Study

- Time study and motion study are results of practices developed by F.W. Taylor, Frank and Lillian Gilbreth.
- Time study: Exercising control over the output in respect of a job by setting standards for performance.
- Time study may be used to compare the effectiveness of alternative work methods.

Steps Involved in Work Study



Method Study or Methods Analysis

- Method study is also known as methods improvement.
- Prime objectives of method study are to eliminate wasteful and inefficient motions.

Steps in method study

1. **Select**- select the work to be studied.
2. **Record**-record all the relevant facts of the present method of direct observation.
3. **Examine**-examine the facts critically in sequence, using special critical examination sheet.
4. **Develop**-develop the best method (i.e) the most practical, economic and effective method, under prevailing circumstances.
5. **Install**-install that method as standard practice
6. **Maintain**- maintain the standard practice by regular routine check.

Motion Study

Motion study is the science of eliminating wastefulness resulting from using unnecessary; ill-directed and inefficient motion. The aim of motion study is to find and perpetuate the scheme of least waste methods of labour.

Micro motion study provides a valuable technique for making minute analysis of those operations that are short in cycle, contain rapid movements and involve high production over a long period of time.

Micro-motions are also known as 'Therbligs'.

Examples of Therbligs

1. Search (Sr)
2. Select (St)
3. Grasp (G)
4. Transport empty (TE)
5. Transport loaded (TL)
6. Hold (H)
7. Release load (RL)
8. Position (P)
9. Pre-position (PP)
10. Inspect (I)
11. Assemble (A)
12. Disassemble (DA)
13. Use (U)
14. Unavoidable delay (UD)
15. Avoidable delay (AD)
16. Plan (Pn)
17. Rest for overcoming fatigue (R)
18. Find (F)

Principles of Motion Economy

Principles of motion economy are divided into three groups.

a. Effective use of the operator
b. Arrangement of the workplace
c. Tools and equipment

Qualified Worker

"A qualified worker is one who is accepted as having the necessary physical attributes, possessing the required intelligence and education and having acquired the necessary skill and knowledge to carry out the work in hand to satisfactory standards of safety, quantity and quality"

Techniques of Work Measurement

The main techniques used to measure work are:

- Direct Time Study.
- Synthesis Method.
- Analytical Estimating.
- Pre determined Motion Time System (PMTS).
- Work sampling or Activity Sampling or Ratio Delay Method.

Steps in Work Measurement

Work measurement involves seven steps.

1. Break the job into elements
2. Record the observed time for each element by means of either time study, synthesis or analytical estimating.

3. Establish elemental time values by extending observed time into normal time for each element by applying a rating factor.
4. Assess relaxation allowance for personal needs and physical and mental fatigue involved in carrying out each element.
5. Add the relaxation allowance time to the normal time for each element to arrive at the work content.
6. Determine the frequency of occurrences of each element in the job, multiply the work content of each element by its frequency (*i.e.,* number of time the element occurs in the job) and add up the times to arrive at the work content for the job.
7. Add contingency allowance if any to arrive at the standard time to do the job.

Productivity and Employees

- Production refers to the total output.
- Productivity: The amount of goods and services produced with resources used.
- Partial productivity: Output in a given period divided by labors hours used in the period.

$$\text{Total productivity} = \frac{\text{Output in a given period}}{\text{Labour + Capital + Materials + Energy used in the same period}}$$

Unit-4

Why Materials Management?

- Materials is one of the five M's(Men, Material, Money, Machine and Methods) of an industrial organization.
- Materials offer considerable scope for improving profit.
- Materials form an important form of current assets in any organization.
- Value addition is the margin between the raw material value and finished goods value.
- Suppliers and materials management account for more than 50 percent of total value.
- Quality of the finished product depends on quality of materials used.
- Conservation of materials and their availability for posterity is one of the planks of social responsibility of business.
- Exploring new sources of supply is a challenge for material management executives.

Materials Management

- Material management involves organizing and coordinating all management functions that are responsible for every aspect of materials, storage, and transformation.
- Buying, storage, and movement of material are the three basic objectives of materials management.
- Optimum investment in inventory is the prime objective of materials management**.**
- Development of personnel is very important for long-term growth of a firm.
- Engineering groups are primarily responsible for standards of specifications.

Importance of Materials Management

1. Lower prices for materials and equipment
2. Faster inventory turnover
3. Continuity of supply
4. Reduced lead time
5. Reduced transportation costs
6. Less duplication of efforts
7. Elimination of buck-passing
8. Reduced materials obsolescence
9. Improved supplier relationships and better records, and information
10. Better interdepartmental cooperation
11. Personnel development

Functions of Materials Management

1. Materials planning and programming
2. Raw material purchase
3. Receiving, store keeping, and warehousing
4. Issuing of material
5. Inventory control
6. Value engineering
7. Transportation of materials
8. Vendor development
9. Vendor rating
10. Disposal of scrap and surpluses

Objectives

Primary Objectives

1. Buying the best item at the lowest cost
2. Reduction in inventory cost and High inventory turnover
3. Maintaining the flow of production
4. Maintaining the consistency of quality
5. Optimization of acquisition and possession, resulting in lower cost
6. Cordial relationship with suppliers
7. Maintaining good records
8. Contribution towards competitiveness
9. Personnel development

Secondary Objectives

1. Promotion of standardization with suppliers
2. Development of reciprocal relations with customers
3. Committees to decide on economic make –or- buy decisions
4. Development of inter departmental relationships

Materials Management Information System (MMIS)

1. MMIS provides on-line information on stock level, work-in- process; finished goods, and stores and spares.
2. It provides information at right time, it also request the supplier to supply the material on time.
3. It also helps in accessing information rapidly, detects errors and assures prompt decision making.
4. It also takes decisions regarding when to buy or when to make parts and the like.

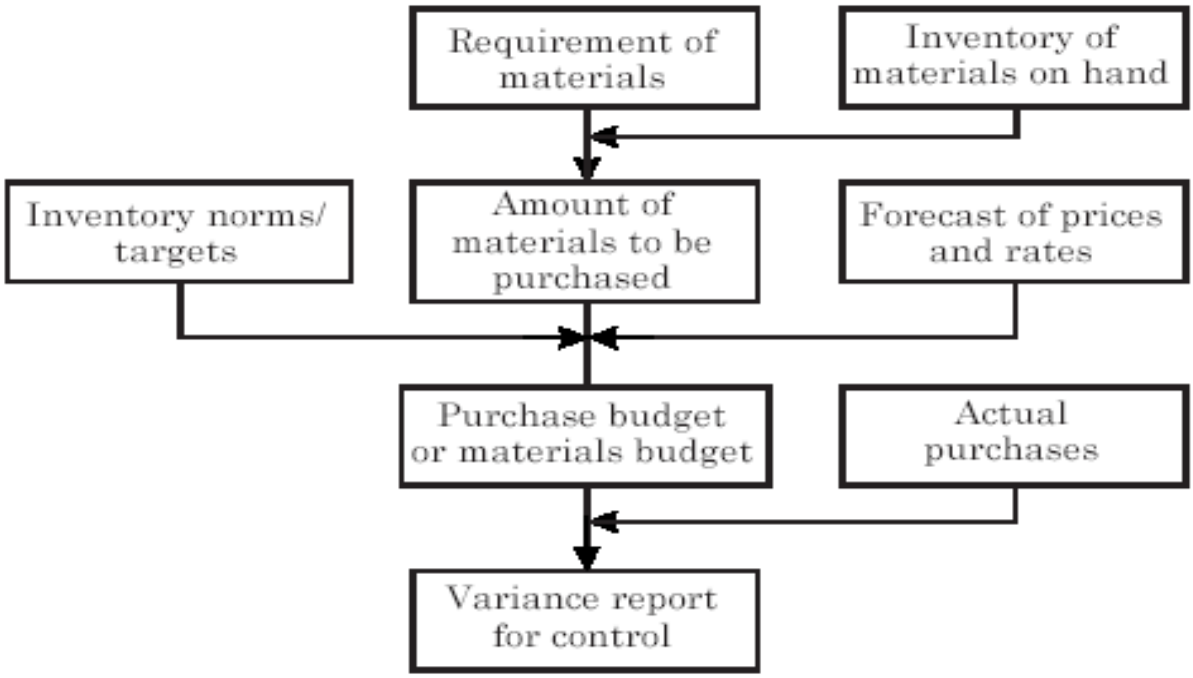
MATERIAL PLANNING AND CONTROL

Material planning is a scientific technique of determining in advance the requirements of raw materials, ancillary parts and components, spares etc. as directed by the production programme. It is a subsystem in the overall planning activity. There are many factors, which influence the activity of material planning. These factors can be classified as macro and micro systems.

1. *Macro factors*: Some of the micro factors which affect material planning, are price trends, business cycles Govt. import policy etc.
2. *Micro factors*: Some of the micro factors that affect material planning are plant capacity utilization, rejection rates, lead times, inventory levels, working capital, delegation of powers and communication.

Materials Budgeting

The Process of Preparing Material Budgets



Materials Budgeting: Process of preparing materials budget or purchase budget in terms of quantity and money value of materials to be procured for a given period of time.

Material Budgeting is an estimate of expenses to be incurred in the procurement of material and its helps in effective execution and control of material plans.

Material Control

Function of maintaining constantly availability of all kinds of materials required for the manufacture of products.

Purchasing

The term 'purchasing' refer to buying of a material or an item from a company or division that supplies materials. Since a manufacturing firm is involved in the conversion of raw material into finished goods, it should ensure that right type of material are purchased in the right time. A one percent saving in cost is equivalent to 10 percent increase in turnover.

Objectives of Purchasing

The basic objective of the purchasing function is to ensure continuity of supply of raw materials, sub-contracted items and spare parts and to reduce the ultimate cost of the finished goods. In

other words, the objective is not only to procure the raw materials at the lowest price but to reduce the cost of the final product.

The objectives of the purchasing department can be outlined as under:

 To avail the materials, suppliers and equipments at the minimum possible costs: These are the inputs in the manufacturing operations. The minimization of the input cost increases the productivity and resultantly the profitability of the operations.

 To ensure the continuous flow of production through continuous supply of raw materials, components, tools etc. with repair and maintenance service.

 To increase the asset turnover: The investment in the inventories should be kept minimum in relation to the volume of sales. This will increase the turnover of the assets and thus the profitability of the company.

 To develop an alternative source of supply: Exploration of alternative sources of supply of materials increases the bargaining ability of the buyer, minimisation of cost of materials and increases the ability to meet the emergencies.

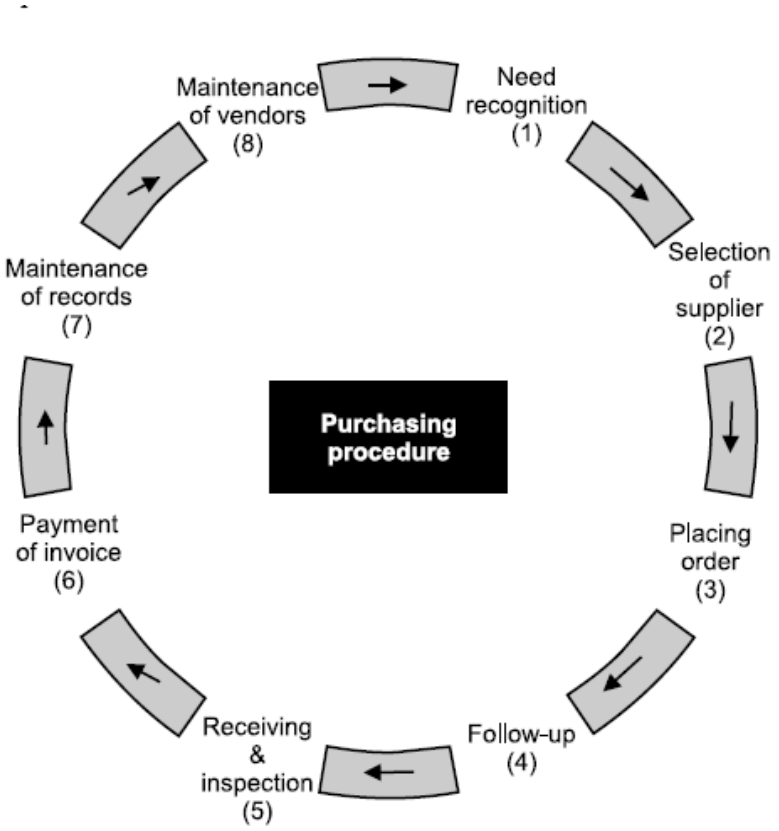
 To establish and maintain the good relations with the suppliers: Maintenance of good relations with the supplier helps in evolving a favourable image in the business circles. Such relations are beneficial to the buyer in terms of changing the reasonable price, preferential allocation of material in case of material shortages, etc.

To achieve maximum integration with other department of the company: The purchase function is related with **production department** for specifications and flow of material, **engineering department** for the purchase of tools, equipments and machines, **marketing department** for the forecasts of sales and its impact on procurement of materials, **financial department** for the purpose of maintaining levels of materials and estimating the working capital required, **personnel department** for the purpose of manning and developing the personnel of purchase department and maintaining good vendor relationship.

 To train and develop the personnel: Purchasing department is manned with varied types of personnel. The company should try to build the imaginative employee force through training and development.

 Efficient record keeping and management reporting: Paper processing is inherent in the purchase function. Such paper processing should be standardised so that record keeping can be facilitated. Periodic reporting to the management about the purchase activities justifies the independent existence of the department.

Purchase Cycle



Purchasing cycle comprising of eight steps.

1. Recognition of Need : Identifying an item that is officially brought to the attention of purchasing department.
2. Description of Requirement: Purchase requisition should give accurate information for ordering recognised product.
3. Selection of Source: Registered suppliers who are approved by the company. Buying from single supplier helps develop long-term relationship and reduces the risk and interruption in the supply. Buying from multiple suppliers may not help in maintaining quality and helps get material at competitive prices.
4. Determination of Price and Availability
5. Placing the Order
6. Order Acknowledgement
7. Follow Up and Expediting
8. Checking The Invoice and Approval

Purchase Functions

1. Obtaining prices
2. Selecting vendors
3. Awarding purchase orders
4. Follow up on delivery promise
5. Adjusting and settling complaints
6. Selecting and training of purchase personnel
7. Vendor relations

Purchasing Policies

- **Ancillary Development:** The firms sub-contracts, i.e., decides to buy the parts from outside suppliers. Mostly the fabricated parts, components are brought from outside suppliers by the firms.
- **Make or buy:** Another purchasing policy is whether to buy the parts or components from outside supplier or manufacture within the firm. The decisions lie depending in various factors.
- **Speculative buying:** Speculative buying is conducted with the hope of making profit out of price changes. Here the profit is made by buying at low price and selling at higher price.

Vendor rating: The evaluation of supplier or vendor rating provides valuable information which help in improving the quality of the decision. In the vendor rating three basic aspects are considered namely quality, service and price

The Development Project Committee of the National Association of Purchasing Agents (U.S.A.) has suggested following methods for evaluating the performance of past suppliers.

1. The categorical plan: Under this method the members of the buying staff related with the supplier like receiving section, quality control department, manufacturing department etc., are required to assess the performance of each supplier. The rating sheets are provided with the record of the supplier, their product and the list of factors for the evaluation purposes. The members of the buying staff are required to assign the plus or minus notations against each factor.

2. The weighted-point method: The weighted-point method provides the quantitative data for each factor of evaluation. The weights are assigned to each factor of evaluation according to the need of the organization, *e.g*., a company decides the three factors to be considered—quality, price and timely delivery. It assigns the relative weight to each of these factors as under:

Quality …… 50 points
Price …… 30 points
Timely delivery …… 20 points

3. Critical incidents method: Record of events related to buyer vendor relationships is maintained in each vendor's file. They reflect positive and negative aspect of actual performance. This kind of documentation useful in discussing ways and means of improving performance, acknowledging the existence of good relationships, determining the competence of a vendor, and if necessary considering termination

4. The cost-ratio plan: Under this method, the vendor rating is done on the basis of various costs incurred for procuring the materials from various suppliers. The cost-ratios are ascertained delivery etc. The cost-ratios are ascertained for the different rating variables such as quality, price, timely delivery etc. The cost-ratio is calculated in percentage on the basis of total individual cost and total value of purchases.

5. Checklist system: A simple checklist is used to evaluate the vendors. Check list may be something like Reliability, technical capability, after sales service, availability, buying convenience etc

VALUE ANALYSIS

Value engineering or value analysis had its birth during the World War II Lawrence D. Miles was responsible for developing the technique and naming it. Value analysis is defined as "an

organized creative approach which has its objective, the efficient identification of unnecessary cost-cost which provides neither quality nor use nor life nor appearance nor customer features." Value analysis focuses engineering, manufacturing and purchasing attention to one objective-equivalent performance at a lower cost.

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

Steps in Value Analysis

In order to answer the above questions, three **basic steps** are necessary:

1. **Identifying the function:** Any useful product has some primary function which must be identified—a bulb to give light, a refrigerator to preserve food, etc. In addition it may have secondary functions such as withstanding shock, etc. These two must be identified.
2. **Evaluation of the function by comparison:** Value being a relative term, the comparison approach must be used to evaluate functions. The basic question is, 'Does the function accomplish reliability at the best cost' and can be answered only comparison.
3. **Develop alternatives:** Realistic situations must be faced, objections should overcome and effective engineering manufacturing and other alternatives must be developed.

STORES MANAGEMENT

Stores play a vital role in the operations of company. It is in direct touch with the user departments in its day-to-day activities. The most important purpose served by the stores is to provide uninterrupted service to the manufacturing divisions. Further, stores are often equated directly with money, as money is locked up in the stores.

Nature of Stores

- Store as building where inventories are kept.
- Storage is the function of receiving, storing, and issuing materials.
- Stores ensure ready accessibility of major materials there-by efficient service to users.
- Minimisation of stores cost, and continuous supply is the prime function of stores.
- Stores layout is a fundamental factor in determining the efficient performance of stores department.
- A satisfactory storage system compromises between the use of space and the use of time.
- Random location means that items can be stored in any storage position which is available.
- Keeping stock on one side of the aisle in which case the layout is called comb type .
- Stores manual is a written statement of policies, and procedures.

Codification

It is one of the functions of stores management. Codification is a process of representing each item by a number, the digit of which indicates the group, the sub-group, the type and the dimension of the item.

OBJECTIVES OF CODIFICATION

The objectives of a rationalized material coding system are:

1. Bringing all items together.
2. To enable putting up of any future item in its proper place.
3. To classify an item according to its characteristics.

4. To give an unique code number to each item to avoid duplication and ambiguity.
5. To reveal excessive variety and promote standardization and variety reduction.
6. To establish a common language for the identification of an item.
7. To fix essential parameters for specifying an item.
8. To specify item as per national and international standards.
9. To enable data processing and analysis.

Inventory

A physical resource that a firm holds in stock with the intent of selling it or transforming it into a more valuable state.

- Raw Materials
- Works-in-Process
- Finished Goods
- Maintenance, Repair and Operating (MRO)

Objectives of Inventory Control

1. To ensure adequate supply of products to customer and avoid shortages as far as possible.
2. To make sure that the financial investment in inventories is minimum (*i.e.,* to see that the working capital is blocked to the minimum possible extent).
3. Efficient purchasing, storing, consumption and accounting for materials is an important objective.
4. To maintain timely record of inventories of all the items and to maintain the stock within the desired limits
5. To ensure timely action for replenishment.
6. To provide a reserve stock for variations in lead times of delivery of materials.
7. To provide a scientific base for both short-term and long-term planning of materials.

Inventory Costs

Inventory costs includes ordering cost plus carrying costs.

1. Ordering Costs
2. Carrying Costs

• Capital Costs

Capital cost is the loss of interest on money invested in inventory building and inventory control equipment.

Storage Space Costs

• Inventory Service Costs
• Handling-equipment Costs
• Inventory Risk Costs

3. Out-of-stock Costs
4. Capacity Costs

Inventory Control Techniques

1. **Always better control (ABC) classification.** In this analysis, the classification of existing inventory is based on annual consumption and the annual value of the items. Hence we obtain the quantity of inventory item consumed during the year and multiply it by unit cost to obtain annual usage cost. The items are then arranged in the descending order of such annual usage cost.

(*a*) ***A-Item:*** Very tight control, the items being of high value. The control need be exercised at higher level of authority.
(*b*) ***B-Item:*** Moderate control, the items being of moderate value. The control need be exercised at middle level of authority.
(*c*) ***C-Item:*** The items being of low value, the control can be exercised at gross root level of authority, *i.e*., by respective user department managers.

2.High, medium and low (HML) classification. In this analysis, the classification of existing inventory is based on unit price of the items. They are classified as high price, medium price and low cost items.

3.Vital, essential and desirable (VED) classification. In this analysis, the classification of existing inventory is based on criticality of the items. They are classified as vital, essential and desirable items. It is mainly used in spare parts inventory.

4.Scarce, difficult and easy to obtain (SDE). In this analysis, the classification of existing inventory is based on the items.

5.GOLF analysis: In this analysis, the classification of existing inventory is based sources of the items. They are classified as Government supply, ordinarily available, local availability and foreign source of supply items.

6.SOS analysis: In this analysis, the classification of existing inventory is based nature of supply of items. They are classified as seasonal and off-seasonal items.

7.Fast moving, slow moving and non-moving (FSN).

8.Economic order quantity (EOQ). Inventory models deal with idle resources like men, machines, money and materials. These models are concerned with two decisions: how much to order (purchase or produce) and when to order so as to minimize the total cost.

9.Max-Minimum system.

10.Two bin system

What is a "Just-in-time System"?

"Just-in-time": A philosophy of manufacturing based on planned elimination of all waste and continuous improvement of productivity.

Overview of JIT manufacturing

1. Inventory reduction
2. Quality improvement
3. Lead time reduction
4. Lead time reduction
5. Continuous Improvement
6. Total Preventive Maintenance
7. Strategic Gain