PHYSICAL INVENTORY AND WAREHOUSE MAINTENANCE

- In a factory, "Stores" perform the same functions as warehouses and contain raw materials, work in process inventory, finished goods, supplies and possibly repair parts.
- Efficient warehouse operations do the following
    - Provide timely service
    - Keep track of items, so they can be found readily and correctly
    - Minimize the total physical effort and thus the cost of moving goods into and out of storage
    - Provide communication links with customers

Cost of Operating a workhouse can be broken down into

a. Capital Costs – Space and Material Handling equipment
b. Operating Costs – Labour

Warehouse Activities

The various warehouse activities include

a. Receive goods
b. Identify the goods
c. Dispatch goods to storage
d. Hold goods
e. Pick goods
f. Marshall the shipment
g. Dispatch the shipment
h. Operate an information System

- To maximize productivity and minimize cost, warehouse management must work with the following
    - Maximum use of space
    - Effective use of labor and equipment

Labor cost can be reduced by using more materials handling equipment. Warehouse management will need to

a. Select the best mix of labor and equipment to maximize the overall productivity of the operation
b. Provide ready access to all skus.
c. Move goods efficiently.

- Several factors influence the effective use of warehouses
    - Cube utilization and accessibility
    - Stock Location
    - Order picking and assembly
    - Packaging

Accessibility means: being able to get at the goods wanted with a minimum amount of work.

Cube Utilization % = (Actual Stored / Total Capacity) * 100

Stock location

Some basic systems of locating stock

a. Group functionally related items together
b. Group fast moving items together
c. Group physically similar items together
d. Locate working stock and reserve stock separately

- There are two basic systems for assigning specific locations to individual stock items
  a. Fixed Location
  b. Floating Location

Fixed Location

Often used at locations where space is not a premium, where throughput is small and where there are few skus.

DisAd: Poor cube utilization. On an average, only 50% of cube space is utilized.

Floating location

This is more often used in places where cube utilization is necessary.

Point of Use Storage

Inventory stored close to where it will be used is termed as Point of Use Storage

Adv:

a. Materials are readily accessible to users
b. Material handling is reduced or eliminated
c. Central Storage costs are reduced
d. Material is accessible at all times

This method is excellent as long as inventory is kept low and operating personnel can keep control of inventory records.

Central Storage

This is more specific to

a. Ease of Control
b. Inventory record accuracy is easier to maintain
c. Specialized storage can be used
d. Reduced safety stock, since users do not need to carry their own safety stock

Order packing and Assembly

There are several systems that can be used to organize the work among which is the following

a. Area Systems – Used in small warehouses where goods are stored in fixed locations
b. Zone Systems – Used for storing related parts together
c. Multi – Order System
   - Same as zone system except that rather than handling individual orders, a number of orders are gathered together and all items divided by zero.
   - Most suited in which there are many items or many small orders with few items.

Working Stock and Reserve Stock

Physical Control and Security

What is needed is a system that makes it difficult for people to make mistakes or be dishonest. There are several elements that help avoiding this

a. A good part numbering system
b. A simple well documented transaction system

4 steps in any transaction

a. Identify the system
b. Verify the quantity
c. Record the transaction
d. Physically execute the transaction

Inventory record Accuracy

3 pieces of information that must be accurate are

a. Part Description
b. Quantity
c. Location

Accurate inventory records enable firms to

a. Operate an effective materials management system
b. Maintain satisfactory customer service
c. Operate effectively and efficiently
d. Analyze inventory

Inaccurate inventory records will result in

a. Lost Sales
b. Shortages and disrupted schedules
c. Excess Inventory
d. Low productivity
e. Poor delivery performance
f. Excessive expediting

Causes of inventory record error

a. Unauthorized withdrawal of material
b. Unsecured stockroom
c. Poorly trained professionals
d. Inaccurate transaction recording
e. Poor transaction recording system
f. Lack of audit capability

Measuring inventory record accuracy

- Tolerance is to judge inventory accuracy, a tolerance level for each part and must be specified.
- Tolerance is the amount of permissible variation between an inventory record and the physical record

Auditing Inventory Records

2 Methods of checking the accuracy of inventory records are

a. Periodic – Counts of all items
b. Cyclic – Counts of Specified items

It is more important to audit the system to find the causes of record inaccuracy and eliminate them. **Cyclic counting** does this.

Periodic Annual Inventory

Primary Purpose of periodic Inventory is

- To satisfy the financial auditors that the inventory records represent the value of the inventory
- The planners, the physical inventory represents an opportunity to correct any inaccuracies in the records
- There are 3 factors in a good preparation
    - House keeping
    - Identification
    - Training

Process

Taking a physical inventory consists of 4 steps

a. Count items and record the count on a ticket left on the item
b. Verify this count by recording or sampling
c. When the verification is finished, collect the tickets and list the items in each department
d. Reconcile the inventory records for differences between the physical count and inventory dollars.

- Physical inventory is taken and for this the factory has to be shutdown and hence the job is done in a hurry and poorly.
- As a result more errors often are introduced into the records that are eliminated
- Because of this, the idea of Cycle Counting was developed.

Cycle Counting

- Cycle counting is a system of counting inventory continually through out the year. Physical inventory counts are scheduled so that each item is counted on a pre-determined schedule
- Advantages of Cycle Counting are
    - Timely detection and correction of problems. Purpose of count is to first find cause of error and then to correct it.
    - Complete or partial reduction of production
    - Use of personnel trained and dedicated to cycle counting

Count Frequency

- Number of times an item is counted in a year is called the Count Frequency.
- For an item, the CF should increase as the value of the item and number of transactions increase.

3 Common methods to determine count frequency

a. ABC Method
b. Zone Method
c. Location Audit Method

Zone Method

- is used when fixed location system is used or when work in process or transit inventory is being counted
- Ideal for fast moving items

When a count should be done

a. When an order is placed
b. When an order is received
c. When the inventory record reaches Zero
d. When a specified number of transactions have occurred
e. When an error occurs

PHYSICAL DISTRIBUTION

Physical Supply is the movement and storage of goods from suppliers to manufacturing.

Physical Distribution is the movement of finished goods from the end of production to the customer.

Channels of Distribution

- A channel of distribution is one or more companies or individuals who participate in the flow of goods and services from the producer to the final user or consumer
- 2 related channels are involved
    - Transaction Channel – concerned with transfer of ownership. The functions include negotiation, selling and contracting.
    - Distribution Channel
        - Concerned with transfer of delivery of goods or services
        - May perform both functions as for transaction channel but not necessarily

The specific way in which materials move depends on many factors as

a. The channels of distribution that the firm is using
b. The types of markets served
c. The characteristics of the product
d. The type of transportation available to move the material

Physical Distribution System

Objective of Distribution Management is to design and operate a distribution system that attains the required level of customer service and does so at least cost.

Activities in a physical distribution system

a. Transportation
b. Distribution Inventory
c. Warehouses
d. Materials Handling
e. Protective Packaging
f. Order Processing and Communication

These are the 6 inter-related activities that affect the customer service and the cost of providing it.

- **Physical Distribution provides a bridge between marketing and production**.

Marketing

"Marketing Mix" is made up of product, promotion, price and place and the latter is created by physical Distribution

- Marketing is responsible for transferring ownership, accomplished by methods of personal selling, advertising, sales, promotion, merchandising and pricing
- Physical Distribution is responsible for giving the customer possession of goods and does so by operating distribution centers
- Physical Distribution has the responsibility of meeting the customer service levels established by marketing and senior management of the firm.

Transportation

Carriers of transportation can be divided into 5 basic models

Rail
Road, including trucks, buses and automobiles
Air
Water
Pipeline

There are two types of costs involved in transportation

a. Fixed Costs – Cost of a Truck
b. Variable Costs – Fuel, maintenance, driver's wages

Terminals

Some of the functions performed by terminals are

a. Weighing
b. Connection with other routes and carriers
c. Vehicle Routing, Dispatching, Maintenance, Administration and Paper work

Legal Types of Carriage

a. Public
b. Private

Economic Regulation has centered on 3 areas

a. Regulation of rates
b. Control of routes and service levers
c. Control of market entry and exit.

a. FOR HIRE carriers

   Common Carriers provide the following

   a. Service available to the public
   b. Service to the designated points or in designated areas
   c. Scheduled service
   d. Service of a given class of movement or commodity

b. Contract Carriers carry only for those they have contract with. They do not serve the general public

Transportation cost elements

4 basic cost elements in transportation

a. Line Haul
b. Pickup and Delivery
c. Terminal Handling
d. Billing and Collecting

Line Haul Costs

Total Line haul costs per hundred vary with

a. Cost Per Mile
b. Distance Moved
c. Weight Moved

Line Haul Costs vary with

a. Cost Per Mile
b. Distance Moved

If shippers want to reduce transportation cost,

a. Increase the weight shipped
b. Maximize Density

Pickup and Delivery Costs

- The carrier will charge for each pickup and weight picked up.
- If a shipper is making several shipments, it will be less expensive if they are consolidated and picked on one trip

Terminal Handling Costs

The basic rule for reducing terminal handling costs is to reduce handling effort by consolidating shipments into fewer parcels

Billing and Collecting

Billing costs can be reduced by consolidating shipments and reducing the pickup frequency.

Total Transportation Costs

To reduce shipping costs, the shipper needs to do the following

- Decrease the line haul costs by increasing the weight shipped

- Decrease pickup and delivery cost by reducing number of pickups. This can be done by consolidating and increasing the weight/ pickup.
- Decrease terminal handling costs by decreasing the number of parcels by consolidating shipments.
- Decrease billing and collecting costs by consolidating shipments

The rate charged by the carrier will vary with the commodity shipped and will depend in the following

a. Value
b. Density
c. Perishability
d. Packaging

Warehousing

Warehouses include

a. Plant Warehouses
b. Regional Warehouses
c. Local Warehouses

General Warehouse

Goods are stored for long periods and prime purpose is to protect goods until they are needed.

Distribution Warehouse

Has a dynamic purpose of movement and mixing. Goods are received in large volume uniform lost, stored briefly and then broken down into small individual orders of different items required by customer in market place.

Role Of Warehouses

Warehouses play 3 important roles

a. Transportation Consolidation
b. Production Mixing
c. Service

Transportation Consolidation is physical distribution is sometimes called **BREAK BULK**, which means the bulk shipments from factories to distribution centers are broken down into small shipments going to local markets.

Product Mixing deals with grouping of different items into an order. These are done from distribution centers having all the ordered items from a centralized location.

Warehousing and transportation costs

The particular shipping pattern will depend largely upon the following

a. Number of Customers
b. Geographic distribution of Customers
c. Customer Order Size

d. Number and location of plants and distribution centers

If truckload shipments are made, the cost is less from the central distribution center, if LTL are made, the cost is less from the local Distribution center.

Market Boundaries

Laid Down Cost (LDC) is the delivered cost of a product to a particular geographic point.

LDC = P + TX where P – Product Cost, T – Transportation Cost per mile, X – Distance.

The Market Boundary is the line between two or more supply sources, where the laid – down cost is the same.

Effect on transportation costs of adding more warehouses

Generally as more distribution centers are added to the system, we can expect the following

a. The cost of truckload shipments to the distribution centers increase
b. The cost of LTL shipments to customers decrease
c. The total cost of transportation to decrease

Packaging

The basic role of packing in any industrial organization is to carry goods through a distribution system to the customer. The package must do the following

a. Identify the product
b. Contain and protect the product
c. Contribute to physical distribution efficiency.

There are atleast 3 levels of packaging required in a distribution system.

a. Primary Package – that holds the product
b. For Small Packages, a shipping container such as corrugated box is necessary.
c. Third level of packaging, where several primary or secondary packages are assembled into a unit load.

Unitization

- Unitization is the consolidation of several units into large units called unit loads, so there is less handling.
- Material handling costs decrease as the size of the unit load increases
- One of the most common unit load is the pallet.

Materials handling

- Materials handling is a short distance movement that takes place in or around a building such as a plant or distribution center
- Objectives of material handling are as follows
    - To increase cube utilization by using the aisle space as much as possible
    - To improve operating efficiency by reducing handling. Increasing the load/ move will result in fewer moves.
    - To improve the service level by increasing the speed of response to customer needs.

Many types of Material Handling equipment are available. They can grouped into 3 categories

a. Conveyors
b. Industrial trucks
c. Cranes and Hoists

Multi Warehouse Systems

Inventory Carrying Costs

SS = (Safety Stock Units/ percentage in total units) *
sqrt((total no of units / no of WC's) / Total Units)

Warehousing Costs

As the number of Distribution Centers increase, there will be a gradual increase in the distribution center costs.

Material handling costs will remain constant until unitization is carried out. But if the DC's increase and some non – unitized shipments are going to be made, then material handling costs increase.

Packaging costs will rise with rise in inventory.

PRODUCTS AND PROCESSES

Life Cycle of a product

a. Introduction Phase
b. Growth Phase
c. Maturity or saturation phase
d. Decline Phase

As profits decline, companies will look for ways to maintain the profitability. There are 3 ways in which this can be done

a. Introduce new products
b. Improve existing products
c. Improve methods of production

Product Development Principles

2 conflicting factors to be considered in establishing the range of products to supply

a. If the product is too narrow, customers may be lost
b. If the product line is too wide, customers may be satisfied, but operating costs will increase because of lack of specialization

The needs of sales and economics of the production must be balanced. Usually this balance can be obtained with good programs of

a. Product Simplification
b. Product Standardization
c. Product Specialization

Simplification is the process of making something easier to do. It seeks to cut out waste by getting rid of needless product varieties, sizes and types.

Standardization is a carefully established specification covering the product's material, configuration, and measurements and so on

Modularization uses standardized parts for flexibility and variety.

Specialization is the concentration of effort in a particular area or occupation

With limited range of products, productivity can be increased and costs reduced by

a. allowing the development of machinery and equipment specially designed to make the limited range of products quickly and cheaply
b. Reducing the number of setups because of fewer task changes
c. Allowing labor to develop speed and dexterity because of fewer task changes

Product and Market Focus

Product and market focus can be based on characteristics such as Customer Grouping, Demand characteristics or degree of customization.

Process Focus: is based on similarity of process. Eg. Automobile manufacturers specialize in assembling automobiles.

Focused Factory

- Focused factories are thought to produce more effectively and economically, than more complex factories, the reason being repetition and concentration in one area allows the workforce and management to gain the advantages of specialization.
- Specialization has the disadvantage of inflexibility

Product Specification and Design

Product Design is responsible for producing a set of specifications that manufacturing can use the product. Products must be designed to be

a. Functional
b. Capable of Low Cost processing

Low Cost Processing

Poor Design can add cost to processing in several ways

a. The product and its components may be designed to make using the most economical methods impossible.
b. Parts may be designed so excessive material has to removed
c. Parts may be designed so operations are difficult
d. Lack of Standardized components may mean batches of work have to be small.
e. Product design can influence indirect costs such as production planning, purchasing or inventory management.

Simultaneous Engineering

To Design products for low cost manufacturing requires close coordination between product design and process design, which is called simultaneous engineering.

Several Advantages to this approach

a. Time to market is reduced
b. Cost is reduced
c. Better Quality
d. Lower total system cost.

Process Design

A process is a method of doing something, generally involving a number of steps or operations. Process Design is the developing and designing of steps.

Nesting

Small processes are linked to form a larger process. This way of looking at the hierarchy of processes is the concept of Nesting.

Factors influencing process design

a. Product Design and Quality Level
b. Demand Patterns and flexibility needed
c. Quantity and capacity considerations
d. Customer Involvement
e. Make or buy decision

A component can be either be made in – house or bought from outside. Reasons to make in – house.

a. Can produce for less cost than a supplier
b. The utilizing existing equipment to fullest extent
c. To keep confidential processes within the control of the firm.
d. To maintain quality
e. To maintain workforce.

Reasons to buy out

a. Requires less capital equipment
b. Users specialized expertise's of suppliers
c. Allows the firm to concentrate on its own area of specialization
d. Provides known and competitive prices.

Processing Equipment

Processing equipments can be classified into

a. General purpose machinery – Less costly, performs variety of operations, Run time is low as it is operated by humans and quantity levels tend to decrease.
b. Special Purpose Delivery

Process Systems

Base on material flow, processes can be organized in 3 ways

a. Flow
b. Intermittent
c. Project

All these can be used to make discrete units such as automobiles or text books or to make non – discrete products such as gasoline, paint or fertilizer.

Flow Processes

- Flow process layout is sometimes called product layout because the system is set up for a limited range of similar products.
- Flow systems produce only a limited range of similar products

If sufficient demand exists, flow systems are extremely efficient for the following reasons

- Workstations are designed to produce a limited range of similar products, so machinery and tooling can be specialized.
- Because material flows from one workstation to another, there is very little build up of work in process inventory.
- Because of the flow system and the low work in process inventory, lead times are short.
- In most cases, flow systems substitute capital for labor and standardize what labor there is into routine tasks.

Because, it so cost – effective, this system of processing should be used wherever and to whatever extent it can be.

Intermittent Process

- Goods are not made continuously as in a flow system but are made at intervals in lots or batches
- Intermittent processes are more flexible. They can change from part or task to another more quickly than can flow processes. This is because they use general purpose machinery and skilled flexibly labor that can perform variety of operations needed.
- Control of workflow is managed through individual work orders for each lot or batch being made.
- Provided the volume of work exists to justify it, flow manufacturing is less costly than intermittent manufacturing
    - Setup Costs are low. Once the line is established, change overs are needed infrequently to run another product
    - Since workcenters are designed for specific products, run costs are low.
    - Because products move continuously from one workstation to next, work – in – process inventory is low
    - Costs associated with controlling production are low because workflows through the process in a fixed sequence.

Project Processes

- Used for large complex projects such as locomotives, ships or buildings

Selecting the process

Capital costs are called fixed costs and the production or run costs are called variable costs

Total Cost (TC) = Fixed Cost (FC) + (Variable cost per unit) (VC) * no of units produced

TC = FC + VC * X

Unit Cost = Total Cost / no of units produced.

Cost Equalization Point (CEP)

Knowing the quantity beyond the cost of using the method B becomes less than for method A enables us to decide easily which process to use to minimize the total cost.

This quantity is called the Cost Equalization Point (CEP)

Increasing Volume

Standardization of parts is a major characteristic of modern mass production

Continuous Process Improvement

Continuous Process Improvement consists of a logical set of steps and techniques used to analyze processes and to improve them.

A. proving productivity
B. People Involvement
C. Teams

Six Steps in CPI

- Select the process to be studied
- Record the existing method to collect the necessary data in a useful form
- Analyze the recorded data to generate alternative improved methods
- Evaluate the alternatives to develop the best method to do work
- Install the method as standard practice by training the operator.
- Maintain the new method

- CPI is a low cost method of designing or improving work methods to maximize the productivity.
- The aim is to increase productivity by better use of existing resources

Workers have two jobs

Their "**As Defined**" job
To **improve their "As Defined" job**

Select the Process

The first step is to decide what to study

a. Observe
b. Select

c. Economic Considerations
d. The Human Factor
e. Pareto Diagrams
f. Cause Effect Diagrams

Observe

Indicators that show areas most needing improvement include

a. High scrap, reprocessing, rework and repair costs
b. Backtracking of material flow caused by poor plant layout
c. Bottlenecks
    a. Excessive overtime
    b. Excessive manual handling of materials, both from workplace and at the workplace
    c. Employee grievances without true assignable causes

Select

In specifying jobs or operations for method improvement, there are 2 major considerations

a. Economic
b. Human

Pareto Diagrams

Pareto Analysis can be used to select problems with the greatest economic impact. This theory says that a few items account for most of the cost or problems. It separates the "Vital Few" from the "Trivial Many"

Examples of the vital few are

a. A few Processes for the bulk of scrap
b. A few suppliers account for the most rejected parts
c. A few problems account for most process downtime.

Steps in Making a Pareto Analysis

a. Determine the method of classifying the data: by Problem, Cause, non – conformity and so forth
b. Select the unit of measure. This is usually dollars, but may be the frequency occurrence
c. Collect data for an appropriate time interval usually long enough to include all likely conditions
d. Summarize the data by ranking the items in descending order according to the selected unit of measure.
e. Calculate the total cost
f. Calculate the percentage of each item
g. Construct a bar graph showing the percentage for each item and a line graph of the cumulative percentage.

Cause Effect Diagram

a. Sometimes called a Fish Borne or an **IshiKawa** Diagram
b. Very useful tool for identifying root causes

Steps in developing a fishbone diagram

a. Identify the problem to be studied and state it in a few words
b. Generate some ideas about the main causes of the problem. Usually all probable root causes can be classified into 6 categories
    a. Materials
    b. Machines
    c. People
    d. Methods
    e. Measurement
    f. Environment

c. brainstorm all possible causes for each of the main causes
d. Once all the causes have been listed, try to identify the most likely root causes and work on these

Record

To be able to understand, what to record, it is necessary to define the process. The following must be determined to properly define the process

a. Process boundaries
b. Process flow
c. Process I/O
d. Components – Composed of people. Methods and equipment
e. Customer
f. Suppliers
g. Environment

Operating process Charts

Those record in sequence only the main operation and inspections. These are useful in primary investigation and give a bird's eye view of the process.

Process Flow Diagrams show graphically and sequentially the various steps, events and operations that make up a process.

Analyze

Find the root cause

Rudyard Kipling's Quote "I keep six honest serving men (They taught me all I know) their names are WHAT, WHY, WHEN, HOW, WHERE and WHO"

Three approaches can help in examining this

a. A questioning attitude
b. Examining the total process to define what is accomplished, how and why
c. Examining the parts of the process

Activities can be defined into 2 major categories

- Those in which something is happening to the product
- Those in which nothing constructive is happening to the product.

In the first category, value is added only when the part is being worked on. Setup, put away and move, while necessary, add cost to the product but do not increase its value. They must be minimized.

Develop

When developing possible solutions, there are 4 approaches to take to help develop a better method.

a. Eliminate all unnecessary work.
b. Combine operations wherever possible – This is a major thrust in JIT manufacturing
c. Re-arrange the sequence of operations for more effective results
d. Simplify wherever possible by making the necessary operations less complex.

Principles of motion economy

There are several principles of motion economy among which are the following

a. Locate materials, tools and workplace within normal working areas and preposition tools and materials
b. Locate the work done most frequently in the normal working areas and everything else within the maximum group areas
c. Arrange work so motions of hands, arms, legs and so on are balanced by being made simultaneously in opposite directions and over symmetrical paths
d. Conditions contributing to operator fatigue must be reduced to a minimum. Provide good lighting, keep tools and materials within maximum working areas, provide for alternate sitting and standing at work and design workplaces of proper height to eliminate stooping.

Human and Environmental factors

Job design: is an attempt to provide more satisfying meaningful jobs and to use the worker's mental and interpersonal skills. These improvements include the following

a. Job enlargement – A job might be expanded to include a sequence of activities instead of only one activity. This is called **horizontal enlargement**.

b. Job enrichment includes setup, scheduling, maintenance and control responsibilities
c. Job rotation is also called cross training

Maintain

This is a follow up activity that has 2 parts

a. Be sure that the new method is being done as it should be
b. Evaluate the change to be sure that the planned benefits are accomplished

JUST IN TIME MANUFACTURING

Just In Time Philosophy

- The most popular way of defining it is, The elimination of all waste and continuous improvement of productivity
- The long term result of eliminating waste is a cost – efficient, quality oriented, fat response organization that is responsive to customer needs.
- **VALUE** satisfies the actual and perceived needs of the customer and does it at a price the customer can afford and considers reasonable. Another word for this is **QUALITY.**

WASTE

Waste caused by poor product specification and design.

Component Standardization

Parts standardization has many advantages in manufacturing. It creates larger quantities of specific components that allow long production runs.

Waste Caused by Manufacturing

Toyota has identified 7 important sources of waste in manufacturing. The first four relate to the design of the manufacturing system and the last 3 to the operation and management of the system.

a. The process
b. Methods
c. Movement
d. Product Defects
e. Waiting Time
    1. Operator
    2. Material
f. Over Production
g. Inventory

If there are lots of inventories, then it takes longer and is more costly before the engineering changes reach the market place.

FOKE YOKE (Fail Safe)

- First introduced by Shigeo Shingo of Japan. It implies the concept of removing faults at the first instance and making a process or product "Fool Proof"
- Errors will always be **"made",** but defects can be **"prevented"**
- Corrective action should take place immediately after a mistake is made

The inspection can take one of the 3 forms

a. Successive Check
b. Self Check
c. Source Inspection

- Successive Check inspection is done by the next person in the process who passes the information back to the worker who just performed the operation who can then make any needed repair.
- Self Check is done by a worker and can be used on all items where a sensory perception is sufficient
- POKE YOKE tries to change either the process or its resources, thus eliminating the need to rely on human experience and knowledge

JIT Environment

Many elements are characteristic of a JIT environment. These can be grouped under the following headings

a. Flow Manufacturing
b. Process Flexibility
c. Total Quality Management
d. Total Productive Maintenance
e. Uninterrupted flow
f. Supplier Partnerships
g. Continuous environment
h. Total Employee Involvement

Flow Manufacturing

- The system is not suitable for making a variety of different products
- Parts can pass one by one in very small lots from one workstation to the next. This has several benefits
    - Q and lead times going through the cell are reduced drastically
    - Production activity control and scheduling are simplified. The cell has only one workcenter to control as opposed to 5 in a conventional system
    - Floor space needed is used
    - Feedback to preceding operations is immediate. If there is a quality problem, it will be found out immediately.

These are the concept of work cells.

Work Cells permit high variety, low volume manufacturing to be repetitive. Work Cells are sometimes called **Cellular manufacturing.**

Machine Flexibility

It's always better to have 2 relatively inexpensive general purpose machines than one large expensive special purpose machine.

Quick changeover

This requires short setup times. They have the following advantages

a. Reduced economic order quantity – Reducing setup time reduces the order qty and Q lead times
b. Reduced Q and manufacturing lead times
c. Reduced WIP inventory
d. Improved Quality
e. Improved process and material flow

Quick Changeover is a success if the setup time for an item is less, thus reducing all the above given issues

Operator Flexibility

People should be cross trained in other skills and in problem solving techniques.

Total Quality Management

Quality is important for 2 reasons.

a. If Quality is not present in what is supplied to the customer and the product is defective, the customer will be dissatisfied.
b. If a process produces scrap, it creates disrupted schedules that delay supplying the customer, increases inventory or causes shortages, washes time and effort on workcenters and increases the cost of the product.

Benefits of good quality program are

a. Less Scrap
b. Less Rework
c. Less Inventory
d. Better On – Time production
e. Timely Deliveries
f. More Satisfied Customers

Quality of Source

It means doing it right the first time and if something goes wrong, stopping the process and fixing it.

Total Productive Maintenance

Traditional Maintenance might be called "**Breakdown Maintenance**" meaning maintenance is done only when a machine breaks down.

- **APICS** defines Total Productive Maintenance as "Preventive Maintenance plus continuing efforts to adapt, modify and refine equipment to increase flexibility, reduce material handling and promote continuous flow

Uninterrupted Flow

Conditions needed to achieve uninterrupted flow of materials

a. Uniform plant loading – called as "Balancing the Line" in Repetitive manufacturing
b. A Pull system
c. Valid Schedules
d. Linearity

- The most frequently used pull system is called the Kanban System
- It is basically a two bin, fixed order quantity, order point system
- The company makes some of everything each day in the proportions to meet demand. If demand shifts between models the assembly line can respond daily. This is called **Mixed Model Scheduling**
- The emphasis in JIT is on achieving the plan. No more No less. This concept is called **Linearity** and is usually reached by scheduling to less than full capacity.

Continuous Process Improvement (CPI) is a major feature of JIT.

Supplier Partnerships

Partnering

JIT philosophy places much emphasis not only on supplier performance but also on supplier relations. Suppliers are looked on as co-producers not as adversaries.

3 Key factors in Partnering

a. Long Term Commitment
b. Trust
c. Shared Vision

Supplier Selection

Factors to be considered while selecting suppliers are

a. Technical Ability
b. Manufacturing Capability
c. Reliability
d. After Sales Service
e. Supplier Location

Other considerations based on partnership relationship

a. The supplier has a stable management system and is sincere in implementing the partnership agreement
b. There is no danger of the supplier breaching the organization's secrets
c. The supplier has an effective quality system
d. The supplier shares the vision of customer satisfaction and delighting the customer

Total Employee Involvement

Staff are responsible for such things as quality control, maintenance and record keeping

Manufacturing Planning and Control in a JIT environment

- Major responsibility for designing processes and methods lies with manufacturing and industrial engineering
- Manufacturing planning and control is responsible for managing the flow of material and work through the manufacturing process, not designing the process
- No matter what planning and control system is used, these are four basic questions to be answered
    - What are we going to make
    - What do we need to make it
    - What do we have
    - What must we get

- Many production situations do not lend themselves to level scheduling and the pull system
    - Where the demand patter is unstable
    - Where custom engineering is required
    - Where quality is unpredictable
    - Where volumes are low and occur infrequently

Capacity Management

From JIT's point of view, it emphasizes on cutting out waste and problems that cause ineffective use of capacity

Linearity, The practice of scheduling extra capacity will improve the ability to meet priority schedules

Inventory Management

Because JIT system reduces the inventory in the system, it reduces order quantities too. But if the annual demand is going to be the same, then more work orders and more paperwork must be tracked. One system that is being used to reduct this is called **BACKFLUSHING** or **POST DEDUCT SYSTEM**

Post Deduct System

- Raw material are recorded into work – in – process
- When work is completed and becomes finished goods, the work in process inventory is relieved by multiplying the number of units completed by the number of parts in the BOM.
- The system works if the bills of materials are accurate and if manufacturing lead times are short.
- All of this work in JIT elements not only reduces waste, but also establishes an environment that allows for effective alternative to MRP in the environment.

Impact on effective lot Sizing

Part of the difficulty with MRP is that often the plans are not effective because of problems or changes including

- Change in Customer requirements, both in timing and quantity
- Supplier delivery problems, including timing, quantity and quality
- Inaccurate databases that can make the plans invalid, depending on the nature of the inaccurate data.
- Production problems including
    - Absenteeism in workforce
    - Productivity or efficiency problems
    - Machine downtime
    - Quality Problems
    - Poor Communication

The Kanban System (Kanban -> Card on ticket)

The information on the Kanban will often include

a. Component part number and identification
b. Storage Location
c. Container Size
d. Workcenter of Origin

2 Card Kanban System

There are two types of card

a. Production card
b. Withdrawal Card

- At the start of the process, there is no movement, since all the cards are attached to full containers. It is only when a card is unattached, that activity is allowed.
- At some point, a downstream process needs some of the parts produced by workcenter2. They take a container of the material, bearing the workcenter2 production card with the center
- The unattached production card is the signal to start the Workcenter2 production to replace the container that was taken.

Important rule of Kanban

- Every container with material must have one, but only one card attached
- When the move card is attached, the production card must be removed
- There are no schedules for the system

Other Kanban Rules

- Every container with parts shall have one, but only one Kanban
- There will be no partial containers stored. Every container will be filled, empty or in the process of being filled or emptied.
- There will be no production or movement without an authorization in the form of an unattached Kanban card.

Card Alternatives

Since the development and successful implementation of Kanban systems in many facilities, many alternatives have been designed and implemented. Some of the alternative methods include

- Single Card Systems – The single card is the production card, with the empty container serving as the move signal
- Color coding of containers
- Designated storage spaces
- Computer Systems often with bar coding serving as the signal generator.

Use the Kanban System for process improvement

Eg. Of river. If there are no rocks that appear, then process is running smoothly. Now reduce the water level to see the first rock appearing. This is the obstacle in production and this has to be removed gradually.

If too much loader is pulled out, there are more number of rocks and obstacles and this might stop the flow.

Lean Production

Some JIT experts attempted to define two type of JIT

- Big JIT – referred to as the overall philosophy or organizational wide implementation of JIT concepts
- Little JIT – referred to the pull production scheduling system generally controlled by Kanban

- Lean production implies understanding and correctly implementing the major enterprise wide changes required to truly eliminate or significantly reduce waste in the system
- It is a system wide philosophical approach used to integrate the system towards an ultimate goal of maximized customer service with minimal system waste.

Various advantages of systems and disadvantages

MRP/ ERP works best in an environment with a great deal of variability and uncertainty. It is not effective in places where there is a lot of data. JIT is not effective in volatile situations like customer demand, processing problems and extensive changes in product design. Kanban works best in a highly stable and predictable environment.

TOTAL QUALITY MANAGEMENT

Quality means more user satisfaction, that goods or services satisfy the needs and expectations of the user.

To achieve the quality according to the above definition, the following are to be considered.

- Quality and product policy
- Product Design
- Manufacturing
- Final Use of product

Quality and product policy

Production planning must decide the market segment to be served, the level of performance expected and the price to be charged and must estimate the expected sales volume.

The basic quality level is thus specified by senior management according to its understanding of the wants and needs of the market segment.

Quality and Product Design

Product designers must build into the product, the quality level described in the general specification, which is got from the firm's studies of the market place.

Quality and Manufacturing

Quality in manufacturing means that at a minimum all production must be within specification limits and the less variation from the nominal, the better the quality.

Quality and Use

Quality has a number of dimensions among which are the following

a. Performance
b. Features
c. Conformance
d. Warranty
e. Service
f. Aesthetics
g. Perceived Quality
h. Price

3 dimensions to performance are important

a. Reliability
b. Durability
c. Maintainability

Total Quality Management is an approach to improving both customer satisfaction and the way organizations do business.

APICS defines this as "It is based in the participation of all members of an organization in improving processes, products, services and culture the work in"

Objective of TQM is to provide a quality product to customers at a lower price.

Six Basic Concepts of TQM

- A committed and involved Management
- Focus on Customer
- Involvement of the total workforce
- Continuous process improvement
- Supplier Partnering
- Performance Measures

Management commitment

- The chief Executive Officer and Senior Management should form a quality council whose purpose is to establish a clear vision of what is to be done
- The quality council must establish a strategic plan that expresses TQM goals and objectives of the organization and how it hopes to achieve them

Customer Focus

Customers have 6 requirements of their suppliers

a. High Quality level
b. High flexibility to change such things as volume, specifications and delivery
c. High service level
d. Short Lead times
e. Low variability in meeting targets
f. Low Costs

Employee Involvement

To gain employee commitment to the organization, TQM requires the following

a. Training
b. Organization
c. Local Ownership

Performance measures can be used to

- Discover which process needs improvement
- Evaluate alternative processes
- Compare actual performance with targets to corrective action can be taken
- Evaluate employee performance
- Show Trends

Basic characteristics that can be used to measure the performance of a particular process or activity such as the following

a. Quantity
b. Cost
c. Time/ Delivery
d. Quality

3 dimensions to quality measurements

a. Function: Does the product as specified
b. Aesthetics: Does the product or service appeal to customers
c. Accuracy

Measurements is needed for all types of process

Quality Cost Concepts

Quality costs fall into 2 broad categories

a. Cost of failure to control quality
b. Cost of controlling quality

Cost of Failure

a. Internal Failure costs
b. External Failure Costs

Costs of controlling quality

a. Prevention Costs
b. Appraisal Costs

Variation as a way of life

2 different types of variation

a. Chance variation
b. Assignable variation

Chance Variation

This variation comes from everything influencing the process

Usually broken down into the following categories

a. People
b. Machine
c. Material
d. Method
e. Environment
f. Measurement

Assignable variation

Chance is not the only cause of variation. A tool may shift or gauge may move, a machine wear or an operator makes a mistake. There is a specific reason for these causes of variation, which is called Assignable Variation.

Statistical Control

As long as only chance variation exists, the system is said to be in statistical control. It there is an assignable cause of variation, the process is not in control and is unlikely to produce a good product.

Statistical control has 2 objectives

- To help select processes capable of producing the required quality with minimum defects.
- To monitor a process to be sure it continues to produce the required quality and no assignable cause of variation exists.

Patterns of variability

- Shape – must be of normal distribution
- Center – Sum of all observations
- Spread – In statistical process control, there are 2 methods of measuring this variation, the range and standard deviation.

Process capability

Lower Specification Limits (LCL)
Upper Specification Limits (UCL)

One process having a narrow spread will produce product within the specification limits, the other process having a wide spread will produce defects. The first process is said to be capable and the second is not.

Process Capability Index (Cp)

The process capability index combines the process capability and tolerance into one index.

If Cp > 1, process is capable of producing parts within tolerance
< 1, process not capable of producing parts within tolerance.

Standard Process Capability Index = 1.33

Cp = (USL – LSL) / 6sigma

Process capability index specifies whether the process variation is satisfactory, but it does not measure whether the process is centered properly.

Cpk Index

This index measures the effect of both center and variation at the same time.

Cpk Index is lesser of (USL – mean)/ 3sigma (or) (mean – LSL)/ 3sigma

The greater the Cpk, the further the 3sigma limit is from the specification limits and the fewer rejects there will be.

Process Control

Process control attempts to prevent the production of excessive defects by showing when the probability is high, there is an assignable cause of variation.

- Once a stable process is established, the limits of the resulting pattern of variation can determined and will serve as a guide for future production.

- When variation exceeds the limits, it shows a high probability that there is an assignable cuase.

Control charts

a. Run Charts
b. Xbar and R chart (XBar means a bar above X)

Run Charts

Suppose a manufacturer was filling bottles and wanted to check the process to be sure the proper amount of liquid was going into each bottle. Samples are taken every half hour and measured.

The average of the samples is then plotted on a chart. This is called Run Chart

While it gives a visual description of what is happening with the process, it does not distinguish between chance variation and assignable cause variation.

Control Limits

Control Limits are set so that there is a 99.7 probability that if the process is in control, the sample value will fail within the control limits. When this situation occurs, the process is said to be in statistical control and there is no assignable cause of variation.

2 Types of changes can occur in a process

- A shift in mean or average showed in XBar portion of chart
- A Change in the spread of the distribution – showed in the R portion of the Chart.

Control Charts for attributes

Other quality Control tools

a. Pareto Charts
b. Check sheets
c. Process flowcharts
d. Scatter plots
e. Cause and Effect Diagrams (Fishbone)

- Statistical process control monitors the process and detects, when the process goes out of control, thus minimizing the production of defective parts.
- 2 inspection procedures
    - 100% inspection – In cases where the cost of failure is exceptionally high, 100% inspection is vital. Eg. Products of medical and aerospace industry
    - Acceptance Sampling – Taking sample of a batch of product and using it to estimate the overall quality of the batch

Reasons for sampling inspection

- Testing the product is destructive
- There is not enough time to give 100% inspection to a batch of products
- It is too expensive to test all of the batch
- Human error is estimated to be as high as 3% when performing long term repetitive testing

Conditions necessary for sampling inspection

- All items must be produced under similar or identical conditions
- A random sample of the lot must be taken
- The lot to be sampled should be homogenous mixture
- The batches to be inspected should be large

Sampling plans

Selecting a particular plan depends on 3 factors

- Consumer's risk
- Producer's risk
- Cost

ISO: International Organization for Standardization

ISO based in Geneva, developed 5 standards. 9000, 9001, 9002, 9003, 9004.

They were originally written for contractual situations between suppliers and customers in which the supplier would develop a quality system that conformed to the ISO standards and was satisfactory to the customer

ISO 9000 series of standards is generic and can be made to fit any service or manufacturing organization's needs.

ISO 9000 explains

a. Basic quality Concepts
b. Defines Key terms
c. Provides guidelines for selecting, using and modifying ISO 9001, 9002 and 9003

ISO 9004 provides a model for guidance in implementing a quality system
ISO 9001 provides a model for Quality assurance in design
ISO 9002 and 9003 provides a model for quality assurance in production an dinstallation

Steps in Bench Marking

- Select the process to benchmark
- Identify an organization that is "Best In Class" in performing the process you want to study
- Study the benchmarked organization
- Analyze the data.

3 phases to flow of materials

- Raw materials flow into manufacturing company from a physical supply system
- They are processed by manufacturing
- Finished goods are distributed to end customers through a physical distribution system

5 important factors in supply chain

- Supply Chain includes all activities and processes to supply a product or service to a final customer

- Any number of companies can be linked to a supply chain
- A customer can be a supplier to another customer so the total chain can have a number of supplier/ customer relationships
- While distribution system can be direct from supplier to customer, depending in the products and markets, it can contain a number of intermediaries such as wholesalers, warehouses and retailers.
- Product or services usually flow from supplier to customer and design and demand information usually flows from customer to supplier. Rarely this is not so.

Production Planning System

- Priority relates to what products are needed, how many are needed and when they are needed. The market place establishes priorities. Manufacturing is responsible for devising plans to satisfy the market demand if possible.
- Capacity depends on the resources of the company
- Capacity is the quantity of work that labor and equipment can perform in a given period.

Planning horizon is the time span from now to some time in the future for which the plan is created.

MPS Planning horizon usually extends from 3 to 18 months but primarily depends on purchasing and manufacturing lead times.

PAC planning horizon: One day to a month

SOP is a cross functional business plan that involves sales and marketing, product development, operations and senior management

The SOP is the forum in which the production plan is developed.

Production Plan Planning Horizon

Following is a general procedure for developing a level production plan

- Total the forecast demand for the planning horizon.
- Determine the opening backlog and the desired ending backlog
- Calculate the total production as follows
  Total Production = Total Forecast + Opening Backlog – Ending Backlog
- Calculate the production required for each period dividing the total production by number of periods
- Spread the existing backlog over the planning horizon according to due date/ period.

Make to Stock Products: MPS is a schedule of finished good items
Order : MPS is a schedule of actual order customers
Assemble to Order : Forecasting and planning is a difficult task

Examples of changes to MPS

- Customer cancel or change orders
- Machines breakdown or new machines are added, changing capacity
- Suppliers have problems and miss delivery dates
- Processes create more scrap than expected

Changes to production schedules can result in the following

- Cost increases due to re-routing, rescheduling, extra setups, expediting and build up work in process inventory
- Desired customer service: A change in quantity of delivery can disrupt the schedule of other orders.
- Loss of credibility for the MPS and planning process

The zones and time fences are as follows

a. Frozen Zone
b. Slushy Zone – Changes in priorities are easy to change. The extent of the slushy zone is defined by planning Time Fence. Within this time fence, the computer will not reschedule MPS orders
c. Liquid Zone – Changes are routing and often are made by computer program

Error Management

Three Types of error occurs

a. Wrong product or Specification
b. Wrong Amount
c. Wrong Shipping Date

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