Uttar Pradesh Rajarshi Tandon
Open University

M.Com.-404
Production Management-II

Uttar Pradesh Rajarshi Tandon
Open University

M.Com.-404
Production Management-II

BLOCK

1

PRODUCTION PLANNING

UNIT 11

Facility Planning : What Is Facility Planning? Need For Facility Planning, Facility Planning Objectives, Types Of Layouts, Product On Live Layout, Fixed Position Layout, Combination Layout, Combination Approach For Developing Process Layout. **5**

UNIT 12 **15**

Aggregate Production Planning : Linkage between long term and short term planning, the purpose of aggregate planning, steps in aggregate planning, dimension of production capacity, managerial importance of aggregate planning.

परिशिष्ट–4
आन्तरिक कवर–दो का प्ररूप
Format of the II Inner Covers

ISBN : 978-93-83328-50-5

Printed and Published by Vinay Kumar, Registrar Uttar Pradesh Rajarshi Tandon Open Prayagraj, 2024

Printed by : Chandrakala Universal Pvt. Ltd 42/7 Jawahar Lal Nehru Road Prayagraj.

UNIT - 11

FACILITY PLANNING

STRUCTURE

11.0 WHAT IS FACILITY PLANNING?

Facility layout decisions are based on criteria aimed at creating an effective and efficient workflow and high standard production. Facilities is defined as the workspace and equipment needed to carry out the operations of the organization. This includes offices, factories, computers, and trucks. The location, design, and layout of an organizations' Facility Planning is aka: Master Planning and Facility Design.

There are 5 Phases of Facility Planning

1. *Site Selection*
   - ❖ New Construction
   - ❖ Existing Building Retrofit
   - ❖ Existing Laundry Renovation/Expansion
2. *Preliminary Design*
   - ❖ Project Kick-off
   - ❖ Define Facility Requirements
   - ❖ As-built Drawings
   - ❖ Alternative Preliminary Designs
   - ❖ Project Cost Estimate

3. *Final Design*
    - ❖ Work Out the Details
    - ❖ Final Design Review / Approval
    - ❖ Freeze the Design
4. *Project Bid*
    - ❖ Building Construction / Modifications
    - ❖ Process Utility Installation
    - ❖ Equipment Purchase / Installation
    - ❖ Design/Build contractor
    - ❖ Process Utilities – Local vs. Laundry
    - ❖ Details, Details, Details! The more details the better the price.
    - ❖ Best Value vs. Lowest Price
5. *Project Management*
    - ❖ Building Construction
    - ❖ Equipment Installation
    - ❖ Equipment Commissioning
    - ❖ Project Follow-up

11.1 Need for Facility Planning

There are many factors that can determine where an organization will locate its facilities. For any given situation, some factors become more important than others in how facility location affects an organization's efficiency and effectiveness. There are several reasons why Facility planning is needed is as below:

1. **Proximity to sources of supply:** Firms that process bulk raw materials usually locate close to the source of supply to reduce transportation costs. Paper mills locate close to forests, canneries are built close to farming areas, and fish processing plants are located close to the labours where the fishing vessels dock.
2. **Proximity to customers:** There are several reasons why an organization would locate close to end customers. Service firms need to be close to customers to be convenient, as is the case for grocery stores, gas stations, fast food restaurants, and hospitals. Transportation costs can also require proximity to customers, as in the case of concrete manufacturing. Perishable products often require that they be produced close to the final market, as is the case for bakeries and fresh flowers.

3. **Community factors:** Communities may offer a number of incentives to entice companies, including waiving or reducing taxes, and providing access roads, water and sewer connections, and utilities. Community attitudes can also play a role in an organization's location decision. Some communities may actively discourage companies that might bring more pollution, noise, and traffic to the area. Some communities may not want a prison to be located in their community. Other communities may welcome such firms because of the jobs, tax revenues, and economic diversity they promise.

4. **Labour factors:** Research shows that the majority of location decisions are largely based on labor factors, since labour is a critical variable for many firms. Labour factors include the prevailing wage rate in a community for similar jobs, the supply of qualified workers, and the average education level of the local population (percentage of high school graduates, etc.). Other labour factors can include the degree of union organizing and the general work ethic of a community, as well as other measures of absenteeism, and worker longevity in a job can play a strong role when a firm makes a location decision.

5. **Other factors:** Many other factors can play a role in the location decision, including quality of life (crime rates, good schools, climate, and recreation options), access to major transportation arteries, construction costs, proximity of the competition, and opportunities for future expansion.

   As mentioned earlier, the importance of any location factor can vary greatly, depending on the circumstances of the decision.

11.2 FACILITY PLANNING OBJECTIVES

Facilities are central to maximizing the efficiency of the overall operations system. Its objectives is to:

Maximize

- Plant efficiency/output
- Production flexibility
- Quality

Minimize

- Production costs
- Work in process (WIP)
- Project costs

LAYOUT

Plant layout refers to the physical arrangement of production facilities. It is the configuration of departments, work canters and equipment in the

conversion process. It is a floor plan of the physical facilities, which are used in production.

According to Moore "*Plant layout is a plan of an optimum arrangement of facilities including personnel, operating equipment, storage space, material handling equipment and all other supporting services along with the design of best structure to contain all these facilities*".

Objectives of Plant Layout

The primary goal of the plant layout is to maximize the profit by arrangement of all the plant facilities to the best advantage of total manufacturing of the product. The objectives of plant layout are:

1. Streamline the flow of materials through the plant.
2. Facilitate the manufacturing process.
3. Maintain high turnover of in-process inventory.
4. Minimize materials handling and cost.
5. Effective utilization of men, equipment and space.
6. Make effective utilization of cubic space.
7. Flexibility of manufacturing operations and arrangements.
8. Provide for employee convenience, safety and comfort.
9. Minimize investment in equipment.
10. Minimize overall production time.
11. Maintain flexibility of arrangement and operation.
12. Facilitate the organizational structure.

Principles of Plant Layout

1. **Principle of integration:** A good layout is one that integrates men, materials, machines and supporting services and others in order to get the optimum utilization of resources and maximum effectiveness.
2. **Principle of minimum distance:** This principle is concerned with the minimum travel (or movement) of man and materials. The facilities should be arranged such that, the total distance travelled by the men and materials should be minimum and as far as possible straight line movement should be preferred.
3. **Principle of cubic space utilization:** The good layout is one that utilize both horizontal and vertical space. It is not only enough if only the floor space is utilized optimally but the third dimension, i.e., the height is also to be utilized effectively.
4. **Principle of flow:** A good layout is one that makes the materials to move in forward direction towards the completion stage, i.e., there should not be any backtracking.

5. **Principle of maximum flexibility**: The good layout is one that can be altered without much cost and time, i.e., future requirements should be taken into account while designing the present layout.
6. **Principle of safety, security and satisfaction: A** good layout is one that gives due consideration to workers safety and satisfaction and safeguards the plant and machinery against fire, theft, etc.
7. **Principle of minimum handling:** A good layout is one that reduces the material handling to the minimum.

11.4 TYPES OF LAYOUTS

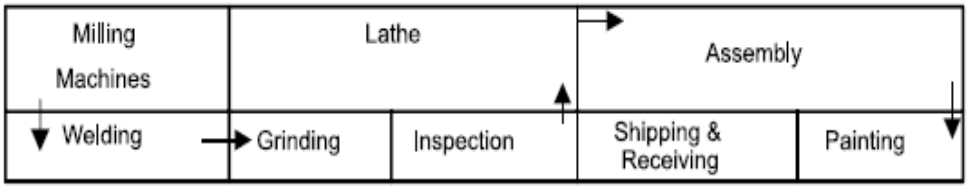
Layouts can be classified into the following five categories:

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

Process Layout

Process layout is recommended for batch production. All machines performing similar type of operations are grouped at one location in the process layout *e.g.,* all lathes, milling machines, etc. are grouped in the shop will be clustered in like groups.

Thus, in process layout the arrangement of facilities are grouped together according to their functions. A typical process layout is shown in Fig. The flow paths of material through the facilities from one functional area to another vary from product to product. Usually the paths are long and there will be possibility of backtracking. Process layout is normally used when the production volume is not sufficient to justify a product layout. Typically, job shops employ process layouts due to the variety of products manufactured and their low production volumes.



Advantages

1. In process layout machines are better utilized and fewer machines are required.
2. Flexibility of equipment and personnel is possible in process layout.
3. Lower investment on account of comparatively less number of machines and lower cost of general purpose machines.

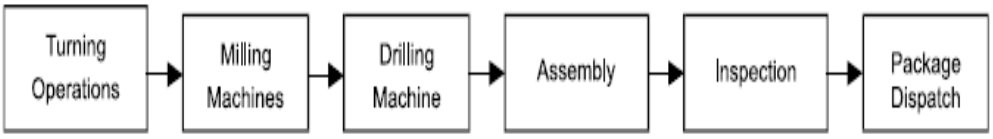
4. Higher utilization of production facilities.
5. A high degree of flexibility with regards to work distribution to machineries and workers.
6. The diversity of tasks and variety of job makes the job challenging and interesting.
7. Supervisors will become highly knowledgeable about the functions under their department.

Limitations

1. Backtracking and long movements may occur in the handling of materials thus, reducing material handling efficiency.
2. Material handling cannot be mechanized which adds to cost.
3. Process time is prolonged which reduce the inventory turnover and increases the in process inventory.
4. Lowered productivity due to number of set-ups.
5. Throughput (time gap between in and out in the process) time is longer.
6. Space and capital are tied up by work-in-process.

11.3.1 PRODUCT LAYOUT

In this type of layout, machines and auxiliary services are located according to the processing sequence of the product. If the volume of production of one or more products is large, the facilities can be arranged to achieve efficient flow of materials and lower cost per unit. Special purpose machines are used which perform the required function quickly and reliably. The product layout is selected when the volume of production of a product is high such that a separate production line to manufacture it can be justified. In a strict product layout, machines are not shared by different products. Therefore, the production volume must be sufficient to achieve satisfactory utilization of the equipment. A typical product layout is shown in Fig.



Advantages

1. The flow of product will be smooth and logical in flow lines.
2. In-process inventory is less.
3. Throughput time is less.
4. Minimum material handling cost.

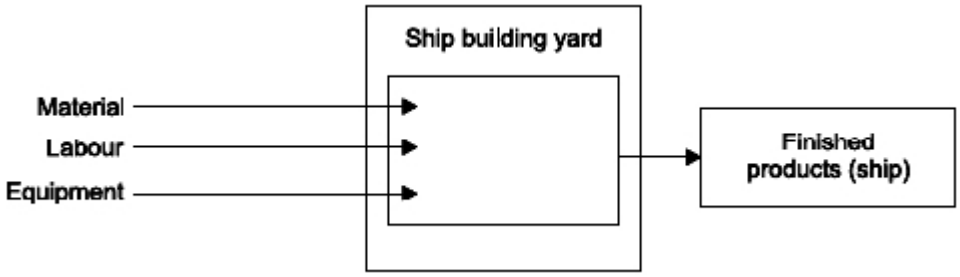
5. Simplified production, planning and control systems are possible.
6. Less space is occupied by work transit and for temporary storage.
7. Reduced material handling cost due to mechanised handling systems and straight flow.
8. Perfect line balancing which eliminates bottlenecks and idle capacity.
9. Manufacturing cycle is short due to uninterrupted flow of materials.
10. Small amount of work-in-process inventory.
11. Unskilled workers can learn and manage the production.

Limitations

1. A **breakdown** of one machine in a product line may cause stoppages of machines in the downstream of the line.
2. A change in product design may require **major alterations** in the layout.
3. The **line output is decided** by the bottleneck machine.
4. Comparatively **high investment** in equipment is required.
5. **Lack of flexibility.** A change in product may require the facility modification.

11.3.2 FIXED POSITION LAYOUT

This is also called the **project type** of layout. In this type of layout, the material, or major components remain in a fixed location and tools, machinery, men and other materials are brought to this location. This type of layout is suitable when one or a few pieces of identical heavy products are to be manufactured and when the assembly consists of large number of heavy parts, the cost of transportation of these parts is very high.



Advantages

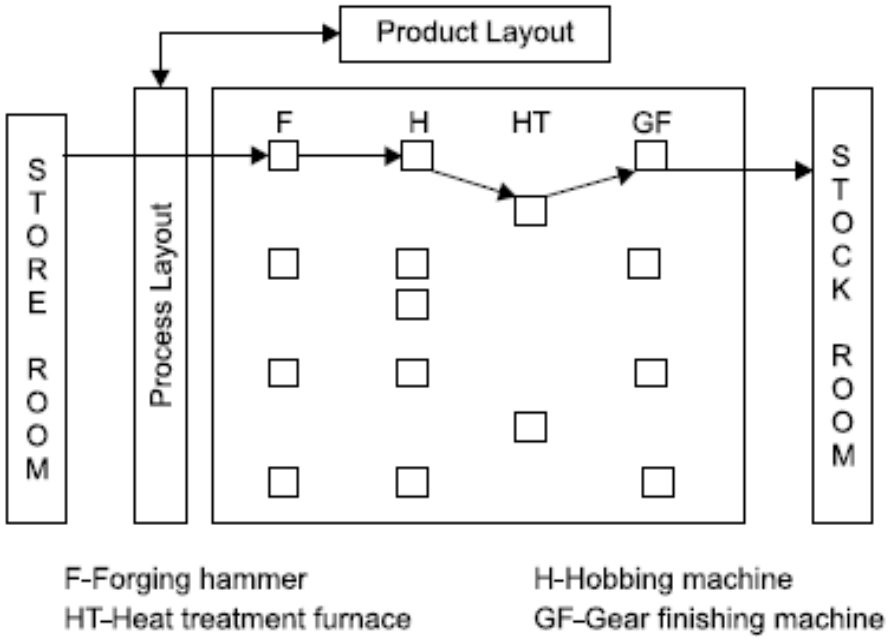
The major advantages of this type of layout are:

1. Helps in job enlargement and upgrades the skills of the operators.
2. The workers identify themselves with a product in which they take interest and pride in doing the job.

3. Greater flexibility with this type of layout.
4. Layout capital investment is lower.

11.3.3 Combination Layout

A combination of process and product layouts combines the advantages of both types of layouts. A combination layout is possible where an item is being made in different types and sizes. Here machinery is arranged in a process layout but the process grouping is then arranged in a sequence to manufacture various types and sizes of products. It is to be noted that the sequence of operations remains same with the variety of products and sizes. Figure shows a combination type of layout for manufacturing different sized gears.



Group Layout (or Cellular Layout)

There is a trend now to bring an element of flexibility into manufacturing system as regards to variation in batch sizes and sequence of operations. A grouping of equipment for performing a sequence of operations on family of similar components or products has become all the important.

Group technology (GT) is the analysis and comparisons of items to group them into families with similar characteristics. GT can be used to develop a hybrid between pure process layout and pure flow line (product) layout. This technique is very useful for companies that produce variety of parts in small batches to enable them to take advantage and economics of flow line layout.

The application of group technology involves two basic steps; first step is to determine component families or groups. The second step in applying group technology is to arrange the plants equipment used to process a particular family of components. This represents small plants

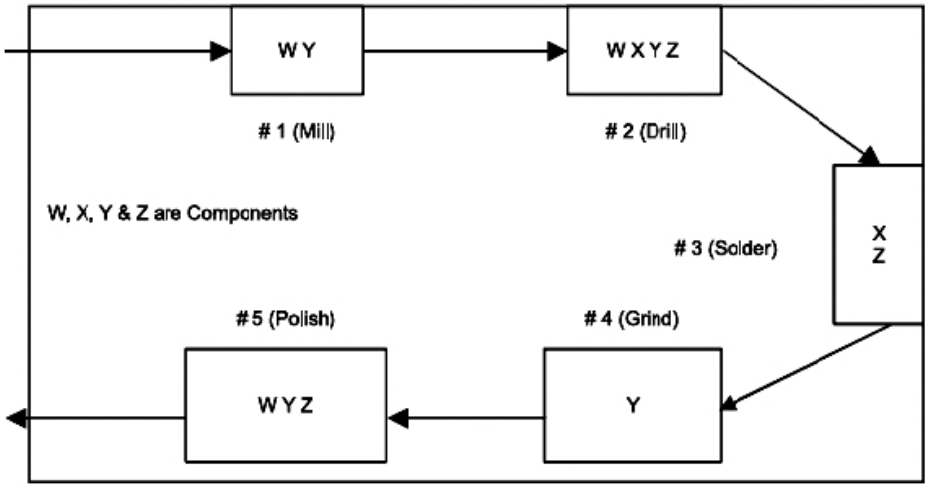
within the plants. The group technology reduces production planning time for jobs. It reduces the set-up time.

Thus **group layout** is a combination of the product layout and process layout. It combines the advantages of both layout systems. If there are *m*-machines and *n*-components, in a group layout (Group-Technology Layout), the *m*-machines and *n*-components will be divided into distinct number of machine-component cells (group) such that all the components assigned to a cell are almost processed within that cell itself. Here, the objective is to minimize the intercell movements.

The basic aim of a group technology layout is to identify families of components that require similar of satisfying all the requirements of the machines are grouped into cells. Each cell is capable of satisfying all the requirements of the component family assigned to it.

The layout design process considers mostly a single objective while designing layouts. In process layout, the objective is to minimize the total cost of materials handling. Because of the nature of the layout, the cost of equipments will be the minimum in this type of layout. In product layout, the cost of materials handling will be at the absolute minimum. But the cost of equipments would not be at the minimum if the equipments are not fully utilized.

In-group technology layout, the objective is to minimize the sum of the cost of transportation and the cost of equipments. So, this is called as multi-objective layout. A typical process layout is shown in Fig.



Advantages of Group Technology Layout

Group Technology layout can increase—

1. Component standardization and rationalization.
2. Reliability of estimates.
3. Effective machine operation and productivity.
4. Customer service.

11.4 Summary

Facilities is defined as the workspace and equipment needed to carry out the operations of the organization. There are 5 Phases of Facility Planning: Site Selection, Preliminary Design, Final Design, Project Bid and Project Management. There is huge requirement of facility planning. Facilities are central to maximizing the efficiency of the overall operations system. Plant layout refers to the physical arrangement of production facilities. Layouts can be classified into the following five categories: Process layout, Product layout, Combination layout, fixed position layout and Group layout.

Self assessment question

1. What Is Facility Planning?
2. What is Needed for Facility Planning?
3. Explain various types of Layouts?

UNIT - 12

AGGREGATE PRODUCTION PLANNING

STRUCTURE

12.0 INTRODUCTION

Production planning and Control is the organization and planning of the manufacturing processes, it coordinates supply and movements of materials and labour; ensures economic and balanced utilization of machines and equipments as well as other activities related with production to achieve the desired manufacturing results in terms of quantity, quality, time and place. Production planning implies formulation, coordination and determination of activities in a manufacturing system necessary for the accomplishment of desired objectives whereas production control is the process of maintaining a balance between various activities evolved during production planning providing most effective and efficient utilization of resources.

Objectives of production planning and control;

- *Determining the nature and magnitude of various inputs factors to manufacture the desired output*
- *To coordinate labour , machines and equipment in the most effective and economic manner,*
- *Establishing targets and checking these against performance.*
- *Ensuring smooth flow of material by eliminating bottlenecks, if any, in production.*
- *Utilization of under employed resources.*
- *To manufacture the desired output of right quality and quantity at right time.*

12.1 LINKAGE BETWEEN LONG TERM AND SHORT TERM PLANNING

Marketing relies on short-term and long-term planning to ensure that company resources are effectively aligned to drive consumer demand at a profit. A short-term plan, sometimes called an operational or tactical marketing plan, is a detailed picture of planned activities, usually over the next 12-month period. Long-term plans, or strategic marketing plans, give the "big picture" of longer-term goals for growth opportunities over five- to 10-year timelines.

Marketing plans are directly related to and evolve out of corporate or company strategic plans. Corporate strategic plans establish broad company goals that are usually expressed in quantifiable terms, such as "to increase operating profit by 5 percent annually over the next five years." These plans look to the future in terms of desired outcomes based on company-wide audits of strengths and weaknesses. In effect, company strategic plans state "where we want to be." In contrast, both tactical and strategic marketing plans are statements of "how to get there." They start with a company's current position and define the pathways to meet the desired outcomes established in the company strategic plan.

Short-Term Plans

Tactical marketing plans are detailed accounts of how the marketing mix — product, distribution, price and promotions — will be managed over the defined period of time, which most commonly is a year, but could be a quarter or even a month, in some cases. If a price increase is required to compensate for increased production costs, the timing of the price increase along with marketing initiatives to mitigate anticipated trade and consumer pushback against the price increase are included in the marketing plan. In effect, tactical plans are "calendars of events" that detail marketing activities on a monthly basis over the next 12 months. They also include supporting monthly sales forecasts and marketing budgets.

Long-Term Plans

Strategic marketing plans establish longer-term marketing strategies against a backdrop of uncertainties relating to future economic, consumer, industry and competitive trends. Many industries need strategic marketing plans because of prolonged lead-times to develop and introduce new products. Such is the case for new product development in the pharmaceutical and defense industries, where products can be in development up to 10 years before market introduction. All companies can benefit from strategic marketing planning because marketing is about creating the future. You need a vision to create the future. Long-term planning opens the window, the vision, into the future.

Integrating Short-Term and Long-Term Planning

Many experienced marketers believe that both tactical and strategic planning responsibilities belong to the marketing department, rather than

leaving marketing strategy to corporate strategists. For instance, Michael Baker, Marketing Professor Emeritus at the University of Strathclyde in Scotland and editor of "The Marketing Book," expressed fear that marketing manager's risk losing the ability to think strategically when removed from the strategic planning process. This can produce narrow-minded, disconnected tactical plans, because they fail to incorporate long-term initiatives that safeguard the future. Short and long-term marketing plans are essential roadmaps that guide the future prosperity of your SMALL BUSINESS. If you are unfamiliar with marketing planning, tap into an abundance of free resources. Visit the Small Business Administration website, or the SCORE website, formerly Service Corp of Retired Executives, for more information on marketing plans.

12.2 AGGREGATE PLANNING

Managing companies for success across a range of time frames - a requisite for achieving both performance and health - is one of the toughest challenges in business. The fact that 10 of the largest 15 bankruptcies in history have occurred since 2001 is playing up its inherent risks. Managements need to build confidence in their ability to realize longer-term strategies and good short-term results. Planning, for any period including aggregate planning, is possible only when management has information available on tap. This is especially true for batch-based manufacturing planning.

Aggregate planning consists of the resource management planning activities that are done after the long-term capacity and capability planning decisions have been made. These planning activities are designed to help the firm achieve its long-term strategic initiatives. The nature of these activities is influenced by the structure of the product delivery systems.

What Is Aggregate Planning?

Firms make the strategic long-term resource commitments that will enable its operations function to achieve its corporate objective. Most of the decisions needed to create these capabilities involve strategic commitments, i.e., where to site and how to site facilities; how to acquire plant and equipment; what type of information systems to be implemented and executed; and how to create an organization with a culture that serves the corporate strategy well.

Aggregate planning is the "big picture" approach to planning for the intermediate term. While strategic planning deals with long range operations of facilities and resources, aggregate planning deals with developing ways to utilize those facilities and resources.

In other words, the aggregate plan links strategic goals and objectives of the organization with the plans for individual products, services and their various components.

Factors Affecting Aggregate Planning

Aggregate planning is an operational activity critical to the organization as it looks to balance long-term strategic planning with short term production success. Following factors are critical before an aggregate planning process can actually start;

- A complete information is required about available production facility and raw materials.
- A solid demand forecast covering the medium-range period
- Financial planning surrounding the production cost which includes raw material, labor, inventory planning, etc.
- Organization policy around labor management, quality management, etc.

For aggregate planning to be a success, following inputs are required;

- An aggregate demand forecast for the relevant period
- Evaluation of all the available means to manage capacity planning like sub-contracting, outsourcing, etc.
- Existing operational status of workforce (number, skill set, etc.), inventory level and production efficiency

12.3 STEPS IN AGGREGATE PLANNING

The process consists of four basic considerations as follows:

- **Concept of Aggregation** starts with a meaningful measure of output. In a single product output organization there is no problem with the output measure. Many organizations have multiple products and it is difficult to find a common factor of measure of output.

  For e.g. steel producer can plan in terms of tons of steel, gallons of paint in case of paint industry. Service organizations such as transport system may use passenger miles as a common measure, health care facilities may use patient visits, and educational institutes may use student to faculty contact ratio in terms of hours as a reasonable measure.

  A group of products or services that have similar demand requirements and common processing, labor and materials requirements is called a Product Family. Therefore a firm can aggregate its products or services into a set of relatively broad families, avoiding too much detail at the planning stage. For example consider the Bicycle manufacture that has aggregated all products into two families: mountain bikes and road bikes. This

approach aids production planning for the assembly lines in the plants.

- **Goals for aggregate planning** there are number of goals to be satisfied. It has to provide the overall levels of output, inventory and backlogs dictated by the business plan. Proper utilization of the plant capacity. It should not be under-utilized because it is waste of resources. It is better to operate at a near full capacity. The aggregate plan should be consistent with the company's goals and policies regarding its employees. A firm may like to have employee stability or hire and layoff strategy. Other firms change employees freely as the output level is varied throughout the aggregate planning horizon.
- **Aggregate Demand Forecasts** The benefits of aggregate planning depends on the accurate forecasting. Any suitable forecasting model can be used to forecast demand for product groups as well as individual products.
- **Interrelationships among decisions:** Here the managers must consider the future consequence of current decisions. This is important mainly due to the fact that output plans are developed for a long period of time.

Strategies for Aggregate Planning:

There are three pure strategies that the planner could use for the Aggregate Planning.

Strategy 1. Vary the number of Productive employees in Response to Varying output Requirements (also known as Chase 1 plan). Here, the average productivity per employee is first calculated which determines the number of employees needed to meet the monthly required output demand. The employees are laid off when the output demand falls. As a result there is always Hiring and laying of employees.

Strategy 2. Maintain a Constant Work Force Size but Vary the Utilization of the Work Force (also known as Level # 1).

Suppose, for example, we chose the strategy of employing 70 workers per month throughout the year. On an average, this work force would be capable of producing 700 wagons each day. During the lean months (January, February, March, July, October, November, December), the work force would be scheduled to produce only the amount forecasted, resulting in scheduled to produce only the amount forecasted, resulting in same idle working hours. During high demand months (April, May, June, August, September), overtime operations would be needed to meet demand. The work force would therefore be intensely utilized during some months and underutilized in other months.

Strategy 3. Vary the Size of Inventory in Response to Varying Demand (also known as Chase # 2 plan). Finished goods inventories in make-to-stock companies can be used as a cushion against fluctuating demand. A fixed number of employees, selected to that little or no overtime or idle time is incurred, can be maintained throughout the planning horizon. Producing at a constant rate, output will exceed demand during slack demand periods, and finished goods inventories will accumulate. During peak periods, when demand is greater than capacity, the demand can be supplied from inventory. This planning strategy results in fluctuating inventory levels throughout the planning horizon.

12.5 MANAGERIAL IMPORTANCE OF AGGREGATE PLANNING

Aggregate planning plays an important part in achieving long-term objectives of the organization. Aggregate planning helps in:

- Achieving financial goals by reducing overall variable cost and improving the bottom line
- Maximum utilization of the available production facility
- Provide customer delight by matching demand and reducing wait time for customers
- Reduce INVESTMENT in inventory stocking
- Able to meet scheduling goals there by creating a happy and satisfied work force
- Laying off/hiring excess/inadequate excess/inadequate excess/inadequate workforce until demand decrease/increase.
- Including overtime as part of scheduling there by creating additional capacity.
- Hiring a temporary workforce for a fix period or outsourcing activity to a sub-contractor.

12.6 Summary

Production planning implies formulation, coordination and determination of activities in a manufacturing system necessary for the accomplishment of desired objectives whereas production control is the process of maintaining a balance between various activities evolved during production planning providing most effective and efficient utilization of resources. Marketing plans are directly related to and evolve out of corporate or company strategic plans. Plans may be short term or long term. Aggregate planning activities are designed to help the firm achieve its long-term strategic initiatives. Aggregate planning process consists of four

basic considerations: Concept of Aggregation, Goals for aggregate planning, Aggregate Demand Forecasts, Interrelationships among decisions. There are three pure strategies that the planner could use for the Aggregate Planning. There is very much managerial planning.

Self Assessment questions

1. Explain the Linkage between Long Term and Short Term Planning?
2. What is The Purpose of Aggregate Planning?
3. Explain the Steps in Aggregate Planning?
4. What are the Dimension of Production Capacity?

Uttar Pradesh Rajarshi Tandon
Open University

M.Com.-404
Production Management-II

BLOCK

2
WORK SYSTEM DESIGN

परिशिष्ट–4
आन्तरिक कवर–दो का प्ररूप
Format of the II Inner Covers

ISBN : 978-93-83328-50-5

UNIT - 13

WORK SYSTEM DESIGN

12.1 Introduction

In development, work design is the application of Socio-Technical Systems principles and techniques to the humanization of work. The aims of work design are to improve job satisfaction, to improve through-put, to improve quality and to reduce employee problems (e.g., grievances, absenteeism).Job design is concerned with structuring jobs in order to improve organizational efficiency and employee job satisfaction. The design of a job should reflect both technological and human considerations. It should facilitate the achievement of organizational objectives and the performance of the work that the job was established to accomplish. At the same time, the design should recognize the capacities and needs of those who are to perform it. Over the last two decades, one of the most influential theories of job design is the Job Characteristics Model (JCM) put forward by Hackman and Oldman (1980). This extensively studied model has been used to explain important work outcomes for workers in a wide variety of blue and white-collar jobs. Fundamental to JCM is the notion that there are two kinds of job motivation: external motivation and internal motivation. External job motivation includes salary, benefits, and bonuses. Internal job motivation derives from the sense of self-satisfaction that one receives from a job well done. Therefore, it is important that they maximize internal job motivation. Internal job motivation occurs when three key conditions are met.

- First, the person must experience **responsibility** for the results of the work, believing that he or she is personally accountable for work outcomes. If one views the quality of the completed work as depending more on external factors than upon one's own initiative or efforts, then he or she will feel less personally satisfied when one does well or dissatisfied when one does not do well.

- Scond, the person must have **knowledge of the results** of his or her work. If the person who does the work never receives knowledge of the results, then that individual has no basis for feeling satisfied about doing well or dissatisfied about doing poorly.

- Tird, the person must experience the work as **meaningful**—as something that "counts" in one's own system of values. If the work being done is seen as trivial, then internal work motivation is unlikely to develop—even when the person has sole responsibility for the work and receives ample information about how well he or she is performing. Hackman and Oldman (1980) believe that jobs have certain characteristics that determine how well the key conditions named above will be met. A sense of responsibility, the first key condition, is facilitated by giving staff

a high degree of autonomy. Knowledge of the results, the second key condition, is facilitated by giving staff feedback on their performance effectiveness. And a sense of meaningfulness, the third key condition, is facilitated by skill variety, task identity, and task significance.

13.2 JOB DESIGN

A job can be defined as the set of tasks and responsibilities of a worker. These tasks and responsibilities, along with performance expectations, work conditions (time and place of work), general skills, and possibly methods to be used, are normally contained in a written job description. There is no set formula for designing jobs that will best fit a production system. Job design is the consciously planned structuring of work effort performed by an individual or a team of persons. There is increasing evidence that poorly designed jobs are a pervasive social problem affecting the mental and physical health of the worker both on and off the job.

Job design helps to determine: What tasks are done, how the tasks are done, how many tasks are done, and in what order the tasks are done. It takes into account all factors which affect the work, and organizes the content and tasks so that the whole job is less likely to be a risk to the employee. The objective of job design is therefore, to develop work assignments that meet the requirements of the organization and the technology, and at the same time also satisfy the personal and individual requirements of the job holder.

Various techniques of job design are

1. Simplification of Job
2. Job Enlargement
3. Job Enrichment
4. Job Rotation

- **Simplification of Job:**

In job simplification jobs are broken in to very small parts as in assembly line operations and work can be done by same individual repeatedly and it will increase productivity and proficiency of individual. However it produces boredom and monotony in worked.

- **Job Enlargement:**

Job enlargement expands job horizontally. It increases job scope; that is, it increases the number of different operations required in a job and the frequency with which the job cycle is repeated. By increasing the number of tasks an individual performs, job enlargement, increases the job scope, or job diversity. Instead of only sorting the incoming mail by department, for instance, a mail sorter's job could be enlarged to include physically delivering the mail to the various departments or running outgoing letters through the postage meter. Job enlargement decreases

some boredom but it is not enough to motivate as nature of work remain same.

Job enlargement means expanding the scope of the job. Many tasks and duties are aggregated and assigned to a single job. It is opposite to job simplification. Job enlargement is an extension of Job rotation, exposing the people to several jobs without changing the job duties to be performed. He is taken off the boring job for a while & is allowed to take up a related task & so on. Monotony is relieved temporarily. Critics are of the opinion that this approach involves nothing more than having to perform several boring jobs rather than one. Job enlargement is to expand in several tasks than just to do one single task. It is also the horizontal expansion of a job. It involves the addition of tasks at the same level of skill and responsibility. It is done to keep workers from getting bored. This would also be considered multi tasking by which one person would do several persons jobs, saving the company money and man hours that normally would be paid to additional workers. Small companies may not have as many opportunities for promotions, so they try to motivate employees through job enlargement. For example when I worked at a restaurant. I would bus the tables, wash the dishes, and run food upstairs. If they had just one person doing each job on the same night, it would cost the management three times the money. This adds more functions; increases variety of tasks and this is short lived. It cannot enrich the human content of job. The ultimate answer is Job Enrichment.

- **Job Rotation:**

Job rotation is the systematic and planned rotation of individuals in pre-determined jobs (other than their own) so they can gain additional knowledge or skills. It is done quite a bit for developing managers (because they need to be familiar with operations overall) and also used with others who want to advance to a new role or become more knowledgeable in their current job role. Job rotation implies systematic movement of employees from one job to the other. Job remains unchanged but employees performing them shift from one job to the other. With job rotation, an employee is given an opportunity to perform different jobs, which enriches his skills, experience and ability to perform different jobs. It is the process of preparing employees at a lower level to replace someone at the next higher level. It is generally done for the designations that are crucial for the effective and efficient functioning of the organization. By this to some extent boredom is reduced. However for this people interest is primary importance. By this they can also learn new things, new techniques, and new ways of doing better work. It may also happen that over a period of time they will be finding a job for which they are better suitable. They can also contribute in a better way to achieve the goals of the organization.

This aspect of job rotation can be seen widely applied in Retail scenario, where end user or consumer is in direct presence all through. This has for large extent reduced boredom, reduced irregularities due to familiarity, acquired new skills & assuming new and varied responsibilities. In other

words it will lead to better job satisfaction, which is the ultimate goal for better contribution. Some of the major benefits of job rotation are:

- It provides the employees with opportunities to broaden the horizon of knowledge, skills, and abilities by working in different departments, business units, functions, and countries
- Identification of Knowledge, skills, and attitudes required
- It determines the areas where improvement is required
- Assessment of the employees who have the potential and caliber for filling the position

- **Job Enrichment:**

Job enrichment is an approach to job design. The focus is to increase the depth of the job (by the amount of discretion and responsibility the job holder has). It is different from job enlargement (which focuses on increasing the number of tasks a job holder is responsible for performing. In job enrichment, additional tasks are not the focus for the goal, but an increase in tasks could be a result of giving the job holder more authority, discretion, and responsibility for decision making in their current role. It is the most effectively motivating tool used by the organizations which enhances the decision making skills of the managers and helps in their overall development. Job enrichment means making the job rich in its contents so that an employee will get more satisfaction while performing that job. It upgrades the responsibility, scope and challenge. A vast majority of the jobs are repetitive and monotonous in nature. This results in reducing the motivational content and human element of the job with repercussions on performance. The central focus of job enrichment is giving people more control over their work (lack of control is a key cause of stress, and therefore of unhappiness.) Where possible, allow them to take on tasks that are typically done by supervisors. This means that they have more influence over planning, executing, and evaluating the jobs they do. In enriched jobs, people complete activities with increased freedom, independence, and responsibility. They also receive plenty of feedback, so that they can assess and correct their own performance.

Job Enrichment tries to embellish the job with factors of motivation: Achievement – Recognition – Increased Responsibilities – Self Involvement – Opportunities for Growth – Advancement – Increased Competence. Job Enrichment is concerned with redesigning the job to include a variety of work content; that gives the person more autonomy & responsibility for planning, directing & controlling his own performance & provide opportunity for personal growth & meaningful work experience. Job Enrichment also for decentralization of decision making rights to individual over areas that directly affect his task functions.

The emphasis is on the result of efforts rather than the procedure to carry out the work, thus making the job result oriented. This also results in motivation, satisfaction in believing oneself to be personally accountable for results & being able to know how satisfactory ones efforts are. By Job

Enrichment, condition or state of human capabilities which were not fully utilized & creation of frustration among the individual is removed to the extent possible.

Work Measurement

Work measurement is also called by the name 'time study'. Work measurement is absolutely essential for both the planning and control of operations. Without measurement data, we cannot determine the capacity of facilities or it is not possible to quote delivery dates or costs. We are not in a position to determine the rate of production and also labor utilization and efficiency. It may not be possible to introduce incentive schemes and standard costs for budget control.

Objectives of Work Measurement

The use of work measurement as a basis for incentives is only a small part of its total application.

The objectives of work measurement are to provide a sound basis for:

1. Comparing alternative methods.
2. Assessing the correct initial manning (manpower requirement planning).
3. Planning and control.
4. Realistic costing.
5. Financial incentive schemes.
6. Delivery date of goods.
7. Cost reduction and cost control.
8. Identifying substandard workers.
9. Training new employees.

Techniques of Work Measurement

For the purpose of work measurement, work can be regarded as:

1. **Repetitive work:** The type of work in which the main operation or group of operations repeat continuously during the time spent at the job. These apply to work cycles of extremely short duration.
2. **Non-repetitive work:** It includes some type of maintenance and construction work, where the work cycle itself is hardly ever repeated identically.

Various techniques of work measurement are:

1. Time study (stop watch technique),
2. Synthesis,
3. Work sampling,
4. Predetermined motion and time study,
5. Analytical estimating.

Time study and work sampling involve direct observation and the remaining are data based and analytical in nature.

1. **Time study:** A work measurement technique for recording the times and rates of working for the elements of a specified job carried out under specified conditions and for analyzing the data so as to determine the time necessary for carrying out the job at the defined level of performance. In other words measuring the time through stop watch is called time study.
2. **Synthetic data:** A work measurement technique for building up the time for a job or pans of the job at a defined level of performance by totaling element times obtained previously from time studies on other jobs containing the elements concerned or from synthetic data.
3. **Work sampling:** A technique in which a large number of observations are made over a period of time of one or group of machines, processes or workers. Each observation records what is happening at that instant and the percentage of observations recorded for a particular activity, or delay, is a measure of the percentage of time during which that activities delay occurs.
4. **Predetermined motion time study (PMTS):** A work measurement technique whereby times established for basic human motions (classified according to the nature of the motion and conditions under which it is made) are used to build up the time for a job at the defined level of performance. The most commonly used PMTS is known as **Methods Time Measurement (MTM).**
5. **Analytical estimating:** A work measurement technique, being a development of estimating, whereby the time required to carry out elements of a job at a defined level of performance is estimated partly from knowledge and practical experience of the elements concerned and partly from synthetic data.

The work measurement techniques and their applications are shown in Table

TABLE: Work measurement techniques and their application

Techniques	*Applications*	*Unit of measurement*
1. Time study	Short cycle repetitive jobs. Widely used for direct work.	Centiminute (0.01 min)
2. Synthetic Data	Short cycle repetitive jobs.	Centi minutes
3. Working sampling	Long cycle jobs/ heterogeneous operations.	Minutes
4. MTM	Manual operations confined to one work centre	TMU (1 TMU = 0.006 min)
5. Analytical estimation	Short cycle non-repetitive job.	Minutes

TIME STUDY

Time study is also called work measurement. It is essential for both planning and control of operations. According to British Standard Institute time study has been defined as *"The application of techniques designed to establish the time for a qualified worker to carry out a specified job at a defined level of performance."*

Steps in Making Time Study

Stop watch time is the basic technique for determining accurate time standards. They are economical for repetitive type of work. Steps in taking the time study are:

1. Select the work to be studied.
2. Obtain and record all the information available about the job, the operator and the working conditions likely to affect the time study work.
3. Breakdown the operation into elements. An element is a instinct part of a specified activity composed of one or more fundamental motions selected for convenience of observation and timing.
4. Measure the time by means of a stop watch taken by the operator to perform each element of the operation. Either continuous method or snap back method of timing could be used.
5. At the same time, assess the operator's effective speed of work relative to the observer's concept of 'normal' speed. This is called performance rating.
6. Adjust the observed time by rating factor to obtain normal time for each element

   Normal = Observed time × Rating
7. Add the suitable allowances to compensate for fatigue, personal needs, and contingencies etc. to give standard time for each element.
8. Compute allowed time for the entire job by adding elemental standard times considering frequency of occurrence of each element.
9. Make a detailed job description describing the method for which the standard time is established.
10. Test and review standards wherever necessary.

Computation of Standard Time

Standard time is the time allowed to an operator to carry out the specified task under specified conditions and defined level of performance. The various allowances are added to the normal time as applicable to get the standard time. Standard time may be defined as the, amount of time required to complete a unit of work:

(*a*) under existing working conditions, (*b*) using the specified method and machinery, (*c*) by an operator, able to the work in a proper manner, and (*d*) at a standard pace.

Thus basic constituents of standard time are:

1. Elemental (observed time).
2. Performance rating to compensate for difference in pace of working.
3. Relaxation allowance.
4. Interference and contingency allowance.
5. Policy allowance.

OT – Observed Time

PRF – Performance Rating Factor

NT – Normal Time

PA – Process Allowances

RPA – Rest and Personal Allowances

SA – Special Allowances

PoA – Policy Allowances

Allowances

The normal time for an operation does not contain any allowances for the worker. It is impossible to work throughout the day even though the most practicable, effective method has been developed.

Even under the best working method situation, the job will still demand the expenditure of human effort and some allowance must therefore be made for recovery from fatigue and for relaxation.

Allowances must also be made to enable the worker to attend to his personal needs. The allowances are categorized as:

(1) Relaxation allowance,

(2) Interference allowance, and

(3) Contingency allowance.

1. Relaxation Allowance

Relaxation allowances are calculated so as to allow the worker to recover from fatigue. Relaxation allowance is a addition to the basic time intended to provide the worker with the opportunity to recover from the physiological and psychological effects of carrying out specified work under specified conditions and to allow attention to personal needs. The amount of allowance will depend on nature of the job.

Relaxation allowances are of two types: fixed allowances and variable allowances.

Fixed allowances constitute:

(*a*) **Personal needs allowance:** It is intended to compensate the operator for the time necessary to leave, the workplace to attend to personal needs like drinking water, smoking, washing hands. Women require longer personal allowance than men. A fair personal allowance is 5% for men, and 7% for women.

(*b*) **Allowances for basic fatigue:** This allowance is given to compensate for energy expended during working. A common figure considered as allowance is 4% of the basic time.

2. Variable Allowance

Variable allowance is allowed to an operator who is working under poor environmental conditions that cannot be improved, added stress and strain in performing the job. The variable fatigue allowance is added to the fixed allowance to an operator who is engaged on medium and heavy work and working under abnormal conditions. The amount of variable fatigue allowance varies from organization to organization.

3. Interference Allowance

It is an allowance of time included into the work content of the job to compensate the operator for the unavoidable loss of production due to simultaneous stoppage of two or more machines being operated by him. This allowance is applicable for machine or process controlled jobs. Interference allowance varies in proportion to number of machines assigned to the operator. The interference of the machine increases the work content.

4. Contingency Allowance

A contingency allowance is a small allowance of time which may be included in a standard time to meet legitimate and expected items of work or delays. The precise measurement of which is uneconomical because of their infrequent or irregular occurrence.

This allowance provides for small unavoidable delays as well as for occasional minor extra work:

Some of the examples calling for contingency allowance are:

_ Tool breakage involving removal of tool from the holder and all other activities to insert new tool into the tool holder.

_ Power failures of small duration.

_ Obtaining the necessary tools and gauges from central tool store. Contingency allowance should not exceed 5%.

5. Policy Allowance

Policy allowances are not the genuine part of the time study and should be used with utmost care and only in clearly defined circumstances.

The usual reason for making the policy allowance is to line up standard times with requirements of wage agreement between employers and trade unions.

The policy allowance is an increment, other than bonus increment, applied to a standard time (or to some constituent part of it, *e.g.*, work content) to provide a satisfactory level of earnings for a specified level of performance under exceptional circumstances. Policy allowances are sometimes made as imperfect functioning of a division or part of a plant.

Compensation

Compensation refers to a wide range of financial & non-financial rewards to employees for their services rendered to the organization. **OR** Employee Compensation refers to all forms of pay going to employees & arising from their employment. It has 2 main components, Direct Financial payments (Wages, salaries, incentives, conveyance, HRA, LTA, commissions & bonus), & Indirect Financial payments (Financial benefits like employer paid insurance, Car Policy, Holiday Homes, Hospitalization, Leave Policy, Retirement Policy etc).

Elements of Compensation:-

- Monthly wage & Salary or total pay including basic wage, house rent allowance, Dearness Allowance & city compensatory allowance;
- onus at the end of the year;
- Economic benefits such as paid holidays, LTA concession;
- Contribution towards insurance premium;
- Contribution towards retirement benefits such as employee provident fund;
- Transport & Medical Facilities.

Compensation Objectives:-

- To reward employees' past performance fairly, in line with efforts, skills and competencies;
- To attract and retain competitive high performing employees;
- To remain competitive in the labor market;
- To align employees' future performance with organizational goals;
- To communicate the employees their worth to the organization;
- To motivate the high performing employees;
- To provide employee social status.

Theories of Remuneration:

- **Reinforcement & Expectancy Theory: -** The Reinforcement theory postulates that a behavior which has a rewarding experience is likely to be repeated. The implication for remuneration is that high employee performance followed by a monetary reward will make future employee performance more likely. In same way, a high performance not followed by a reward will make its recurrence unlikely in future. Vroom's Expectancy theory focuses on the link between rewards & behavior.
- **Equity Theory: -** Adam's equity theory posit that employee's perceptions of how they are treated by their firm is of prime importance to them. The dictum 'a fair day work for fair day pay' denotes a sense of equity felt by employees. When employees perceive inequity, it can result in lower productivity, higher absenteeism or increase in turnover. The remuneration system needs to meet 3 types of equity- internal, external & individual.

  1. **Internal Equity: -** Involves the perceived fairness of pay differentials among different jobs within an organization. Employees should feel that the pay differentials among jobs are fair, given the corresponding differences in job responsibilities;
  2. **External Equity:** Involves employees' perception of the fairness of their remuneration relative to those outside the organization. What competitors pay to similar jobs will have its impact on employee motivation, commitment & Performance.
  3. **Individual Equity:** Considers employee perception of pay differentials among individuals who hold identical jobs in the same organization. Seniority contributes to differences in remuneration received by 2 individuals in the same cadre.

  - **Agency Theory: -** The Agency Theory focuses on the divergent interests & goals of the organization's stakeholders & the way the employee remuneration can be used to align these interests & goals. Employers & Employees are the 2 main stakeholders in an organization. Employers assume the role of principals & employees play the role of agents. It is natural that the employees expect high agency costs while the employers seek to minimize it. The agency theory says that the principal must choose a contracting scheme that helps align the interest of the agents with the principal's own interests. It can be behavior oriented (Merit Pay) OR

Outcome oriented (e.g. Profit Sharing, ESOP, and Commissions etc.)

Factors Affecting Wage/Compensation:

External Factors:-

1. **Demand & Supply of Labor:** Demand & Supply of Labor influence wage & salary fixation. A low wage may be fixed when the supply of labor exceeds the demand for it. A higher wage will have to be paid when the demand exceeds supply, as in the case of skilled worker. High remuneration to skilled labor is necessary to attract & retain it.
2. **Productivity of Workers:** Productivity of labor also influences wage fixation. Productivity can arise due to increased effort of the worker or as a result of the factors beyond the control of the worker such as improved technology, machines, equipment & better management. Higher productivity will automatically fetch more profit to the firm, where in turn workers will be paid high wages in comparison to other firms with low productivity.
3. **Cost of Living:** This criteria matters during periods of rising prices, & is forgotten when prices are stable or falling. The justification for cost of living as a criterion for wage fixation is that the real wages of workers should not be allowed to be reduced down by price increases. A rise in the cost of living is sought to be compensated by payment of dearness allowance, basic pay to remain undisturbed.
4. **Labor Unions:** The presence & absence of labor organizations often determine the quantum of wages paid to employees. Employers in non-unionized factories enjoy the freedom to fix wages & salaries as they please. Because of large-scale unemployment, these employers hire workers at little or even less than legal minimum wages. The employees of strongly unionized companies too, have no freedom in wage & salary fixation, as they are forced by the pressure of labor representatives in determining & revising pay scales.
5. **Government:** To protect the working class from the exploitation of powerful employers, the Government has enacted several laws. Laws on minimum wages, hours of work, equal pay for equal work, payment of dearness allowances, payment of bonus etc have been enacted & enforced to bring about a measure of fairness in compensating the working class.
6. **Society:** Remuneration paid to employees is reflected in the prices fixed by an organization for its goods & services. For this reason the consuming public is interested in remuneration decision.
7. **The Economy:** The last external factor that has its impact on wage & salary fixation is the state of the economy. For E.g. A Depressed

Economy will probably increase the labor supply, which in turn should serve to lowering the going wage rate.

Internal Factors:

1. **Business Strategy:** The overall strategy which a company pursues should determine the remuneration to its employees. Where the strategy of the enterprise is to achieve rapid growth, remuneration should be higher than what competitors pay. Where the strategy is to maintain & protect current earnings, because of the declining fortunes of the company, remuneration level needs to be average or even below average.
2. **Job Evaluation & Performance Appraisal:** Job evaluation helps establish satisfactory wage differentials among jobs. Performance Appraisal helps award pay increases to employees who show improved performance.
3. **The Employee:** Several employees related factors interact to determine his or her remuneration. These are Performance, Seniority, experience, potential & Luck.

Challenges of Remuneration:

- **Skill based pay:** In the traditional job based pay employees are paid on the basis of job they do. In the skill based system workers are paid on the basis of number of jobs they are capable of doing, or on the depth of knowledge. The purpose of this system is to motivate employees to acquire additional skills so that they become more useful to the organization. (Pay for performance/ Pay for seniority);
- **Pay Reviews:** Pay once determined should not remain constant. It must be reviewed & changed often, but how often becomes a relevant question. Pay reviews may be made on predetermined dates, anniversary dates or there could be flexible reviews.
- **Pay Secrecy**: Just how much & what types of information about pay should be provided to employees is a question that troubles HR managers. The tendency among most firms is to maintain pay secrecy as this would help avoid pay comparisons likely to me made by employees.
- **Monetary versus Non-monetary Rewards:**
- The issue relating to monetary & non-monetary rewards has primarily tax implications. Many non-monetary rewards such as medical benefits & housing are fully or partially exempted from taxes. Employees & even employers prefer non-monetary benefits than monetary rewards.
- **Eliticism & Egalitarianism**: Firms become egalitarian when they place most of their employees under the same remuneration plan. The plan becomes elitist when the organizations establish different remuneration schemes. E.g. In some firms only the CEO is eligible

for stock options. In others, even the lowest paid workers are offered stock options.

- **Salary compression:** A salary inequity problem, generally caused by inflation, resulting in longer-term employees in a position earning less than workers entering the firm today.
- The pay cycle, Salary increases and promotions, Overtime and shift pay, Probationary pay, Paid and unpaid leaves, Geography, Equity & its impact on Pay Rates.

Methods to Address Equity Issues/ Establishing Pay Rates:

- **Salary Survey:** It is difficult to set pay rates if you don't know what others are paying, so salary surveys- surveys of what others are paying play a big role in pricing jobs. It is aimed at determining prevailing wage rates. Virtually every employer conducts at least an informal telephone, newspaper, or Internet Salary survey. Many Employers use surveys published by Consulting Firms, Governmental Agencies, etc. Employers use survey data to price benchmark jobs. Salary surveys can be formal or informal way. It is mostly to get information of employees, overtime policies, starting salaries, sick leave, insurance & paid vacations.
- **Job Evaluation:** Job Evaluation is a systematic process of analyzing & evaluating jobs to determine the relative worth of each job in an organization. Once the worth of jobs is determined, it becomes easier to fix the wage structure that will be fair & equitable. The basic procedure is to compare the jobs in relation to one another- For E.g. in terms of required effort, responsibility, & skills.

Objectives

1. Maintenance of consistent wage policy.
2. Enable management to gauge & control its payroll costs more accurately.
3. Provide a framework for periodic review of wage & salaries.
4. To manage internal & external consistency in the compensation.
5. Reduce grievances & labor turnover & thereby, increase employee morale & improve management-employee relationship.
6. Serve as a basis for negotiation with the union.

Techniques of Job Evaluation:

1. **Ranking Method:** Ranking is one of the simplest & the oldest job evaluation methods. In this method, the jobs in an organization are assessed based on the knowledge, skills, effort & other job dimensions associated with each job. Jobs also can be arranged according to the relative difficulty in performing them.

Ranking involves preparation of brief job descriptions & assigning ranks to the jobs in accordance with their worth in the organization.

2. **Job classification/ Job Grading**: In this method the jobs are classified & graded based on their significance & their worth to the organization. The jobs at various levels in an organization are placed under different grades, which are clearly defined. Grades are formulated on the basis of the nature of tasks & responsibilities of the jobs, the authority associated with them & the knowledge & skill required for the jobs.

3. **Point rating Method:** The point method or point rating method is one of the most widely used methods of job evaluation. In this method, a point scale is developed to evaluate the jobs. However, different scales might be required to evaluate different jobs. For E.g. all the managerial jobs might be evaluated on one scale, all the operational on another & the clerical jobs on one scale etc.

4. **Factor Comparison Method:** Here they determine & define the specific factors like mental requirements, skills, physical requirements, responsibilities, working conditions etc. Next they will identify the key jobs or benchmark jobs, which are well known & have an established pay rate in the organization. The factors in each benchmark job are compared & ranked based on their relative importance.

Process of Job Evaluation:

- **Preparation of a Job Evaluation Plan**: The need for job evaluation is determined & detailed plan of how to go about the whole exercise, including the method to be adopted, is prepared;
- **Job Analysis**: Job Analysis provides the basic information for job evaluation. Job Analysis helps in understanding the tasks & responsibilities associated with a job.
- **Job Description & Job Specification:**
  - **Selection of Job Dimensions:** The different factors which will be the basis for evaluating each job, have to be determined. Once these dimensions are selected, monetary values have to be attached to each of these jobs, as it is a reflection of its contribution to the organization & its significance.
  - **Implementation of the evaluation:** The employees should be educated about the program to make them understand the basis & the procedure of job evaluation.
  - **Maintenance:** The results of job evaluation have to

be updated from time to time to match the changing organizational needs.

- **Group Similar Jobs into Pay Grades:** Once the committee has used job evaluation to determine the relative worth of each job, it can turn to the task of assigning pay rates to each job; however, it will usually want to first group jobs into pay grades. The committees will probably group similar jobs into grades for pay purposes. So, instead of having to deal with hundreds of pay rates, it might only have to focus on e.g. 10 or 12. A pay grade is comprised of jobs of approximately equal difficulty or importance as established by job evaluation.
- **Price Each Pay Grade– Wage Curves:** The next step is to assign pay rates to your pay grades. Wage curve can be used to help assign pay rates to each pay grade or to each job. The wage curve shows the pay rates currently paid for jobs in each pay grade, relative to the points or rankings assigned to each job or grade by the job evaluation. The purpose of wage curve is to show the relationships between (1) the value of the job as determined by one of the job evaluation methods & (2) the current average pay rates for your grades.

– **Fine tune Pay Rates:-**

It Involves (1) Developing Pay rates & (2) Correcting out of line rates.

1. 1. Developing Pay Rates: Most employers do not pay just one pay rate for all jobs in a particular grade. For E.g. GE Medical won't want to pay all its accounting clerks, from beginners to long tenure, at the same rate. Instead, employers develop vertical pay ranges for each of the pay grades. These pay ranges are a series of steps or levels within a pay grade, usually based upon years of service. These pay ranges lets the employer take a more flexible stance in the labor market. It also let companies provide for performance differences between employees within the same grade or between those with different seniorities.

2. Correcting Out-of-Line Rates: The wage rate for a particular job may now fall well off the wage line or well outside the rate range for its grade. This means that the average pay for that job is currently too high or too low, relative to other jobs in the firm. For underpaid jobs, the solution is clear, raise the wage of underpaid employees to the minimum of the rate range for their pay grade.

Pricing Managerial & Professional Jobs:

Developing compensation plans for managers or professionals is similar in many respects to developing plans for any employee. The basic aim is the same i.e. to attract & keep good employees, & in job evaluation-classifying jobs, ranking them or assigning points to them is applicable to managerial & professional jobs. Compensation for a company's top executives usually consists of 4 main elements. ***Base Pay-*** Includes the person's fixed salary as well as often guaranteed bonuses such as 10% of pay at the end of quarter, regardless of whether or not the company makes profit.

Short term incentives- Are usually cash or stock bonuses for achieving short-term goals, such as year-to-year increases in sales revenue. ***Long term incentives*** aim to encourage the executive to take actions that drive up the value of the company's stock. ***Executive benefits & perks*** might include supplemental executive pension plans, supplemental life insurance & health insurance without a deductible.

What Determines Executive Pay?

- - Company Size;
- Company Performance;
- Business Strategy;
- Corporate Trends;
- Complexity & Unpredictability of the decisions they make.

Elements of Executive Pay:

Salary is traditionally the cornerstone of executive compensation; it is the element on which employer's layer benefits, incentives, & perquisites- all normally conferred in proportion to base pay. Executive compensation emphasizes performance incentives more than do other employees pay plans, since organizational results are likely to reflect executives' contributions more directly than lower-level employees. Boards are boosting the emphasis on performance based pay.

Compensating Professional Employees:

Professional Employees are those whose work involves the application of learned knowledge to the solution of the employer's problems. Compensating Professional employees like engineers & scientists presents unique problems. Analytical jobs like these emphasize creativity, problem solving, & compensable factors not easily compared or measured. Employers can also use job evaluation for professional jobs. Compensable factors here tend to focus on problem solving, creativity, technical knowledge & expertise.

Competency Based Pay:

Competency Based Pay means the company pays for the employee's range, depth, & types of skills & knowledge, rather than for the job title he or she holds. Experts variously call this competence- knowledge or skill-based pay. With competency based pay, an employee in a class-I job who could do class II work gets paid as a class II worker, not a class I. Competencies are demonstrable characteristics of a person, including knowledge, skills, and behaviors, that enable performance. Pay for knowledge pay plans reward employees for learning organizationally relevant knowledge- for instance Microsoft pays new programmers more as they learn the intricacies of Windows Vista. Skill-based pay tends to be used more for workers with manual jobs- thus carpenters earn more as they become more proficient at finishing cabinets.

Why Use Competency Based Pay?
- Support High-Performance Work system: (Encourage employees to work self-motivated way, organizing work around teams, pushing more responsibility for things etc)
- Support Strategic Aims: (Paying for skills, knowledge & competencies is more strategic)Support Performance Management: Performance management means aligning employees goals, training, appraisals & rewards so that they support the company's strategic goals. There is not much a manager can do to "manage" the employee's job duties. So, paying for competencies rather than duties gives the employer more control over managing the employee's performance.

Competency Based Pay in Practice:

In practice, skill/competency/knowledge-based pay programs generally contain 4 main elements:-

- A system that defines specific skills, and a *process* for tying the person's pay to his or her skill
- A *training system* that lets employees seek and acquire skills
- A formal competency *testing* system
- A *work design* that lets employees move among jobs to permit work assignment *flexibility*.

Competency Based Pay:

Pros:-
- Higher quality;
- High productivity;
- Higher Growth;
- High Motivations;
- Higher job Satisfaction;
- Healthy Competition.

Cons:-
- Implementation problems;

- The cost implications of paying employees for knowledge, skills & behaviours even if they are not used;
- Complexity of program –systems and evaluations and assessment;
- Uncertainty that the program improves productivity.

Concepts of Wages:

Various forms of wage & salary policies have been developed, differing according to such factors as the nature of the business its location, needs of the workers, capacity of the employee to pay, & general economic conditions prevailing in a country.

- **Minimum Wage: -** "A minimum wage is that wage which is sufficient to cover the bare physical needs of a worker and his family". It was observed that the minimum wage must provide for the preservation of the efficiency of the worker (education, medical requirements & amenities). It is the wage which has to be paid to the workers irrespective of the capacity of the industry to pay.
- **Fair Wage: -** Fair Wage is understood in 2 ways. In a narrow sense, wage is fair if it is equal to the rate prevailing in the same trade & in the neighborhood for similar work. In a wider sense, it will be fair if it is equal to the predominant rate for similar work throughout the country & for the trades in general.
- **Living Wage:-** Living Wage is a step higher than fair wage. Living Wage may be described as one which should enable the wage earner to provide for himself/herself & his/her family not only the bare essentials of like food, clothing, & shelter, but a measure of frugal comforts including education for children, protection against ill health, requirements of essential social needs, & measure of insurance against the more important misfortunes including old age.

Principles of Wage Administration:

- Wage Policies should be carefully developed, having in mind the interests of (a) Management as the representative of the owners (b) the employees, (c) the consumers (d) the community;
- Wage Policies should be clearly expressed in writing to ensure Uniformity & Stability;
- Management should see to it that the employees know & understand the wage policies;
- Wage policies should be evaluated from time to time to make certain that they are adequate for current needs;
- Matching Employee Expectations;

- Reinforcing positive employee behavior & contribution to the organization;
- Eliminating any discrepancies in wage administration in the organization.

Basic Wage Plans:

- **Time Wage Plan:** Under this system, the worker is paid for the amount of time spent on the job. This is the oldest & most common system & the wages are based on a certain period of time during the course of work. The period of time may be an hour, a day, a week etc & the wage rate will depend upon time fixed for wok is completed irrespective of output or completion of the work.
- **Piece Wage Plan:** Under this system, the output of work is the basis of wage payment. A worker is paid according to the amount of work completed or the number of units turned out irrespective of time taken. Though the time is not essence in this system, it is assumed that the worker will not take more than average time to complete the job. The earnings of a worker depend upon the speed of his work & his own skill & efficiency.
- **Skill base pay**: Under this system, employees are compensated for their job related skills. This is also called knowledge based pay. Under a typical skill based system, companies hire employees at below-market rates. Once they gain extensive knowledge & new skills, they are promoted & rewarded with an increased pay.
- **Competency based pay:** Competency can be defined as the knowledge, skills & behavior of an individual that contribute to a worker's performance. The competencies of the best performing employee are indentified & the employee is compensated for these competencies that he/she brings to the job.

CASELET

PRODUCTIVITY GAINS AT WHIRLPOOL

Workers and management at Whirlpool Appliance's Benton Harbor plant in Michigan have set an example of how to achieve productivity gains, which has benefited not only the company and its stockholders, but also Whirlpool customers, and the workers themselves. Things weren't always rosy at the plant. Productivity and quality weren't good. Neither were labor-management relations. Workers hid defective parts so management wouldn't find them, and when machines broke down, workers would simply sit down until sooner or later someone came to fix it. All that changed in the late 1980s. Faced with the possibility that the plant would be shut down, management and labor worked together to find a way to keep the plant open. The way was to increase productivity-producing more without using more resources.

Interestingly, the improvement in productivity didn't come by spending money on fancy machines. Rather, it was accomplished by placing more emphasis on quality. That was a shift from the old way, which emphasized volume, often at the expense of quality. To motivate workers, the company agreed to gain sharing, a plan that rewarded workers by increasing their pay for productivity increases.

The company overhauled the manufacturing process, and taught its workers how to improve quality. As quality improved, productivity went up because more of the output was good, and costs went down because of fewer defective parts that had to be scrapped or reworked. Costs of inventory also decreased, because fewer spare parts were needed to replace defective output, both at the factory and for warranty repairs. And workers have been able to see the connection between their efforts to improve quality and productivity.

Not only was Whirlpool able to use the productivity gains to increase workers' pay, it was also able to hold that lid on price increases and to funnel some of the savings into research.

Questions

1. What were the two key things that Whirlpool management did to achieve productivity gains?

2. Who has benefited from the productivity gains?

3. How are productivity and quality related?

4. How can a company afford to pay it workers for productivity gains?

5. Explain compensation management. Describe how in an organization any compensation plan can keep motivated to its employees?

Self Assessment Questions

3. What do you mean by work measurement?

2. Discuss the various techniques of work measurement.

3. Discuss the different types of allowances.

4. How any compensation plan helps to keep motivated to their employees?

UNIT - 14

MANAGEMENT INFORMATION FOR PRODUCTION SYSTEM

14.1 CROSS-FUNCTIONAL SYSTEM

A **cross-functional system** is a group of people with different functional expertise working toward a common goal. It may include people from finance, marketing, operations, and human resources departments. Typically, it includes employees from all levels of an organization. Members may also come from outside an organization (in particular, from suppliers, key customers, or consultants).

Cross-functional teams often function as self-directed teams responding to broad, but not specific directives. Decision making within a team may depend on consensus, but often is led by a manager/coach/team leader.

A cross-functional information system is the third era of information systems, after calculations systems and functional systems. Cross-functional systems were designed to integrate the activities of the entire business process, and are called so because they 'cross' departmental boundaries. Changing over to a cross-functional system from a functional one can be problematic at times, as it involves the coordination of activities across multiple departments, with the users changing the way that they work. There is no clear line of authority, and fierce peer competition can often lead to interdepartmental rivalries that hinder the development of the new system.

Example Of Cross Functional System

1. Enterprise Resource Planning (ERP) is an integrated computer-based system used to manage internal and external resources, including tangible assets, financial resources, materials, and human resources. Its purpose is to facilitate the flow of information between all business functions inside the boundaries of the organization and manage the connections to outside stakeholders. Built on a centralized database and normally utilizing a common computing platform, ERP systems consolidate all business operations into a uniform and enterprise-wide system environment. An ERP system can either reside on a centralized server or be distributed across modular hardware and software units that provide "services" and communicate on a local area network. The distributed design allows a business to assemble modules from different vendors without the need for the placement of multiple copies of complex and expensive computer systems in areas which will not use their full capacity.

Cross-Functional Teams

The simplest definition of cross-functional teams (or CFTs) is groups that are made up of people from different functional areas within a

company—marketing, engineering, sales, and human resources, for example. These teams take many forms, but they are most often set up as working groups that are designed to make decisions at a lower level than is customary in a given company. They can be either a company's primary form of organizational structure, or they can exist in addition to the company's main hierarchical structure.

Cross-functional teams have become more popular in recent years for three primary reasons: they improve coordination and integration, span organizational boundaries, and reduce the production cycle time in new product development. Bringing people together from different disciplines can improve problem solving and lead to more thorough decision making. The teams foster a spirit of cooperation that can make it easier to achieve customer satisfaction and corporate goals at the same time.

Cross-functional teams are not new. Northwestern Mutual Life insurance company pioneered their use in the 1950s when the CEO of the company brought together people from the financial, investment, actuarial, and other departments to study the impact that computers would have on the business world. As a result of that first CFT, Northwestern was among the first companies in the country to create an information systems department that gave the company a large competitive advantage as computers gained in popularity. The company now relies on cross-functional teams in almost every facet of its organization. Based on success stories like this one, CFTs slowly grew in popularity throughout the 1960s and 1970s before exploding in popularity in the 1980s when faster production time and increased organizational performance became critical in almost every industry.

Cross-functional teams are similar to conventional work teams, but they differ in several important ways. First, they are usually composed of members who have competing loyalties and obligations to their primary subunit within the company (for example, a marketing person serving on a cross-functional team has strong ties to his or her home department that may conflict with the role he or she is being asked to play on the CFT). Second, in companies where CFTs are being used on a part-time basis as opposed to a permanent organizational structure, they are often temporary groups organized for one important purpose, which means group members are often under considerable pressure. On these temporary teams, the early development of stable and effective group interaction is imperative. Finally, CFTs are often held to higher performance standards than conventional teams. Not only are they expected to perform a task or produce a product, they are also expected to reduce cycle time, create knowledge about the CFT process, and disseminate that knowledge throughout the organization.

For cross-functional teams to succeed, several factors have been identified that are imperative:

- Team members must be open-minded and highly motivated.
- Team members must come from the correct functional areas.

- A strong team leader with excellent communication skills and a position of authority is needed.
- The team must have both the authority and the accountability to accomplish the mission it has been given.
- Management must provide adequate resources and support for the team, both moral and financial.
- Adequate communications must exist.

Without any one of these elements, any cross-functional team will be fighting an uphill battle to succeed.

Cross-Functional Teams and New Product Development

Many businesses have been able to use cross-functional teams to reduce the cycle time in new product development. As a result, CFTs have become a common tool in new product development at many companies, especially those in industries in which rapid change and innovation is the norm. CFTs have shown the flexibility to adapt to changing market needs and the ability to more quickly develop innovative products.

In the past, new product development invariably meant gathering data sequentially from a number of departments before a new product was given the green light. First, the idea would be conceptualized. Then, it would be handed off to the marketing department, which would conduct market research to see if the product was viable. The product might then be passed on to the sales department, which would be asked to create a sales estimate. From there, the idea would move on to engineering or manufacturing, which would determine the costs to produce the product. Finally, with all those numbers gathered over the course of months, or even years, the product would move to an executive committee which would either approve or kill the project. By that time, market conditions sometimes had shifted sufficiently to render the product obsolete.

Cross-functional teams eliminate the "throw it over the wall" mentality that passes a product off from department to department. Instead, a member of each of the above functional areas would have a representative on the new product team. Team members would learn of the new product at the same time and would begin working on estimates together. If part of the product simply could not be manufactured cheaply enough, the team member from that area could immediately sit down with the engineering rep and come up with a new production method. The two of them could then meet with the marketing and sales team members and discuss new ways to position the product on the market. The result, say

proponents, is a vastly improved product that is manufactured and released to the market in far less time than was achieved using traditional methods.

Establishing a Cross-Functional Team

Set Goals

When CFTs are first convened, conflict may be the result. There is a good chance that some of the members of the new team have bumped heads in the past when their functional areas clashed over a project. Additionally, some CFT members may think that their area of specialty is the most important on the team and thus assume an inflated sense of value to the team. Finally, since CFTs often bring together people who have vastly different ranks in the organizational hierarchy, there can be power plays by members who are high-ranking employees off the team but are actually less important stakeholders on the team. Those high-ranking team members may try to assert authority over the team in a situation when they should be deferring to lower-ranking team members.

The High Production Volume Information System (HPVIS) is a database that provides access to health and environmental effects information obtained through the High Production Volume (HPV) Challenge. This program "challenges" companies to make this data publicly available on chemicals produced or imported into the United States in quantities of 1 million pounds or more per year.

On this Web site, HPVIS enables users to search for summary information, test plans, and new data on HPV chemicals as they are received by the Agency. Currently, the HPVIS database contains over 340 submissions, representing almost 900 chemical substances, either as a single chemical submission or as a member of a chemical category.

EPA is carefully reviewing HPV chemical data to characterize the hazards and risks associated with HPV chemicals. HPVIS contains HPV Chemical Hazard Characterizations prepared during EPA's ongoing review of the health and environmental effects data contained with each HPV Challenge Program submission. HPVIS also contains Risk-Based Prioritization documents prepared from EPA's examination of HPV Challenge hazard data along with chemical use and exposure information collected from the 2006 Inventory Update Reporting (IUR). These recommendation documents prioritize HPV chemicals for follow-up data collection or management actions based on their potential risks.

Database

A **database** is an organized collection of data. The data is typically organized to model relevant aspects of reality (for example, the availability of rooms in hotels), in a way that supports processes requiring this information (for example, finding a hotel with vacancies).

Database management systems (DBMSs) are specially designed applications that interact with the user, other applications, and the database itself to capture and analyze data. A general-purpose **database management system (DBMS)** is a software system designed to allow the

definition, creation, querying, update, and administration of databases. Well-known DBMSs include MySQL, PostgreSQL, SQLite, Microsoft SQL Server, Microsoft Access, Oracle, SAP, dBASE, FoxPro, IBM DB2 and FilemakerPro. A database is not generally portable across different DBMS, but different DBMSs can inter-operate by using standards such as SQL and ODBC or JDBC to allow a single application to work with more than one database.

Data Collection and HPVIS Content

In the HPV Challenge Program, companies have sponsored more than 2,200 HPV chemicals, with approximately 1,400 chemicals sponsored directly through the HPV Challenge Program and over 860 chemicals sponsored indirectly through international efforts. Only directly sponsored HPV Challenge Program chemicals make it to HPVIS.

Under the program, when companies, such as chemical manufacturers and trade associations, voluntarily sponsor a set of HPV chemicals, they provide existing data or perform tests on the chemicals, and submit their test data to this database. To ensure consistency, sponsors follow the Screening Information Data Set (SIDS), developed by the Organization for Economic Cooperation and Development (OECD). SIDS provides internationally agreed upon tests for screening chemicals for human and environmental hazards.

HPVIS consists of basic hazard (toxicity) and environmental fate information on HPV chemicals that can be used by environmental managers, public decision-makers, and others in their own health and environmental protection activities.

Manufacturing Information System

The information needs were and are always there. Information systems used to exist when computerized environments were not available. Automation has enhanced the availability of information. Every industry has its own departmental structure which gives rise to a different set of sub-systems as part of the information system. Here we would consider the sub-systems of a manufacturing system only.

Following are the sub-systems of an information system

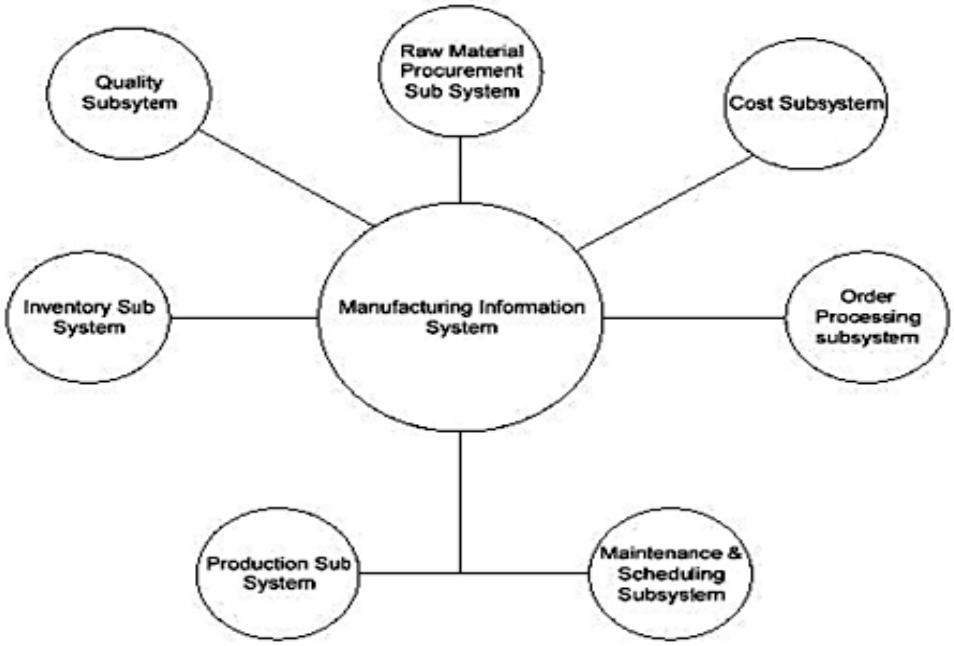
Raw Material Procurement Sub-System

This is the commencement of the manufacturing process. Some might think of procurement as a simple purchasing process like any other commodity but the spirit of having an all-embracing raw material procurement sub-system is simply more than that

Parameters of Raw-material Procurement

Like with every system, there has to be a list of minimum specifications which every system or subsystem has to cover. Purchasing logistics of an entity critically affect time to market and other quality related issues. Issues like selection of suppliers, choice between local purchase or import and delivery time taken by the supplier. All these

concerns are met and dealt with in the purchase subsystem. The complexity of the purchase subsystem should depend on types of raw materials required, number of suppliers to deal with and complexity of the terms of purchase agreements for long term. With higher customer expectations, every organization wants to efficiently manage its suppliers and other internal processes. Supply chain management spans all movement and storage of raw materials, work-in- process inventory, and finished goods from point-of-origin to point-of-consumption. A procurement system should help in improving the supply chain of the organization.



Inventory Sub System

Inventory subsystem focuses on maintaining records and movements on inventory levels and usage. This control of inventory is critical to the organization since money lock-in of raw materials purchase represent substantial investment. Timely production of finished goods require availability of right quantity of material, maintenance of right stock levels, determination of lead times and flex times and exchange of information with supplier at the right time. An inventory subsystem helps us to address these issues. Inventory subsystems are critical where the organization is following Just in Time approach a philosophy which encourages zero tolerance for stock levels and placing orders exactly when they are needed for manufacturing.

Proper logistic management is important for the timely and quality production.

Various factors which can play critical role are

– Who to purchase from supplier selection

- When to purchase time of delivery or raw materials
- How much to purchase Ideal stock levels
- An efficient inventory subsystem helps us to deal with these issues in a time saving manner.

Production Sub System

It can be seen as the most critical part of the entire manufacturing sub system. Basically it tracks the flow of the job through the entire production process. It also records change in form of goods or transfer of goods from one place to the other

Maintenance & Scheduling Sub System

For efficient production, the machines should be timely available. Many a times, the machine is under repair and is not available to be used for production. Without this subsystem, there is a possibility of customer's orders not being met on time. Certain issues that can be very important are

- ·Deciding delivery time in accordance with availability of machines.
- ·Any foreseen machine-down-time.
- ·Any major overhauling / tuning / replacement expected may result in unavailability of machine. An overhauling schedule should be kept so that the production of finished goods is not halted.
- ·Avoiding duplication of jobs for the same machine.

Quality Sub system

This subsystem ensures the production made and end product being delivered to the customer are conforming the quality standards set by the company. Quality covers aspects for the organization like better quality raw materials and what is being purchased is according to organization's standards and improved finished goods in accordance with the customer specification.

The question now arises is why do we need a quality sub-system? It is defined and demanded by customer, it has to be achieved by management, it is a firm wide responsibility and these subsystem provide the firm's managers with information that reveals the extent to which the firms products are achieving the quality goals.

Total Quality Management (TQM)

TQM is a set of management and control activities which focus on quality assurance. The quality of the products and services is enhanced and then offered to consumers. An organizational undertaking to improve the quality of manufacturing and service, it focuses on obtaining continuous feedback for making improvements and refining existing processes over the long term. There are certain Graphical tools used to implement and promote TQM. For instance

- Histogram

- ❖ Pareto Analysis
- ❖ Cause & Effect Diagram

Costing Sub System

Costs are incurred more frequently in a manufacturing entity. Monitoring these costs on regular basis requires instituting a formal cost subsystem. Cost sub systems are responsible for generation of cost reports which represent cost break ups on various bases, for instance

- ❖ Machine usage basis
- ❖ Product basis
- ❖ Department wise

Order Processing Sub System

This subsystem deals with following issues.

·Status of orders placed with suppliers

·Status of departmental requisitions

·Quality of materials received

·Any other issues related to suppliers

Order processing subsystem gives a snapshot of statuses of various orders placed, at any given time.

Management Levels in Manufacturing Information Systems

Manufacturing Information System should cater for information requirements at each level, for instance

Strategic level

3. Locating new plant which can save cost
4. Investment in new manufacturing technology

Knowledge Level

3. Distribute knowledge to drive the production process
4. Innovating new forms of manufacturing processes

Management level

2. Monitoring production costs and resources

Operational Level

2. Status of production tasks

Planning Productions/Operations

This function in many firms is supported by IT. The major areas of planning and their computerized support are as follows.

- ❖ Materials Requirement Planning (MRP)
- ❖ Manufacturing Resource Planning (MRP II)
- ❖ Automated Software

Computer Aided Design (CAD)

Computer Aided Manufacturing (CAM)

Computer Integrated Manufacturing (CIM)

Materials Requirement Planning (MRP)

Material procurement needs to be planned in compliance with the production Schedule. Initially companies used to do plan it manually through a document termed as "Material Requirement Plan". Material

Requirements Planning (MRP) is software based production planning and inventory control system for material procurement and scheduling.

It helps meeting three objectives:

- ❖ Ensure materials and products are available for production and delivery to customers.
- ❖ Maintain the lowest possible level of inventory.
- ❖ Plan manufacturing activities, delivery schedules and purchasing activities.

MRP helps in getting the right material and physical resources together at the right place and at the right time to meet the customer's requirements. This helps in achieving on time delivery, High Quality, at the best price.

Manufacturing Resource Planning (MRP II)

An expanded version of MRP that integrates finance, accounting, accounts payable and other business processes into the MRP system. It also includes production scheduling function, and inventory control functions. It is an integrated computer system that connects the regular MRP to other functional area, especially finance and human resources. It is made up of a variety of functions, each linked together:

- ❖ Business planning
- ❖ Sales and operations planning
- ❖ Production planning
- ❖ Master scheduling
- ❖ Material requirements planning
- ❖ Capacity requirements planning

Automated Tools

IT has been used successfully in cutting the time required for the design of products, services or processes. Some of these applications are

- – ·Computer Aided Design (CAD)
- – ·Computer Aided Manufacturing (CAM)
- – ·Computer Integrated Manufacturing (CIM)

Computer Aided Design (CAD)

"It is a system that enables drawings to be constructed on a computer screen and subsequently stored, manipulated and updated electronically."

The ability to rotate or create movement in the design allows testing for clearances and frequently reduces the cost of prototyping the products. The technology is used for a wide variety of products in such fields as architecture, electronics, and aerospace, naval, and automotive engineering. Although CAD systems originally merely automated drafting, they now usually include three-dimensional modeling and computer- simulated operation of the model. Rather than having to build prototypes and change components to determine the effects of tolerance ranges, engineers can use computers to simulate operation to determine loads and stresses. For example, an automobile manufacturer might use CAD to calculate the wind drag on several new car-body designs without having to build physical models of each one. In microelectronics, as devices have become smaller and more complex, CAD has become an especially important technology. Among the benefits of such systems are lower product-development costs and a greatly shortened design cycle. While less expensive CAD systems running on personal computers have become available for do-it- yourself home remodeling and simple drafting, state-of-the-art CAD systems running on workstations and mainframe computers are increasingly integrated with computer-aided manufacturing system.

Computer Aided Manufacturing (CAM)

Computer-aided manufacturing (CAM) is a form of automation where computers communicate work instructions directly to the manufacturing machinery. The technology evolved from the numerically controlled machines of the 1950s, which were directed by a set of coded instructions contained in a punched paper tape. Today a single computer can control banks of robotic milling machines, lathes, welding machines, and other tools, moving the product from machine to machine as each step in the manufacturing process is completed. Such systems allow easy, fast reprogramming from the computer, permitting quick implementation of design changes. The most advanced systems, which are often integrated with computer-aided design systems, can also manage such tasks as parts ordering, scheduling, and tool replacement.

It is a system that uses computer aided techniques to control production facility. Some of these techniques are

- Computer-aided process planning Use of computer to control activities and functions to prepare a detailed set of plans and instructions to produce a machine or part. -- Machines
- Computerized Numerical control (CNC) refers specifically to the computer control of machine tools for the purpose of (repeatedly)

manufacturing complex parts in metal as well as other materials. e.g. drills, wood routers use this technology.

- ❖ Robotics programming The science or study of the technology associated with the design, fabrication, theory, and application of robots. Automobile industry.

Self Assessment Questions

1. What is the importance of management information for production system?
2. How TQM help in production system?

UNIT - 15

JUST IN TIME

15.1

Just-In-Time (JIT) manufacturing is a process by which companies don't keep lots of excess inventory; instead, they manufacture a product as an order comes in. It is a management philosophy of continuous and forced problem solving.

The objective of JIT manufacturing system is to:

- Eliminate waste that is, minimize the amount of equipment, materials, parts, space, and worker's time, which adds a great value to the product
- Increase productivity

JIT means making what the market demands when it is in need. It is the most popular systems that incorporate the generic elements of lean systems. Lean production supplies customers with exactly what the customer wants, when the customer wants, without waste, through continuous improvement.

Deploying JIT results in decrease of inventories and increases the overall efficiencies. Decreasing inventory allows reducing wastes which in turn results in saving lots of money. There are many advantages of JIT:

- Increases the work productivity
- Reduces operating costs
- Improves performance and throughput
- Improves quality
- Improves deliveries
- Increases flexibility and innovativeness

For industrial organizations to remain competitive, cost efficiencies have become compulsory. JIT helps in this process. It is extended to the shop floor and also the inventory systems of the vendors. JIT has been extended to mean continuous improvement. These principles are being applied to the fields of Engineering, Purchasing, Accounting, and Data processing.

However, for organizations to completely implement JIT manufacturing system, they need to have a proper commitment along with the following basic facilities - proper material, quality, equipment, and people involvement.

Characteristics of JIT

In this section, we will study different methods by which inefficiency is reduced and unproductive time is minimized. The consequent savings are to be utilized for reducing cost and rendering better service to the customer. Shigeo Shingo an authority on JIT at Toyota classifies the wastes to be eliminated as follows. *(See Figure : Seven wastes)*

The seven wastes to be eliminated according to JIT are:

1. Over production
2. Inventory
3. Waiting time
4. Movement
5. Effort
6. Defective products
7. Over processing

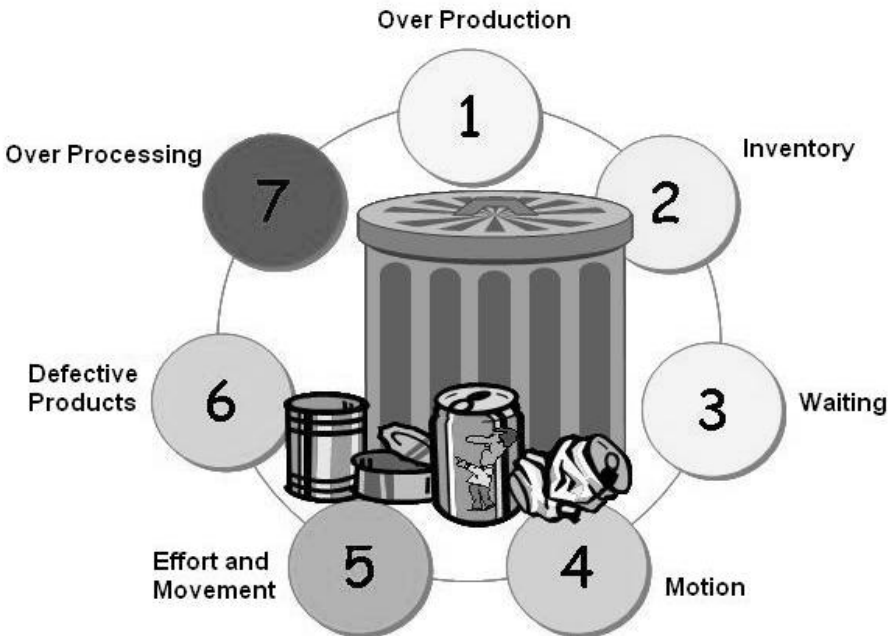


Figure: Seven wastes

1. ***Over production*:** Over production is to manufacture products before it is actually needed. If the demand for that product decreases, the extra parts or products produced may not be useful or needed. Also over production results in high storage costs and is also difficult to detect defects. So, over production is considered a waste.

2. ***Inventory:*** Excess procurement or production builds up stock of materials which are not immediately used, thus locking space and funds carrying heavy costs. The figure 13.2, illustrates the inventories at different levels of an organization – Supplier distribution, Production, and Customer distribution.

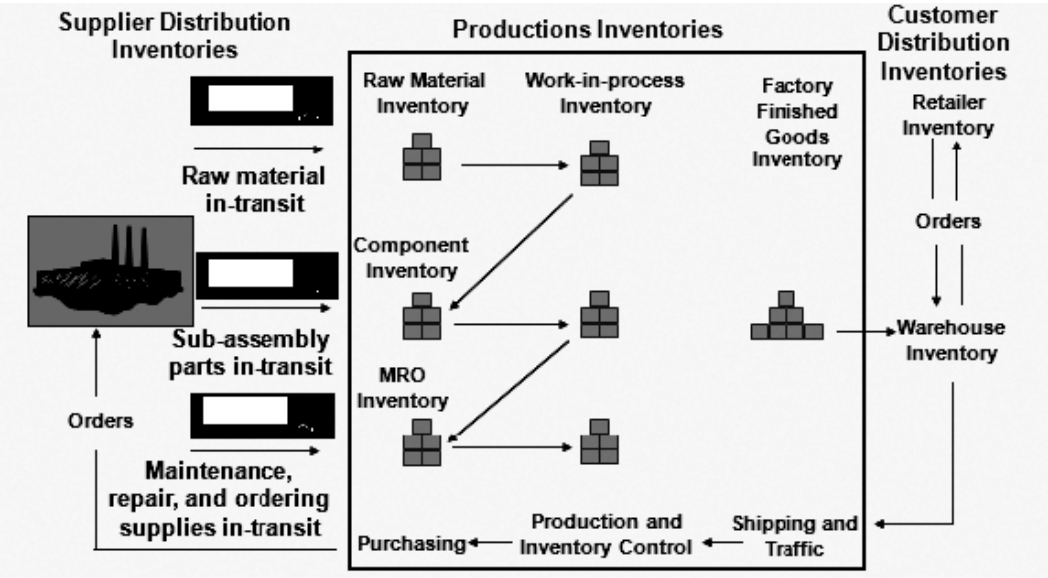


Figure: Inventories in an organization

3. ***Waiting time:*** Waste of time happen when goods are not moving or being processed. The operator, the machine or the part will either be not working or be worked upon. The duration of waiting is can be said to be unproductive and may create more serious consequences.

4. ***Movement:*** Any unnecessary movement is a waste of energy; it causes blockages, disrupting movements and delaying the flow of other items creating delays.

5. ***Effort:*** The people, who work, do not make a study as to how the products on which they are making are utilized and do not realize the purpose for which they are made. This lack of education will lead to waste of resources. Finally, they end up in shortage of resources when needed.

6. ***Defective products:*** The defective products lead to a tremendous loss to the company. This is because they use up the same equipments, workmen and the time that would be used to make good products. Thus defective products use up resources and result in losses.

7. ***Over Processing:*** Some steps like unnecessary processing or production do not add value to the final output. As a result, it is waste of all the inputs that go into the process.

Since these wastes have to be eliminated, a thorough study of how they occur and what steps would result in their elimination is of paramount importance.

Philosophy of JIT

The philosophy of JIT is simple: the storage of unused inventory is a waste of resources. JIT inventory systems expose hidden cost of keeping inventory, and are therefore not a simple solution for a company to adopt. The company must follow an array of new methods to manage the consequences of the change. The ideas in this way of working come from many different disciplines including statistics, industrial engineering, production management, and behavioral science. The JIT inventory philosophy defines how inventory is viewed and how it relates to management.

Inventory is seen as incurring costs, or waste, instead of adding and storing value, contrary to traditional accounting. This does not mean to say JIT is implemented without awareness that removing inventory exposes pre-existing manufacturing issues. This way of working encourages businesses to eliminate inventory that does not compensate for manufacturing process issues, and to constantly improve those processes to require less inventory. Secondly, allowing any stock habituates management to stock keeping. Management may be tempted to keep stock to hide production problems. These problems include backups at work centers, machine reliability, and process variability, lack of flexibility of employees and equipment, and inadequate capacity.

In short, the Just-in-Time inventory system focus is having “the right material, at the right time, at the right place, and in the exact amount”, without the safety net of inventory. The JIT system has broad implications for implementers.

Implementation of JIT

JIT, Total Quality Management (TQM) and other developmental measures, are possible only with top management commitment and a learning culture in the organization. The main handicap to any programme is the resistance by the organizational members, even at the top, to make changes. This resistance may take the form of non-cooperation and may enlarge to become sabotage. These usually show up at the implementation stage. So, communication of the goals is to be realized and the objectives of each team are to be framed effectively. Initially, a milestone chart helps in establishing various steps to be taken and correcting the activities as the process is on. This is the best way of ensuring success. It is well to remind you at this stage that JIT is not a destination, but an ongoing continuous improvement programme in the process of achieving TQM.

- **Pre-requisites of JIT**

Like any advanced method of production and quality improvement, some pre-requisites are needed to be in place so that, implementation is easy and the results are identifiable. The following table gives the requirements from the design process to the measurement of performance.

Table: Prerequisites for measurement of performance	**Design Flow Process**	1. Link operations 2. Balance workstation capacities 3. Relay-out for flow 4. Emphasis preventive maintenance 5. Reduce lot sizes 6. Reduce set-up and changeover times
b	**Total Quality Control**	1. Worker responsibility for quality 2. Measure – SQC 3. Enforce compliance 4. Fail-safe methods 5. Automatic inspection
c	**Stabilize Schedule**	1. Level schedule 2. Under utilize capacity
d	**Kanban Pull**	1. Demand pull 2. Back flush 3. Reduce lot sizes
e	**Work with Vendor**	1. Reduce lead times 2. Frequent deliveries 3. Project usage requirements 4. Quality expectation
f	**Reduce Inventories**	1. Look for other areas 2. Stores 3. Transit 4. Carousels 5. Conveyors
g	**Improve Product Design**	1. Standard product configuration 2. Standardize and reduce number of parts 3. Process design with product design 4. Quality expectations

The above activities lead to:

a. Solving problems concurrently

1. Root cause

2. Solve permanently
3. Team approach
4. Line and specialist responsibility
5. Continual education

b. Measuring performance

1. Emphasize improvement
2. Track trends

You will observe that when above requirements are met, we achieve JIT to a very close extent.

- **Shop floor control**

Realistic planning and scheduling takes the frequency with which setups have to be changed to manage material flow without building up inventories into consideration, and leads to JIT manufacturing.

SMED (Single Minute Exchange of Dies) gives flexibility for production process. Advocated by Shigeo Shingo, SMED method calls for designing, making fixtures, and tooling which are instrumental in changing setups so that, changes are to be effected within a minute. The de-clamping and clamping elements should be made for this purpose.

Application of Kanban, wherever suitable is another mechanism for controlling flow of material. Maintenance of machines and periodic shop floor inspection is necessary. Verifying whether the processes are delivering components within the tolerances specified is needed.

- **JIT Purchasing**

The essence of JIT purchasing, lies in treating the purchaser as a participant in your activities. Cooperative relationship leads to the development of the supplier who understands company's requirements and in situations where he confronts any difficulty, he should be in a position to approach the company for its solution. Being open and trusting helps the organizations to identify the problems and go to the source which is like implementing TQM.

Every problem or discovery of a defect is considered an opportunity, which the supplier and the company together get a deeper understanding of the problem, and the solutions will not only solve that problem, but also ones that were hidden. It is also the practice of many companies who procure a large number of parts manufactured from their vendors to have supplies made to the assembly in specific quantities to meet the needs just in time.

Self certification by the vendor is resorted to ensure quality of the material. The actual users are given autonomy to demand from the supplier, the quantities required as well as the time of its need. Any change in demand is conveyed and complied. This requires cooperation and trust between the supplier and the customer. This is how JIT

purchases work. The JIT purchasing concept attempts to reduce replenishment lead time by utilizing suppliers located close to the using plant and by ordering small quantities, which in turn reduces a supplier's workload per period. The most important aspects of the JIT purchasing concept focus on new ways of dealing with suppliers and a clear-cut recognition of the appropriate purchasing role in the development of corporate strategy. Suppliers should be viewed as outside partners who can contribute to the long-run welfare of the buying firm rather than as outside adversaries. The major actions focus on attempts to reduce the ordering cost and replenishment lead time values. Hahn et al noted that more systematic empirical research is needed to assess the costs and benefits of JIT purchasing systems. Such research should provide new dimensions and opportunities for refining existing purchasing and materials management theory.

- **Vendor managed inventory**

The very purpose of JIT is to reduce inventory at all places in the supply chain. Inventory is considered a waste because inventory is created by using materials, machines and efforts of persons. All of these are resources which have already been used up and that portion of it which is not consumed and sent up the value chain causes a drag on the system. However, inventories are inevitable because uncertainties exist at every stage, making it necessary to provide a buffer so that demands do not go unfilled. The challenge is to keep it to the minimum. To make this happen, the calculations involving the following are necessary.

- ☐ Forecasts of the market demand
- ☐ Capacities of the equipments
- ☐ Worker absenteeism
- ☐ Suppliers' lead times
- ☐ Quality of the produced components

Each of these will have many factors which affect them. JIT depends upon accurate assessment of them and based on the decisions taken, activities are initiated. These should result in holding materials as small as the number of components or products as feasible to maintain flow of material without disruption. Many companies make their suppliers hold their inventories and request them to make timely supplies. This may be done at a cost.

CASELET

Anode Electronics produces different kinds of electronic products like TVs and tape recorders. Since the world market of electronics was moving towards high variety of products and the delivery of the orders was getting shorter, the top managers of Anode Electronics were under a great pressure to increase the competitive position of the company in the market. One of the executive managers of Anode Electronics suggested implementing a system called JIT with the hope that inventory levels would be reduced and quality production would increase.

The main aspect in introducing JIT manufacturing system in a company is to educate the staff about JIT. Four middle level managers were asked to attend a seminar conducted by a company called Electrode Combinations who have already implemented this system, so that they could explain the whole company about JIT manufacturing system. A group of managers, one from each department were a part of the team who discussed what is to be done and how to implement JIT in their company. According to their discussions, the following 5 activities were called the 5 JIT principles.

- ☐ Classify materials on the shop floor based on its usefulness
- ☐ Place the value-added materials in handy positions
- ☐ Clean up the non-value-added materials
- ☐ Maintain the factory in a good looking shape
- ☐ Let the employees in the company have good habits and follow the rules

With these activities, the working environment in Anode Electronics was improved and the safety, quality, and productivity were increased. As the JIT system was newly implemented in Anode Electronics, the company started continuously improving the quality of the products. The managers of each department formed an improvement committee to look after the implementation of JIT in different areas of the company, especially the shop floor. All necessary materials were posted with a ‘red card’ and deposited for further rework. Thus all materials have been identified in terms of their names, places, quantities, and so on. The concept of visual management, which is management simply by eye sight, has been strongly motivated and encouraged.

Tremendous resistance from suppliers and workers was faced during the early stage of developing the JIT system. High level commitments of top manager, determination of pushing JIT system and suppliers’ involvement have helped to achieve JIT material flow. With

this, the Anode Electronics Company has laid down a solid foundation for the JIT system so that the production system can be operated smoothly to improve safety, quality, and productivity over the years. The quality and productivity problems 'under the water' have shown up and have been solved.

A major success in the implementation of JIT system showed the reduction in the amount of inventory and workers. Inventory level has reduced by 63%, parts inventory has reduced by 50%, and the number of workers has reduced from 1020 to 865 during the past four years. The growth rate of the company has increased by 5% every year.

Key Processes to Eliminate Waste

The key processes to eliminate the wastes are listed below:

1. Kanban for material flow
2. High quality productions
3. Small and uniform workloads
4. Suppliers as partners
5. Flexible workforce and training
6. Total productive maintenance

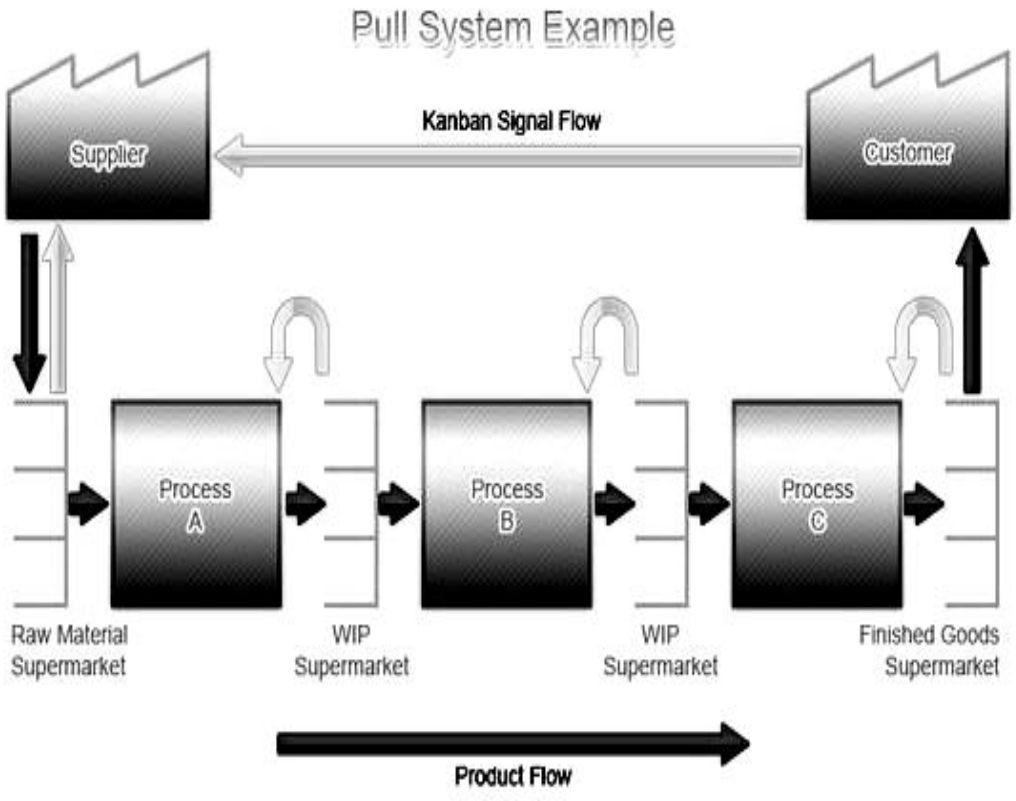
Let us discuss in brief about each processes in this section.

Kanban for material flow

Controlling material flow using cards through the manufacturing system implementing JIT is called Kanban. These cards are used to tell a work station to perform a certain function on materials.

Kanban means a 'Visible Card' and also 'Signal' in Japanese language. These cards are used for communicating the quantities required at the 'customers' point for his use. This means that the operator next in line, who is the customer, decides how many units he needs and asks for them. The operator who receives the card should make only that many and supply. Similarly, the operator makes a demand on his predecessor by a 'kanban' and receives only the required quantity. This is called the pull system.

See figure for the operation of the Pull/Kanban system. It controls the flow of resources in a production process when and where a customer order is placed. This system helps to eliminate waste in handling, storing, and delivering the product to the customer.



Example of a Kanban signal flow

The containers used in the material flow are designed to hold specific components in certain numbers. Kanban system is a physical control system which uses cards and containers, that is, materials must not be removed without posting a card at the receiving post.

Advantages of Kanban processes are listed below.

- ☐ The orders are controlled and triggered from defined locations
- ☐ Inventory costs and Work in Progress (WIP) are reduced
- ☐ The control of stock in the inventory will be improved
- ☐ The lead time to deliver is reduced
- ☐ The process demand can be visualized
- ☐ The process of deviation escalation and rectification of root cause of the deviations in production can be improved

High quality production

JIT production is meant for products which are repetitive in nature. The system has its origin in providing a solution to a manufacturing process, where the finished product has a number of parts that get assembled. The problems in such situations will be to keep the arrival of parts, components, and sub-assemblies so that no shortages will occur while holding up production. Therefore, it becomes vital that all parts that form

the flow in many streams are of high quality, so that the assembly does not get held up.

For JIT to be successful inventories have to be kept to the minimum and every component produced must represent highest quality. It is relevant to mention Taguchi's insistence on achieving the target value to realize quality. The permitted tolerances do not ensure high quality. Controlling variability by strict adherence to best processes with built-in robustness to achieve Six Sigma standards ensures high quality. These help in realizing JIT, which has economy in focus and provide an additional factor for competitiveness. So, high quality production helps in reducing the waste of inventory space to the maximum extent.

Small and uniform workloads

Manufacturing facilities have to produce a number of parts to meet the requirements of a number of products. Offering variety in terms of products is a strategy that most businesses practice.

Manufacturing all the products in large volumes and maintaining stocks at various distribution centers is highly uneconomical and no organization would contemplate such a plan. The input resources like the raw materials, bought-out-items, transportation, storage and funds, lay a heavy burden on the system. Added to that, the costs and the operations involved in the transformation process become unthinkable.

The solution is to be able to produce a variety of products in small numbers and plan the production schedules in such a way that the production facilities become more adept in meeting the market demands. The aim is to reduce inventories, but at the same time not to lose business. So, a small load on various work centre's, both at in-house facilities as well as those of sub-contractors, is the answer.

Achieving uniformity of loading is important to avoid piling up of work in process. Soft wares are specially developed to tackle these problems which help in achieving the desired result. However, any decision will have a trade off. The frequent changes in set ups, increased transportation, production hold ups owing to mismatch of the production of different parts. The costs involved on both counts have to be weighed and then decisions are to be taken.

Suppliers as partners

Suppliers are those companies which undertake supplying the manufactured products of an organization. Suppliers can be the dealers for organizations or conduct some transformation activity on the materials delivered by organizations to them. In all cases, since organizations do business with them, they will have a profit for the service rendered by them.

If the technology they have is superior, if the equipments they use are optimal and the workforce is efficient, the benefits would increase for them at a cost to the organization.

If there are a number of suppliers, the organizations would exploit the situation and decrease the cost by choosing the one who charges the least. With this exploitative environment, there are some disadvantages to the organization, such as:

- ☐ Commitment to meet the organization needs is less
- ☐ Giving the benefit of their learning to the organization has fewer chances
- ☐ Transferring organization knowledge to the suppliers for improved service would be absent
- ☐ Likelihood of quality suffers

As explained earlier, to be able to implement JIT, we need to change schedules quite often either delaying or hastening the production of some items almost on a daily basis, if not hourly. The main concern in such situations will be a build up of inventory or stock out positions. Problems of communication add to the difficulties. The following ways will ensure cooperation of the suppliers and timely delivery of supplies with good quality.

- ☐ Treating suppliers as a part of the organization's business and sharing information
- ☐ Providing technical and financial assistance
- ☐ Seeking supplier's help in improving process
- ☐ Building up rapport between the employees of the supplier organization
- ☐ Assuring business

Many times, the supplier, owing to his specialized operations, may contribute to the organization's productivity. Quality enhancement programs can be implemented simultaneously for faster and better results.

Flexible workforce and training

Flexible workforce consists of workmen who are capable of performing many tasks. It may be at their specified workstations, or at other workstations, where the skills required may be quite different from those which they use regularly.

The operational managers can look for personnel's who have an attitude for learning other skills. They should give the personnel training so that when shortages occur, they can be utilized to get over stoppages of work and disruption in workflow. This flexibility ensures reliable customer service and overcomes bottlenecks.

Part time and temporary employees also enable the company to overcome surges in demand. In such cases specially trained regular workers can be asked to take over tasks which require high skills and the non-regular employees can be given jobs which are simple and can be handled by them without causing any disturbance in the production.

Total productive maintenance

Maintenance of equipment is a fundamental requirement to increase the productivity in required quantities with high quality. The presumption that machines deliver these is the basis to JIT philosophy.

Generally, periodic and preventive maintenance is conducted by the operator, sometimes with the help of the supervisor. These activities help them to understand the machine better and give an opportunity to sense when the equipment may need a major repair or reconditioning. This is to be done to bring back the machine to give the required quantities and not have any impermissible variations.

Break downs generally occur as the symptoms are neglected. In total productivity maintenance, the worker is trained to:

- ☐ Maintain the machine
- ☐ Keep record of the parts to be replaced on periodic basis
- ☐ Make arrangements to procure them or make them

This helps the worker to maintain his machine in a perfect order without breakdown. It will be his responsibility to maintain the machine and his assistance to others should be available. With these responsibilities, the worker will also have the autonomy to undertake measures to ensure productivity and quality.

Benefits of JIT

Main benefits of JIT include:

- *Reduced setup time.* Cutting setup time allows the company to reduce or eliminate inventory for "changeover" time. The tool used here is SMED (single-minute exchange of dies).
- *The flow of goods from warehouse to shelves improves.* Small or individual piece lot sizes reduce lot delay inventories, which simplifies inventory flow and its management.
- *Employees with multiple skills are used more efficiently.* Having employees trained to work on different parts of the process allows companies to move workers where they are needed.
- *Production scheduling and work hour consistency synchronized with demand.* If there is no demand for a product at the time, it is not made. This saves the company money, either by not having to pay workers overtime or by having them focus on other work or participate in training.
- *Increased emphasis on supplier relationships.* A company without inventory does not want a supply system problem that creates a part shortage. This makes supplier relationships extremely important.
- *Supplies come in at regular intervals throughout the production day.* Supply is synchronized with production demand and the

optimal amount of inventory is on hand at any time. When parts move directly from the truck to the point of assembly, the need for storage facilities is reduced.

- *Minimizes storage space needed.*
- *Smaller chance of inventory breaking/expiring.*

Case Study

Flexibility helps JIT at L'Oréal

L'Oréal cosmetics are now the world's largest toiletries and cosmetics group, with a presence in over 140 different countries. In the UK, the 45 000 square meter purpose-built facility in mid-Wales produces 1300 product types in a spotlessly clean environment, which is akin to a pharmaceutical plant in terms of hygiene, safety and quality. The plant has 55 production lines and 45 different production processes, and the manufacturing systems employed are of a flexibility that allows them to run each of the 1300 product types every two months – that means over 150 different products each week. But the plant was not always as flexible as this. It has been forced to enhance its flexibility by the requirement to ship over 80 million items each year. The sheer logistics involved in purchasing, producing, storing and distributing the volume and variety of goods has led to its current focus on introducing JIT principles into the manufacturing process.

To help achieve its drive for flexibility and for JIT production, L'Oreal organized the site into three production centers', each autonomous and focused within technical families of products. Their processes and production lines are then further focused within product sub-divisions. Responsible for all the activities within his area, from pre-weighing to dispatch, is the Production Centre Manager, whose role also encompasses staff development, training and motivation. Within the focused production canters, improvement groups have been working on improving shop-floor flexibility, quality and efficiency. One of the projects reduced the setup times on the line which produces hair colorants from 2.5 hours to only eight minutes. These new changeover times mean that the company can now justify even smaller batches, and may give the company the flexibility to meet market needs just-in-time. Prior to the change in setup time, batch size was 30 000 units; now batches as small as 2000– 3000 units can be produced cost-effectively.

Questions

1 What did L'Oréal do to help it organize the process of setup reduction?

2 What do you think L'Oréal gained from doing each of these things?

3 If we could halve all changeover times in the factory, what effect would this have on inventory?

Self Assessment Questions

1. What are the characteristics of JIT?
2. What are the conditions for implementation of the JIT system with success?
3. What do you understand by Vendor Managed Inventory (VMI)?

UNIT - 16

LOGISTICS MANAGEMENT

16.1

Logistics is concerned with getting the products and services where they are needed and when they are desired. It is difficult to accomplish any marketing or manufacturing without logistical support. It involves the integration of information, transportation, inventory, warehousing, material handling, and packaging.

The operating responsibility of logistics is the geographical repositioning of raw materials, work in process, and finished inventories where required at the lowest cost possible.

The formal definition of the word 'logistics' as per the perception of Council of Logistics Management is the process of planning, implementing and controlling the efficient, effective flow and storage of goods, services and related information from the point of origin to the point of consumption for the purpose of conforming to customer requirements.

Mission of logistics is providing a means by which customer satisfaction is achieved. Art of moving, lodging and supplying troops, supplies and equipment is logistics. Concept of logistics has moved into business to move, lodge and supply inputs and outputs.

Logistics is practiced for ages since organized activity began. Without logistics support no activity can be performed to meet defined goal. The current challenge is to perform logistics scientifically in order to optimize benefits to the organization.

Logistics is a planning function of management. Logistics function is concerned with taking products and services where they are needed and when they are needed.

Logistics ensures that the required inputs [what] to a value adding process are made available, where they are needed, when they are needed and in the quantities [how much] they are needed. It also ensures that the outputs of the value adding process are made available where they are needed when they are needed and in the quantities [how much?] they are needed.

There are many ways of defining logistics but the underlying concept might be defined as follows: 'Logistics is the process of strategically managing the procurement, movement and storage of materials, parts and finished inventory through the organization and its

marketing channels in such a way that current and future profitability are maximized through the cost-effective fulfillment of orders.'

Genesis of Modern Logistics

Several Modern Management concepts are born or refined in the crucible of II World War. You may remember several OR techniques like Value Analysis & PERT/CPM have their origin in the II World War. Resources come under pressure in a war, like no other time and one is expected to deliver results in spite of all odds. These trying situations forced the military planners to evolve solutions to their problems. After the war these concepts traveled to business where resource crunch is usual. In business there is no enemy, but there are competitors who pose threat to the organizations survival.

Field Marshall Rommel's words that 'before they are fought, battles are won or lost by quartermasters' speak about the importance of logistics.

There are several examples where battles are lost due to long & ineffective supply lines.

Logistics received great importance in military planning and subsequently became a very important management function in the course of last 40 years.

Logistical management includes the design and administration of systems to control the flow of material, work in process and finished inventory to support business unit strategy.

Overview of logistics function

Logistical History of India: India was a maritime power since about 300 BC, trading with several countries of the world bringing prosperity home. Traders of Surat brought riches to the country by extensive maritime trade. Like many of our excellent practices, logistical efficiency also faded away over a period of time.

Some important logistical feats in history:

1. **Berlin Airlift – 1945: A study in logistics.** When the city of Berlin was blockaded by Soviets and all supply lines were cut off, Americans planned and executed a major logistics operation to feed the city from air.
2. **Indians in the Gulf countries – 1991:**
   1n 1991, when gulf war broke out, Indian Government evacuated thousands of Indians from the gulf countries and brought them home in a massive exercise employing Indian airlines planes.
3. **Operation Overlord-1945:** Allies' invasion of Europe and subsequent victory In II World War.
4. **American war of Independence**
   Keeping 12,000 soldiers armed and fed from England was a big task; British lost the American war of independence due to bad logistics.

Objectives of logistics management

1. **Rapid response**

   F-flexibility objective of an organization: Some companies measure this as response time to customer's order. On an average how much time do we need to fulfill one particular type of customer's order in a year? This is a measure of **Rapid response**

   Logistics should ensure that the supplier is able to respond to the change in the demand very fast. Entire production should change from traditional **push system** to **pull system** to facilitate rapid response. Instead of stocking the goods and supplying on demand, orders are executed on shipment to shipment basis. Information Technology plays an important role here as an **enabler**. IT helps management in producing and delivering goods when the consumer needs them. This results into reduction of inventory and exposes all operational deficiencies. Now the management resolves these deficiencies and slashes down costs. [Concept of SMED and KANBAN as practiced by JIT companies in Japan or elsewhere]

2. **Minimum variance**

   D-delivery objective of an organization, this can be measured as 'On Time Delivery' or **OTD.** If 100 deliveries are made in a month/quarter/year how many reached as per the commitment made to the customer? This percentage is **OTD.**

   Any event that disrupts a system is variance. Logistics operations are disrupted by events like delays due to obstacles in information flow, traffic snarls, acts of god, wrong dispatches, damage in transit. Traditional approach is to keep safety stocks and transport the goods by high cost mode. The cost of this approach is huge. Logistics is expected to minimize these events, thereby minimize and improve on On Time Delivery.

3. **Minimum inventory**

   This is component of **cost** objective of a company. **Inventory** is associated with a huge baggage of costs. It is termed as a necessary evil. Objective of minimum inventory is measured as Inventory Turns or Inventory Turnover Ratio. Americans call this measure as **turn velocity**. Logistics management reduces these turns without sacrificing customer satisfaction. Lower turns ensure effective utilization of assets devoted to stock. [Concept of single piece flow as practiced by JIT companies in Japan or elsewhere]. Logistical management should keep the overall well being of a company in view and fix a minimum inventory level without trying to minimize the inventory level as an isolated objective

4. **Movement consolidation**

   Transportation is the biggest contributor to logistics cost. Transportation cost depends on product type, size, weight, distance to be transported etc. for transporting small shipments just in time

[reduction in inventory costs] expensive transport modes are used which again tend to hike the costs. **Movement consolidation** is planning several such small shipments together [of different types of shipments] by integrating interests of several players in the supply chain. Generally, large shipment size and long distances reduce transportation cost per unit. Movement consolidation shall result into reduction in transportation costs.

5. **Quality**

   If the quality of product fails logistics will have to ship the product out of customers' premises and repeat the logistics operation again. This adds to costs and customer dissatisfaction. Hence logistics should contribute to TQM initiative of management. In fact, commitment to TQM has made the management's world over wake up to the significance of logistics function. Logistics can play a significant role in total quality improvement by improving the quality of logistics performance continuously and continually.

6. **Life cycle support** Logistics function is expected to provide life cycle support to the product after sale. This includes

   a. **After sales service**: the service support needed by the product once it is sold during its life cycle.

   b. Reverse **logistics** or Product recall as a result of

   - rigid quality standards [critical in case of contaminated products which can cause environmental hazard]
   - transit damage [leaking containers containing hazardous material]
   - product expiration dating
   - rigid laws prohibiting unscientific disposal of items associated with product [packaging]
   - Rigid laws making recycling mandatory
   - Erroneous order processing by supplier
   - Reverse logistics is an important component of logistics planning

Activities of the Logistics Functions

Logistics function consists of following sets of activities:

(1) **Order processing.** Though this activity does not contribute much to total costs, yet it is treated important because of its contribution to lead time.

(2) **Transportation Management.** Transportation involves-

- Firm's own transport (if goods are to be collected)

- Hiring of transport (if services of external firm are to be used)
- Routing and load planning.
- Selection of the most suitable of transport (i.e. rail, road, sea or air).
- Packaging needed (i.e. loose, pallets or special).
- Documentation required (especially if goods are arriving from overseas.)

(3) **Inventory management.** Inventories require to be maintained to take care of needs between the time of demand and time of supply. Inventory management involved decisions concerning.

- Buffer stocks.
- Lead time.
- Replenishment of stocks.

(4) **Warehousing.** Is concerned with management of space to hold inventories and it involves such problems as:

- Site selection.
- Space determination.
- Layout and design.
- Receipts and issues and storage.
- Preservation.

(5) Materials handling is concerned with movement of product at the stocking point and it involves such decision as :

- Smoothening of materials flow.
- Selection of materials handling equipment.
- Maintenance of materials handling equipment.

(6) **Packaging** is concerned with design of packing of the product that ensures damage free movement of the product and is conducive to efficient handling and storage.

(7) **Acquisition** is concerned with sourcing, planning and ordering of the product in order to ensure its availability in the right quantity, at the right time, at the right place and at the right cost. Acquisition, however, dose not includes other purchasing activities such as price negotiation, vendor rating etc.

(8) **Product scheduling** is concerned with preparation of aggregate quantities to be produced in accordance with demands, actual as well as projected. Product scheduling, however, dose not include day-to-day detailed scheduling carried out by production planner.

(9) **Information system** is a must for the successful implementation of logistics function. Database on customer location, sales volume, inventory levels, lead times etc. must be maintained.

Improving Effectiveness of Logistics Management

Five pillars to the effective logistics are: (i) Logistical network, (ii) Transport (iii) information, (iv) Inventory and (v) Warehousing, materials handling and packaging.

(1) **Logistical network** include facilities such as manufacturing, warehouse, dealers and retail stores. The larger the geographical spread, the more complex the film's logistical network. Superior logistical network, based on systematic analysis and determination of number of each type of facilities, their geographical location, specific work allocations etc. can be a very big competitive tool.

(2) **Information.** Accurate forecasting and good order management are essential for the systematic inventory management JIT and Contingency Replenishment (CR) and quick response (QR) to the customer. Timely information thus is the key to the logistical performance. Modern information technology, in the form of both hardware (faxes, mobile phones, e-mail) and software (Enterprise Resource Planning) have removed the deficiencies in information.

(3) **Transport.** Cost, speed and reliability are key determinants of the effectiveness, whether it is a war or business. Since time is the essence, quality of transport performance becomes the critical factor. Further, as speed and cost of transport are inter-related, careful selection of the transport becomes essential for optimum cost. For example, faster transport costs mean more money but reduce inventories and improve customer service.

(4) **Inventory management.** Good inventory management system must be put into place to achieve desired customer service with minimum inventory investment. Inventory policies must be carefully devised. Excessive inventories hide deficiencies (e.g. deficiencies of logistics network, poor quality of suppliers, interior purchase order management etc.) while too low inventories cause delay in order execution, slow response and deficient customer service. Selective treatment based on following principles generally lead to effective inventory management:

- Enough quantity of high profit high volume products, demanded by the core customer, may be carried in stock while or negligible inventory may be kept of low-profit-low volume products purchased by a fringe of customers.

- Core customers may be serviced by fast reliable air service while orders of other customers may be dispatched by surface transport.
- Commitment to deliver product rapidly and timely (say within the declared period) must be preceded by enhanced capabilities of logistic network.
- Commitment of rapid and consistent delivery should be intended to gain customer service advantage and to neutralize the strength that a competitor enjoys.

(5) **Warehousing, materials handling and packaging.** The choice and location of the warehouse should be with a view to get closer to the core customers. Materials handling within the warehouse should be planned to ensure safe and speedy receipt, movement, storage and packaging of customer's requirements.

Key issues in logistics

Logistics is a process which interfaces and interacts with the entire company and with external companies, vendors, customers, carriers and more. Logistics is responsible for the movement of products from your vendor's right through to the delivery at your customer's door, including moves through manufacturing facilities, warehouses, and third-parties, such as repackagers or distributors. It is not shipping and receiving, nor is it traffic or warehousing. It is more.

Logistics must make work effectively. This is required by your customers and, in turn, by your company. For effective logistics, there are five key issues--

- Movement of product. This is often the way that logistics is viewed in many companies. Rush ship an order. Expedite in a component. But there is more. Products moves should complement the corporate strategy. If the emphasis is on cost reduction, lower inventories, customer service or whatever, then products must move in a way that is consistent with the emphasis. Product must also flow, not just move, from, to, between and among vendors, manufacturing sites, warehouses and customers. If it does not flow, then there is not a supply pipeline. Instead there are imbalances in inventories with components and finished goods not being where they should be.

  The movement may be extremely broad in geographical scope. Raw materials and completed units can move between and among all regions of the world. While other departments in the company may focus on select geographical regions for sourcing, manufacturing or sales, logistics must deal with all of these. Everything must move.

  The movement plan must be flexible. Forecasting may be the weak link in all corporate planning and execution. So the movement

must be able to adjust and deal with the swings in business activity. This may require a multi-mode, and/or a multi-carrier and/or multi-level service program to keep the global supply chain moving smoothly. For example, it may require a mix of ocean and air modes to keep a smooth pipeline, especially if there are significant swings in volumes and requirements. Or a mix of fast-boat and slow-boat transit time ocean carriers, trading off transit time and freight costs for sea freight service. Or, if the destination is on the East Coast, a mix of MLB service and all-water, similar to the multi-carrier approach but staying, perhaps, with the same steamship line.

- Movement of information. It is not enough to move product and materials. You must know where they are. You must know what inventories are where and if critical action is required. You must know what orders are coming in and when they must be delivered. Information--timely and accurate-- is vital for sound decision-making.

  The information must flow between the company and its suppliers, carriers, forwarders, warehouses and customers. It must also move internally among purchasing, customer service, logistics, manufacturing, sales, marketing and accounting. And doing this goes beyond Email, faxes and phone calls. Investment in information technology is not an alternative anymore; it is a requirement for logistics and corporate effectiveness.

  Systems should exist at the macro or corporate level and view. Since logistics is a process which interacts with many other groups in the company, it is fundamental that a corporate system be in place. It has to be dynamic for handling customer orders, production planning, material requirements planning, distribution requirements planning, finance and sales forecasting. It must be able to receive orders via EDI, transmit Advance Ship Notices, accommodate multiple warehouse and plant locations in both a single site and aggregated views, track inventories at various levels, such as eaches and cases, and more.

  There must also be systems at the micro, or logistics level and view. Programs are needed for warehouse management, cross-docking, shipment tracking for example. Each in turn takes technology, with bar-coding and scanning. These satisfy the operations/reactive and the planning/anticipatory needs.

- Time/service. The ability to respond to the dynamics of the global marketplace--changing forecasts, customer requirements, new product introductions, new sourcing, and how to manage all these changes--must be done quickly. Raw materials and components must be ordered and arrive completely, accurately and quickly. Orders must be filled completely, accurately and quickly. It is no longer months or weeks for lead times. It may not even be days. Hours may decide customer service, competitiveness and value-

added. Back orders are not tolerated. If your company cannot properly respond, your customers will look for those who can.

Service is more than having to expedite a shipment. Time/service is a factor of competition, customer requirements, your company's position in the industry, your corporate culture, how well everyone in the global supply chain works together, and how well everyone works together in your company. Logistics is the link among all this. And the more diverse the geographical scope of vendors, manufacturing, warehouses and customers, the more critical is time. Distance means time. Yet time delays are not acceptable. Movement of product and movement of information show their impact here.

- Cost. Cost is the key measure by which logistics effectiveness is often measured. Freight, warehouse labor, public warehouse charges and other items on the P&L. Or inventory, a balance sheet item. Cost control, containment, and management is important for corporate profitability. Fiscal stewardship is a duty of all managers. The highest price does not mean the best service, and it may not be the service you need. Nor does the lowest price necessarily meet your needs.

There is no doubt about how important costs are. But the company must be careful. Minimizing the cost of the various logistics elements, such as freight and warehousing, can sub optimize the effectiveness of the logistics group and of the company in satisfying its customers.

Cost has a relation to service. They go hand in hand. As you define your service against your costs or costs against service, the give and take develops into your operating costs and budgets. Then you have to make sure that the cost can be managed. Otherwise costs can go out of control, or seem to.

However, there is no ready mechanism which really makes proper recognition in costs for time/service or for adjustments in any part of the company plan. There is no item in the P&L or balance sheet for Time/Service, which is the driver of a company's logistics efforts. Logistics cost measurement is a shortcoming in the present accounting systems. There were designed when the Model A was being built and are not adequate in today's competitive business world. They make discreet cost buckets in a weak attempt to measure a dynamic, global logistics process.

In addition there may be other issues such as currency conversion and fluctuations. Air freight is quoted in the currency of the origin country. Ocean terminal and other accessorial origin charges are also in origin country currency. Warehouses in other countries will invoice in origin currencies. Currency conversion and dynamics can create unfavorable or favorable cost variances which have nothing to do with logistics performance.

- Integration--within your company, between you and your customers and between you and your vendors. Integration--

bringing it all together--within your company is vital. Logistics is a process. Effectiveness requires that each relevant element of the organization do its part. However there is a problem with doing this. The organization chart. The traditional organization with its boxes and defined responsibilities is a collection of functional silos. Each silo segments and collects different parts of the vendor purchase/manufacturing/sales activity and stores it. Hence there is no process. There is a compartmentalization, a fragmenting of the process. This creates an anti-process effect.

In addition to internal integration, you must bring together and work with the external players. Your vendors, including your carriers and warehouses, must understand what you are doing and why. You must share your logistics vision and plan with them. This sharing and understanding will better enable them to cooperate with and assist you. They may be able to offer ideas and gain sharing to further improve the logistics effectiveness and the key issues with it.

Integration with customers is important. You and everyone in your company must be working and satisfy your customers. You should review written customer requirements with everyone in the logistics department and with everyone in the company. It is not enough to a company to tear apart the written requirements and hand them to various departments. That is not integration. That is functional silos.

Meeting with key customers is very good. A face-to-face discussion with him about his requirements and how you will meet them is important. This shows how much you value him and want to work with him. What does he need? How does he need it? Why does he need it? When does he need it? The more you know about your customer and his needs, the more valued of a supplier you are to him. This is a competitive advantage. Partnerships and alliances can be developed or enhanced.

Caselet

The management of Yummy Noodles Company was contemplating on introducing 200 grams pack of savory noodles into the Indian market at Rs. 10 per pack. This was only for one month which was construed to be as a test marketing period. During this period, the Company wanted to have a "blitz" strategy of flooding the market with their product.

In the subsequent month, the management of Yummy Noodles Company had planned to raise the price of the pack to Rs. 15, while the weight of the pack was to be fixed at 250 grams. A free gift in the form of a plastic bowl with a spoon was also planned.

Two months **before** the launch of the actual production, the marketing department of the company brought out advertisements regarding the savory noodles. The advertisements were displayed on bill-boards, TV, radio, print media.

Schools and colleges were also targeted to rope in students and children to buy the product. Production of the noodles was planned to be started along with the marketing program. The forecast of the number of expected packets that could be sold for the first month was around 75,000, and 1,25,000 for the second month. The production was required to be started **earlier** to meet the target of projected demand as well as to account for the changeover in the pack-size in the second month.

You are appointed as a logistics consultant by the Company. You are required to guide the Company regarding the following

a) The Company is very keen that its product must be well-received in the market. What coordination is required between the production, marketing and other departments of the Company? (Note: You are required to **spell-out** the various **departments** (namely, warehousing, production, quality control, packaging, etc.) that are expected to be required in the Company)

b) Explain the role of the Logistics Department in the introductory phase.

Self Assessment Questions

1. Explain Logistics management.

2. What are the advantages of logistics?

3. What are the objectives of logistics management?

4. What are the issues with logistic management?

Uttar Pradesh Rajarshi Tandon
Open University

M.Com.-404
Production Management-II

BLOCK

3

WORK SYSTEM DESIGN

परिशिष्ट–4
आन्तरिक कवर–दो का प्ररूप
Format of the II Inner Covers

ISBN : 978-93-83328-50-5

UNIT - 17

ISSUES IN MATERIALS MANAGEMENT

17.1

Materials Management is simply the process by which an organization is supplied with the goods and services that it needs to achieve its objectives of buying, storage and movement of materials. Materials Management is related to planning, procuring, storing and providing the appropriate material of right quality, right quantity at right place in right time so as to co-ordinate and schedule the production activity in an integrative way for an industrial undertaking. Most industries buy materials, transport them in to the plant, change the materials in to parts, assemble parts in to finished products, sell and transport the product to the customer. All these activities of purchase of materials, flow of materials, manufacture them in to the product, supply and sell the product at the market requires various types of materials to manage and control their storage, flow and supply at various places. It is only possible by efficient materials management. The materials requirements planning, purchasing, inventory planning, storage, inventory control, materials supply, transportation and materials handling are the activities of materials management. About 20-25 years ago, there was no cut-throat competition in the market to sell the various consumer items manufactured by different industrial undertakings and the availability of materials to manufacture these items was not scarce. Therefore, materials management was not thought to be so important and its separate identity in the organization was not felt. But today it has become an important management activity to streamline production. Actually before the production begins it is necessary to ensure availability of all the types of materials needed for production and its supply at the various production centers. Planning, purchasing and scheduling are the main functions of materials management. It aims at improved productivity. It is used to reduce the cost, which increases profitability and streamlines the production. Apart from management of material cost and its supply it helps in its proper utilization, transportation, storage, handling and distribution.

The market research and forecasting both for sales of company's product and purchasing of various materials required for producing the product are needed at the planning stage. Purchasing, procurement of materials, transportation, storage, inventory control, quality control and inspection of materials and goods supplied at various production centers before production are also managed as routine work. Materials handling, packaging, warehouse planning, accounting, scrap, surplus and obsolete materials disposal, finished goods safety and care are the activities

managed by the materials management department. Selection of personnel for marketing, purchasing, inventory control, stores management and materials handling and their training and placement is also to be seen by the materials management department. This indicates that it is very essential to have a materials management department in any organization to support the management in the production activities. It also helps in the marketing, sales promotion and control of all the types of materials for its quantity, quality and cost.

Objectives of Materials Management

The objectives and functions of materials management can be categorized in two ways as follows:

(I) Primary objectives

(II) Secondary objectives

They are discussed below:

(I) Primary objectives

This can be classified as:

(*i*) Efficient materials planning

(*ii*) Buying or Purchasing

(*iii*) Procuring and receiving

(*iv*) Storing and inventory control

(*v*) Supply and distribution of materials

(*vi*) Quality assurance

(*vii*) Good supplier and customer relationship

(*viii*) Improved departmental efficiency

(II) Secondary objectives

There can be several secondary objectives of materials management. Some of them are given below:

(*i*) Efficient production scheduling

(*ii*) To take make or buy decisions

(*iii*) Prepare specifications and standardization of materials

(*iv*) To assist in product design and development

(*v*) Forecasting demand and quantity of materials requirements

(*vi*) Quality control of materials purchased

(*vii*) Material handling

(*viii*) Use of value analysis and value engineering

(*ix*) Developing skills of workers in materials management

(*x*) Smooth flow of materials in and out of the organization

Scope or Functions of Materials Management

Materials management is defined as "*the function responsible for the coordination of planning, sourcing, purchasing, moving, storing and controlling materials in an optimum manner so as to provide a pre-decided service to the customer at a minimum cost*".

From the definition it is clear that the scope of materials management is vast.

The functions of materials management can be categorized in the following ways:

1. Material Planning and Control
2. Purchasing
3. Stores Management
4. Inventory Control or Management
5. Standardization
6. Simplification
7. Value Analysis
8. Ergonomics
9. Just-in-Time (JIT)

All the above mentioned functions of materials management has been discussed in detail

1. **Materials planning and control:** Based on the sales forecast and production plans, the materials planning and control is done. This involves estimating the individual requirements of parts, preparing materials budget, forecasting the levels of inventories, scheduling the orders and monitoring the performance in relation to production and sales.

2. **Purchasing:** This includes selection of sources of supply finalization in terms of purchase, placement of purchase orders, follow-up, maintenance of smooth relations with suppliers, approval of payments to suppliers, evaluating and rating suppliers.

3. **Stores management or management:** This involves physical control of materials, preservation of stores, minimization of obsolescence and damage through timely disposal and efficient handling, maintenance of stores records, proper location and stocking. A store is also responsible for the physical verification of stocks and reconciling them with book figures. A store plays a vital role in the operations of a company.

4. **Inventory control or management:** Inventory generally refers to the materials in stock. It is also called the idle resource of an enterprise. Inventories represent those items, which are either stocked for sale or they are in the process of manufacturing or they are in the form of materials, which are yet to be utilized. The interval between receiving the purchased parts and transforming them into final products varies from

industries to industries depending upon the cycle time of manufacture. It is, therefore, necessary to hold inventories of various kinds to act as a buffer between supply and demand for efficient operation of the system. Thus, an effective control on inventory is a must for smooth and efficient running of the production cycle with least interruptions.

5. Other related activities

(*a*) *3S*

(*i*) *Standardization:* Standardization means producing maximum variety of products from the minimum variety of materials, parts, tools and processes. It is the process of establishing standards or units of measure by which extent, quality, quantity, value; performance etc. may be compared and measured.

(*ii*) *Simplification:* The concept of simplification is closely related to standardization. Simplification is the process of reducing the variety of products manufactured. Simplification is concerned with the reduction of product range, assemblies, parts, materials and design.

(*iii*) *Specifications:* It refers to a precise statement that formulizes the requirements of the customer. It may relate to a product, process or a service.

Example: Specifications of an axle block are Inside Dia. = 2 ± 0.1 cm, Outside Dia. = 4

± 0.2 cm and Length = 10 ± 0.5 cm.

(b) Value analysis*:* Value analysis is concerned with the costs added due to inefficient or unnecessary specifications and features. It makes its contribution in the last stage of product cycle, namely, the maturity stage. At this stage research and development no longer make positive contributions in terms of improving the efficiency of the functions of the product or adding new functions to it.

(*c*) *Ergonomics* *(Human Engineering):* The human factors or human engineering is concerned with man-machine system. Ergonomics is "the design of human tasks, man-machine system, and effective accomplishment of the job, including displays for presenting information to human sensors, controls for human operations and complex man-machine systems." Each of the above functions are dealt in detail.

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

sub-system 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.

Techniques of material planning

The basis for material planning is the forecast demand for the end products. Forecasting techniques such as weighted average method, exponential smoothening and time series models are used for the same. Once the demand forecast is made, it is possible go through the excurses of material planning.

Bill of materials is a document which shows list of materials required, unit consumption location code for a given product. An explosive chart is a series of bill of material grouped in a matrix form so that combined requirements for different components can be done requirements of various materials are arrives at from the demand forecast, using bill of materials, through explosion charts. Thus material requirement plan will lead to be the development of delivery schedule of the materials and purchasing of those material requirements.

Purchasing

Purchasing is an important function of materials management. In any industry purchase means buying of equipments, materials, tools, parts etc. required for industry. The importance of the purchase function varies with nature and size of industry. In small industry, this function is performed by works manager and in large manufacturing concern; this function is done by a separate department. The moment a buyer places an order he commits a substantial portion of the finance of the corporation which affects the working capital and cash flow position. He is a highly responsible person who meets various salesmen and thus can be considered to have been contributing to the public relations efforts of the company. Thus, the buyer can make or mar the company's image by his excellent or poor relations with the vendors.

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:

1. **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.

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

3. **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.

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

5. **To establish and maintain the good relations with the suppliers:** Maintenance of good relations with the supplier helps in evolving a favorable 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.

6. **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.

7. **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.

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

Parameters of Purchasing

The success of any manufacturing activity is largely dependent on the procurement of raw materials of right quality, in the right quantities, from right source, at the right time and at right price popularly known as **ten 'R's'** of the art of efficient purchasing. They are described as the basic principles of purchasing. There are other well known parameters such as right contractual terms, right material, right place, right mode of transportation and right attitude are also considered for purchasing.

1. **Right Price**

   It is the primary concern of any manufacturing organization to get an item at the right price. But right price need not be the lowest price. It is very difficult to determine the right price; general guidance can be had from the cost structure of the product. The 'tender system' of buying is normally used in public sector organizations but the objective should be to identify the lowest 'responsible' bidder and not the lowest bidder. The technique of 'learning curve' also helps the purchase agent to determine the price of items with high labor content. The price can be kept low by proper planning and not by rush buying. Price negotiation also helps to determine the right prices.

2. **Right Quality**

   Right quality implies that quality should be available, measurable and understandable as far as practicable. In order to determine the quality of a product sampling schemes will be useful. The right quality is determined by the cost of materials and the technical characteristics as suited to the specific requirements. The quality particulars are normally obtained from the indents. Since the objective of purchasing is to ensure continuity of supply to the user departments, the time at which the material is provided to the user department assumes great importance.

3. **Right Time**

   For determining the right time, the purchase manager should have lead time information for all products and analyze its components for reducing the same. Lead time is the total time elapsed between the recognition of the need of an item till the item arrives and is provided for use. This covers the entire duration of the materials cycle and consists of pre-contractual administrative lead time, manufacturing and transporting lead time and inspection lead time. Since the inventory increases with higher lead time, it is desirable to analyze each component of the lead time so as to reduce the first and third components which are controllable. While determining the purchases, the buyer has to consider emergency situations like floods, strikes, etc. He should have 'contingency plans' when force major clauses become operative, for instance, the material is not available due to strike, lock-out, floods, and earthquakes.

4. Right Source

The source from which the material is procured should be dependable and capable of supplying items of uniform quality. The buyer has to decide which item should be directly obtained from the manufacturer. Source selection, source development and vendor rating play an important role in buyer-seller relationships. In emergencies, open market purchases and bazaar purchases are restored to.

5. Right Quantity

The right quantity is the most important parameter in buying. Concepts, such as, economic order quantity, economic purchase quantity, fixed period and fixed quantity systems, will serve as broad guidelines. But the buyer has to use his knowledge, experience and common sense to determine the quantity after considering factors such as price structure, discounts, availability of the item, favorable reciprocal relations, and make or buy consideration.

6. Right Attitude

Developing the right attitude, too, is necessary as one often comes across such statement:

'Purchasing knows the price of everything and value of nothing'; 'We buy price and not cost'; 'When will our order placers become purchase managers?'; 'Purchasing acts like a post box'.

Therefore, purchasing should keep 'progress' as its key activity and should be future-oriented.

The purchase manager should be innovative and his long-term objective should be to minimize the cost of the ultimate product. He will be able to achieve this if he aims himself with techniques, such as, value analysis, materials intelligence, purchases research, SWOT analysis, purchase budget lead time analysis, etc.

7. Right Contracts

The buyer has to adopt separate policies and procedures for capital and consumer items. He should be able to distinguish between indigenous and international purchasing procedures. He should be aware of the legal and contractual aspects in international practices.

8. Right Material

Right type of material required for the production is an important parameter in purchasing.

Techniques, such as, value analysis will enable the buyer to locate the right material.

9. Right Transportation

Right mode of transportation has to be identified as this forms a critical segment in the cost profile of an item. It is an established fact that the cost of the shipping of ore, gravel, sand, etc., is normally more than the cost of the item itself.

10. Right Place of Delivery

Specifying the right place of delivery, like head office or works, would often minimize the handling and transportation cost.

PURCHASING PROCEDURE

The procedure describes the sequence of steps leading to the completion of an identified specific task. The purchasing procedure comprises the following steps:

1. Recognition of the need

The initiation of procedure starts with the recognition of the need by the needy section. The demand is lodged with the purchase department in the prescribed Purchase Requisition Form forwarded by the authorized person either directly or through the Stores Department. The purchase requisition clearly specifies the details, such as, specification of materials, quality and quantity, suggested supplier, etc. Generally, the low value sundries and items of common use are purchased for stock while costlier and special items are purchased according the production programmes. Generally, the corporate level executives are authorized signatories to such demands. Such purchases are approved by the Board of Directors. The reference of the approval is made on requisition and a copy of the requisition is sent to the secretary for the purpose of overall planning and budgeting.

2. The selection of the supplier

The process of selection of supplier involves two basic aspects: searching for all possible sources and short listing out of the identified sources. The complete information about the supplier is available from various sources, such as, trade directories, advertisement in trade journals, direct mailing by the suppliers, interview with suppliers, salesmen, suggestions from business associates, visit to trade fair, participation in industries convention, etc. Identification of more and more sources helps in selecting better and economical supplier. It should be noted that the low bidder is not always the best bidder. When everything except price is equal, the low bidder will be selected. The important considerations in the selection are the price, ability to supply the required quantity, maintenance of quality standards, financial standing etc. It should be noted that it is not necessary to go for

this process for all types of purchases. For the repetitive orders and for the purchases of low-value, small lot items, generally the previous suppliers with good records are preferred.

3. Placing the order

Once the supplier is selected the next step is to place the purchase order. Purchase order is a letter sent to the supplier asking to supply the said material. At least six copies of purchase order are prepared by the purchase section and each copy is separately signed by the purchase officer.

Out these copies, one copy each is sent to store-keeper, supplier, accounts section, inspection department and to the department placing the requisition and one copy is retained by the purchase department for record.

4. Follow-up of the order

Follow-up procedure should be employed wherever the costs and risks resulting from the delayed deliveries of materials are greater than the cost of follow-up procedure, the follow-up procedure tries to see that the purchase order is confirmed by the supplier and the delivery is promised. It is also necessary to review the outstanding orders at regular intervals and to communicate with the supplier in case of need. Generally, a routine urge is made to the supplier by sending a printed post card or a circular letter asking him to confirm that the delivery is on the way or will be made as per agreement. In absence of any reply or unsatisfactory reply, the supplier may be contact through personal letter, phone, telegram and/or even personal visit.

5. Receiving and inspection of the materials

The receiving department receives the materials supplied by the vendor. The quantity are verified and tallied with the purchase order. The receipt of the materials is recorded on the specially designed receiving slips or forms which also specify the name of the vendor and the purchase order number. It also records any discrepancy, damaged condition of the consignment or inferiority of the materials. The purchase department is informed immediately about the receipt of the materials. Usually a copy of the receiving slip is sent to the purchase department.

6. Payment of the invoice

When the goods are received in satisfactory condition, the invoice is checked before it is approved for the payment. The invoice is checked to see that the goods were duly authorized to purchase, they were properly ordered, they are priced as per the agreed terms, the quantity and quality confirm to the order, the calculations are arithmetically correct etc.

7. Maintenance of the records

Maintenance of the records is an important part and parcel of the efficient purchase function.

In the industrial firms, most of the purchases are repeat orders and hence the past records serve as a good guide for the future action. They are very useful for deciding the timings of the purchases and in selecting the best source of the supply.

8. Maintenance of vendor relations

The quantum and frequency of the transactions with the same key suppliers provide a platform for the purchase department to establish and maintain good relations with them. Good relations develop mutual trust and confidence in the course of the time which is beneficial to both the parties. The efficiency of the purchase department can be measured by the amount of the goodwill it has with its suppliers.

Selection of Suppliers

Selection of the right supplier is the responsibility of the purchase department. It can contribute substantially to the fundamental objectives of the business enterprise. Different strategies are required for acquiring different types of materials. The selection of supplier for standardized products will differ from non-standardized products. Following factors are considered for the selection of suppliers:

A. Sources of supplier

The best buying is possible only when the decision maker is familiar with all possible sources of supply and their respective terms and conditions. The purchase department should try to locate the appropriate sources of the supplier of various types of materials. This is known as 'survey stage'. A survey of the following will help in developing the possible sources of supply:

1. Specialized trade directories.

2. Assistance of professional bodies or consultants.

3. The buyer's guide or purchase handbook.

4. The manufacturer's or distributor's catalogue.

5. Advertisements in dailies.

6. Advertisement in specialized trade journals.

7. Trade fair exhibitions.

B. Development of approved list of suppliers

The survey stage highlights the existence of the source. A business inquiry is made with the appropriate supplier. It is known as 'Inquiry Stage'. Here a short listing is made out of the given sources of suppliers in terms of production facilities and capacity, financial standing, product quality, possibility of timely supply, technical competence, manufacturing

efficiency, general business policies followed, standing in the industry, competitive attitude, and interest in buying orders etc.

C. Evaluation and selection of the supplier

The purchase policy and procedure differ according to the type of items to be purchased. Hence, evolution and selection of the supplier differ accordingly. In the 'purchasing handbook' edited by Aljian, it has been described that the following variables to be considered while evaluating the quotations of the suppliers:

1. Cost Factors

Price, transportation cost, installation cost if any, tooling and other operations cost, incidence of sales tax and excise duty, terms of payment and cash discount are considered in cost factor.

2. Delivery

Routing and F.O.B. terms are important in determining the point at which the title to the goods passes from vendor to the buyer and the responsibility for the payment of the payment charges.

3. Design and Specification Factors

Specification compliance, specification deviations, specification advantages, important dimensions and weights are considered in line with the demonstration of sample, experience of other users, after sale services etc.

4. Legal Factors

Legal factors include warranty, cancellation provision, patent protection, public liability, federal laws and reputation compliance.

5. 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. How much weight should be given to each of these factors is a matter of judgment and is decided according to the specific need of the organization. Quality would be the main consideration in the manufacturing of the electrical equipments while price would be the prime consideration in the product having a tense competitive market and for a company procuring its requirements under the blanket contract with agreed price, the supplier rating would be done on the basis of two variables namely quality and delivery.

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. The periodic meetings, usually at the interval of one month, are held by senior man of the buying staff to consider the individual rating of each section. The consolidation of the individual rating is done on the basis of the net plus value and accordingly, the suppliers are assigned the categories such as 'preferred', 'neutral' or 'unsatisfactory'. Such ratings are used for the future guidance. This is a very simple and inexpensive method. However, it is not precise. Its quality heavily depends on the experience and ability of the buyer to judge the situation. As compared to other methods, the degree of subjective judgment is very high as rating is based on personal whim and the vague impressions of the buyer. As the quantitative data supported by the profits do not exist, it is not possible to institute any corrective action with the vendor. The rating is done on the basis of memory, and thus it becomes only a routine exercise without any critical analysis.

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

The evaluation of each supplier is made in accordance with the aforesaid factors and weights and the composite weighted-points are ascertained for each suppliers—A, B and C— are rated under this method. First of all the specific rating under each factor will be made and then the consolidation of all the factors will be made for the purpose of judgment.

Quality rating: Percentage of quantity accepted among the total quantity is called quality rating. In other words, the quality of the materials is judged on the basis of the degree of acceptance and rejections. For the purpose of comparison, the percentage degree of acceptance will be calculated in relation to the total lots received. **Price rating** is done on the basis of net price charged by the supplier. **Timely delivery** rating will be done comparing with the average delivery schedule of the supplier.

3. **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. At the end, all such cost-ratios will be adjusted with the quoted price per unit. The plus cost-ratio will increase the unit price while the minus cost-ratio will decrease the unit price. The net adjusted unit price will indicate the vendor rating. The vendor with the lowest net adjusted unit price will be the best supplier and so on. Certain quality costs can be inspection cost, cost of defectives, reworking costs and manufacturing losses on rejected items etc. Certain delivery costs can be postage and telegrams, telephones and extra cost for quick delivery etc.

Special Purchasing Systems

The following are some of the important purchasing systems:

1. Forward Buying

Forward buying or committing an organization far into the future, usually for a year. Depending upon the availability of the item, the financial policies, the economic order quantity, the quantitative discounts, and the staggered delivery, the future commitment is decided. This type of forward buying is different from speculative buying where the motive is to make capital out of the price changes, by selling the purchased items. Manufacturing organizations normally do not indulge in such buying. However, a few organizations do 'Hedge', particularly in the commodity market by selling or buying contracts.

2. Tender Buying

In public, all semblance of favoritism, personal preferences should be avoided. As such, it is common for government departments and public sector undertakings to purchase through tenders. Private sector organizations adopt tender buying if the value of purchases is more than the prescribed limits as Rs. 50000 or Rs. 100000. The steps involved are to establish a bidders' list, solicit bids by comparing quotations and place the order with the lowest bidder. However, care has to be taken that the lowest bidder is responsible party and is capable of meeting the delivery schedule and quality requirements. Open tender system or advertisement in newspapers is common in public sector organizations. As advertising bids is costly and time consuming, most private sector organizations solicit tenders only from the renowned suppliers capable of supplying the materials.

3. Blanket Order System

This system minimizes the administrative expenses and is useful for 'C' type items. It is an agreement to provide a required quantity of specified items, over a period of time, usually for one year, at an agreed price. Deliveries are made depending upon the buyer's needs. The system relieves the buyers from routine work, giving him more time for focusing attention on high value items. It requires fewer purchase orders and thus reduces clerical work. It often achieves lower prices through quantity discounts by grouping the requirements. The supplier, under the system maintains adequate inventory to meet the blanket orders.

4. Zero Stock

Some firms try to operate on the basis of zero stock and the supplier holds the stock for these firms. Usually, the firms of the buyer and seller are close to each other so that the raw materials of one are the finished products of another. Alternatively, the system could work well if the seller holds the inventory and if the two parties work in close coordination. However, the price per item in this system will be slightly higher as the supplier will include the inventory carrying cost in the price. In this system, the buyer need not lock up the capital and so the purchasing routine is reduced. This is also significantly reduces obsolescence of inventory, lead time and clerical efforts in paper work. Thus, the seller can devote his marketing efforts to other customers and production scheduling becomes easy.

5. Rate Contract

The system of rate contract is prevalent in public sector organizations and government departments. It is common for the suppliers to advertise that they are on 'rate contract' for the specific period. After negotiations, the seller and the buyer agree to the rates of items. Application of rate contract has helped many organizations to cut down the internal administrative lead time as individual firms need to go through the central purchasing departments and can place orders directly with the suppliers. However, suppliers always demand higher prices for prompt delivery, as rate difficulty has been avoided by ensuring the delivery of a minimum quantity at the agreed rates. This procedure of fixing a minimum quantity is called the running contract and is being practiced by the railways. The buyer also has an option of increasing the quantity by 25% more than the agreed quantity under this procedure.

6. Reciprocity

Reciprocal buying means purchasing from one's customers in preference to others. It is based on the principle "if you kill my cat, I will kill your dog", and "Do unto your customers as you would have them do unto you". Other things, like soundness from the ethics and economics point of view being equal, the principles of reciprocity can be practiced. However, a purchasing executive should not indulge in reciprocity on his initiative when the terms and conditions are not equal with other suppliers. It is often sound that less efficient manufacturer and distributors gain by reciprocity what they are unable to gain by price and quality. Since this tends to discourage competition and might lead to higher process and fewer suppliers, reciprocity should be practiced on a selective basis.

7. Systems Contract

This is a procedure intender to help the buyer and the sellers to reduce administrative expenses and at the same time ensure suitable controls. In this system, the original indent, duly approved

by competent authorities, is shipped back with the items and avoids the usual documents like purchase orders, materials requisitions, expediting letters and acknowledgements, delivery period price and invoicing

procedure, Carborandum company in the US claims drastic reduction in inventory and elimination of 40000 purchase orders by adopting the system contracting procedure.

It is suitable for low unit price items with high consumption.

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.

Functions of Stores

The functions of stores can be classified as follows:

1. To receive raw materials, components, tools, equipment's and other items and account for them.
2. To provide adequate and proper storage and preservation to the various items.
3. To meet the demands of the consuming departments by proper issues and account for the consumption.
4. To minimize obsolescence, surplus and scrap through proper codification, preservation and handling.
5. To highlight stock accumulation, discrepancies and abnormal consumption and effect control measures.
6. To ensure good house keeping so that material handling, material preservation, stocking, receipt and issue can be done adequately.
7. To assist in verification and provide supporting information for effective purchase action.

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. Many organizations in the public and private sectors, railways have their own system of codification, varying from eight to thirteen digits. The first two digits represents the major groups, such as raw materials, spare parts, sub-contracted items, hardware items, packing material, tools, oil, stationery etc. The next two digits indicate the sub-groups, such as, ferrous, non-ferrous etc. Dimensional characteristics of length, width, head diameter etc. constitute further three digits and the last digit is reserved for minor variations.

Whatever may be the basis, each code should uniquely represent one item. It should be simple and capable of being understood by all. Codification should be compact, concise, consistent and flexible enough to accommodate new items. The groupings should be logical, holding similar

parts near to one another. Each digit must be significant enough to represent some characteristic 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 a 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.

Advantages of Codification

As a result of rationalized codification, many firms have reduced the number of items. It enables systematic grouping of similar items and avoids confusion caused by long description of items since standardization of names is achieved through codification, it serves as the starting point of simplification and standardization. It helps in avoiding duplication of items and results in the minimization of the number of items, leading to accurate record. Codification enables easy recognition of an item in stores, thereby reducing clerical efforts to the minimum. If items are coded according to the sources, it is possible to bulk the items while ordering. To maximize the aforesaid advantages, it is necessary to develop the codes as concerned, namely, personnel from design, production, engineering, inspection, maintenance and materials.

Inventory Control or Management

Meaning of Inventory

Inventory generally refers to the materials in stock. It is also called the idle resource of an enterprise. Inventories represent those items which are either stocked for sale or they are in the process of manufacturing or they are in the form of materials, which are yet to be utilized. The interval between receiving the purchased parts and transforming them into final products varies from industries to industries depending upon the cycle time of manufacture. It is, therefore, necessary to hold inventories of various kinds to act as a buffer between supply and demand for efficient operation of the system. Thus, an effective control on inventory is a must

for smooth and efficient running of the production cycle with least interruptions.

Reasons for Keeping Inventories

1. To stabilize production: The demand for an item fluctuates because of the number of factors, *e.g.,* seasonality, production schedule etc. The inventories (raw materials and components) should be made available to the production as per the demand failing which results in stock out and the production stoppage takes place for want of materials. Hence, the inventory is kept to take care of this fluctuation so that the production is smooth.

2. To take advantage of price discounts: Usually the manufacturers offer discount for bulk buying and to gain this price advantage the materials are bought in bulk even though it is not required immediately. Thus, inventory is maintained to gain economy in purchasing.

3. To meet the demand during the replenishment period: The lead time for procurement of materials depends upon many factors like location of the source, demand supply condition, etc.

So inventory is maintained to meet the demand during the procurement (replenishment) period.

4. To prevent loss of orders (sales): In this competitive scenario, one has to meet the delivery schedules at 100 per cent service level, means they cannot afford to miss the delivery schedule which may result in loss of sales. To avoid the organizations have to maintain inventory.

5. To keep pace with changing market conditions: The organizations have to anticipate the changing market sentiments and they have to stock materials in anticipation of non-availability of materials or sudden increase in prices.

6. Sometimes the organizations have to stock materials due to other reasons like suppliers minimum quantity condition, seasonal availability of materials or sudden increase in prices.

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.

Benefits of Inventory Control

It is an established fact that through the practice of scientific inventory control, following are the benefits of inventory control:

1. Improvement in customer's relationship because of the timely delivery of goods and service.
2. Smooth and uninterrupted production and, hence, no stock out.
3. Efficient utilization of working capital. Helps in minimizing loses due to deterioration, obsolescence damage and pilferage.
4. Economy in purchasing.
5. Eliminates the possibility of duplicate ordering.

Techniques of Inventory Control

In any organization, depending on the type of business, inventory is maintained. When the number of items in inventory is large and then large amount of money is needed to create such inventory, it becomes the concern of the management to have a proper control over its ordering, procurement, maintenance and consumption. The control can be for order quality and order frequency.

The different techniques of inventory control are:

(1) ABC analysis,

(2) HML analysis,

(3) VED analysis,

(4) FSN analysis,

(5) SDE analysis,

(6) GOLF analysis and

(7) SOS analysis.

The most widely used method of inventory control is known as ABC analysis. In this technique, the total inventory is categorised into three sub-heads and then proper exercise is exercised for each sub-heads.

Standardization

Standardization means producing maximum variety of products from the minimum variety of materials, parts, tools and processes. It is the process of establishing standards or units of measure by which extent, quality, quantity, value, performance etc., may be compared and measured.

Advantages of Standardization

All the sections of company will be benefited from standardization as mentioned below.

Benefits to Design Department

1. Fewer specifications, drawings and part list have to prepared and issued.
2. More time is available to develop new design or to improve established design.
3. Better resource allocation.
4. Less qualified personnel can handle routine design work.

Benefits to Manufacturing Department

1. Lower unit cost.
2. Better quality products.
3. Better methods and tooling.
4. Increased interchangeability of parts.
5. Better utilization of manpower and equipment.
6. Accurate delivery dates.
7. Better services of production control, stock control, purchasing, etc.
8. More effective training.

Benefits to Marketing Department

1. Better quality products of proven design at reasonable cost leads to greater sales volume.
2. Increased margin of profit.
3. Better product delivery.
4. Easy availability of sales part.
5. Less sales pressure of after-sales services.

Benefits to Production Planning Department

1. Scope for improved methods, processes and layouts.
2. Opportunities for more efficient tool design.
3. Better resource allocation.
4. Reduction in pre-production activities.

Benefits to Production Control Department

1. Well proven design and methods improve planning and control.
2. Accurate delivery promises.
3. Fewer delays arise from waiting for materials, tools, etc.

4. Follow-up of small batches consumes less time.

Benefits to Purchase and Stock Control Department

1. Holding of stock of standard items leads to less paper work and fewer requisitions and orders.
2. Storage and part location can be improved.
3. Newer techniques can be used for better control of stocks.
4. Because of large purchase quantities involved, favourable purchase contracts can be made.

Benefits to Quality Control Department

1. Better inspection and quality control is possible.
2. Quality standards can be defined more clearly.
3. Operators become familiar with the work and produce jobs of consistent quality.

Other Benefits

1. Work study section is benefited with efficient break down of operations and effective work measurement.
2. Costing can obtain better control by installing standard costing.
3. More time is available to the supervisors to make useful records and preserve statistics.
4. Reduced reductions and scrap.
5. Helps supervisors to run his department efficiently and effectively.

Disadvantages of Standardization

Following are the disadvantages of standardization:

1. Reduction in choice because of reduced variety and consequently loss of business or customer.
2. Standard once set, resist change and thus standardization may become an obstacle to progress.
3. It tends to favor only large companies.
4. It becomes very difficult to introduce new models because of less flexible production facilities and due to high cost of specialized production equipment.

Simplification

The concept of simplification is closely related to standardization. Simplification is the process of reducing the variety of products manufactured. Simplification is concerned with the reduction of product range, assemblies, parts, materials and design.

Advantages of Simplification

Following are the advantages of simplification:

1. Simplification involves fewer, parts, varieties and changes in products; this reduces manufacturing operations and risk of obsolescence.
2. Simplification reduces variety; volume of remaining products may be increased.
3. Simplification provides quick delivery and better after-sales services.
4. Simplification reduces inventory and thus results in better inventory control.
5. Simplification lowers the production costs.
6. Simplification reduces price of a product.
7. Simplification improves product quality.

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.

Value analysis is concerned with the costs added due to inefficient or unnecessary specifications and features. It makes its contribution in the last stage of product cycle, namely, the maturity stage. At this stage, research and development no longer make positive contributions in terms of improving the efficiency of the functions of the product or adding new functions to it.

Value is not inherent in a product, it is a relative term, and value can change with time and place. It can be measured only by comparison with other products which perform the same function. Value is the relationship between what someone wants and what he is willing to pay for it. In fact, the heart of value analysis technique is the functional approach. It relates to cost of function whereas others relate cost to product. It is denoted by the ratio between function and cost.

Value = Function/Cost

Value Analysis Framework

The basic framework for value analysis approach is formed by the following questions, as given by Lawrence D. Miles:

1. What is the item?
2. What does it do?
3. What does it cost?

4. What else would do the job?
5. What would the alternative cost be?

Value analysis requires these questions to be answered for the successful implementation of the technique.

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. In order to develop effective alternatives and identify unnecessary cost the following thirteen value analysis principles must be used:
    1. Avoid generalities.
    2. Get all available costs.
    3. Use information only from the best source.
    4. Brain-storming sessions.
    5. Blast, create and refine: In the blast stage, alternative productive products, materials, processes or ideas are generated. In the 'create' stage the ideas generated in the blast stage are used to generate alternatives which accomplish the function almost totally. In the refining stage the alternatives generated are sifted and refined so as to arrive at the final alternative to be implemented.
    6. Identify and overcome road blocks.
    7. Use industry specialists to extend specialized knowledge.
    8. Key tolerance not to be too light.
    9. Utilize the pay for vendors' skills techniques.
    10. Utilize vendors' available functional products.
    11. Utilize specialty processes.
    12. Utilize applicable standards.
    13. Use the criterion 'Would I spend my money this way?'

Ergonomics (Human Engineering)

The word 'Ergonomics' has its origin in two Greek words *Ergon* meaning laws. So it is the study of the man in relation to his work. In USA and other countries it is called by the name 'human engineering or human factors engineering". ILO defines human engineering as, "The application of human biological sciences along with engineering sciences to achieve optimum mutual adjustment of men and his work, the benefits being measured in terms of human efficiency and well-being."

The human factors or human engineering is concerned with man-machine system. Thus another definition which highlights the man-machine system is: "The design of human tasks, man-machine system, and effective accomplishment of the job, including displays for presenting information to human sensors, controls for human operations and complex man-machine systems."

Human engineering focuses on human beings and their interaction with products, equipment facilities and environments used in the work. Human engineering seeks to change the things people use and the environment in which they use the things to match in a better way the capabilities, limitations and needs of people.

Objectives of Human Engineering

Human engineering (ergonomics) has two broader objectives:

1. To enhance the efficiency and effectiveness with which the activities (work) is carried out so as to increase the convenience of use, reduced errors and increase in productivity.
2. To enhance certain desirable human values including safety reduced stress and fatigue and improved quality of life.

Thus, in general the scope and objective of ergonomics is "designing for human use and optimizing working and living conditions". Thus human factors (ergonomics) discover and apply information about human behavior. Abilities and limitations and other characteristics to the design of tools, machines, systems, tasks, jobs and environment for productive, safe, comfortable and effective human use. Ergonomics aims at providing comfort and improved working conditions so as to channelize the energy, skills of the workers into constructive productive work. This accounts for increased productivity, safety and reduces the fatigue. This helps to increase the plant utilization.

Just-In-Time (JIT) Manufacturing

Introduction

Just-In-Time (JIT) Manufacturing is a philosophy rather than a technique. By eliminating all waste and seeking continuous improvement, it aims at creating manufacturing system that is response to the market needs.

The phase just in time is used to because this system operates with low WIP (Work-In- Process) inventory and often with very low finished goods

inventory. Products are assembled just before they are sold, subassemblies are made just before they are assembled and components are made and fabricated just before subassemblies are made. This leads to lower WIP and reduced lead times. To achieve this organizations have to be excellent in other areas *e.g*. quality.

According to Voss, JIT is viewed as a "*Production methodology which aims to improve overall productivity through elimination of waste and which leads to improved quality*". JIT provides an efficient production in an organization and delivery of only the necessary parts in the right quantity, at the right time and place while using the minimum facilities".

Seven Wastes

Shiego Shingo, a Japanese JIT authority and engineer at the Toyota Motor Company identifies seven wastes as being the targets of continuous improvement in production process. By attending to these wastes, the improvement is achieved.

1. Waste of over production eliminate by reducing set-up times, synchronizing quantities and timing between processes, layout problems. Make only what is needed now.
2. Waste of waiting eliminate bottlenecks and balance uneven loads by flexible work force and equipment.
3. Waste of transportation establishes layouts and locations to make handling and transport unnecessary if possible. Minimize transportation and handling if not possible to eliminate.
4. Waste of processing itself question regarding the reasons for existence of the product and then why each process is necessary.
5. Waste of stocks reducing all other wastes reduces stocks.
6. Waste of motion study for economy and consistency. Economy improves productivity and consistency improves quality. First improve the motions, then mechanize or automate otherwise. There is danger of automating the waste.
7. Waste of making defective products develop the production process to prevent defects from being produced, so as to eliminate inspection. At each process, do not accept defects and makes no defects. Make the process fail-safe. A quantify process always yield quality product.

Benefits of JIT

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

1. *Product cost*—is greatly reduced due to reduction of manufacturing cycle time, reduction of waste and inventories and elimination of non-value added operation.

2. *Quality*—is improved because of continuous quality improvement programs.
3. *Design*—Due to fast response to engineering change, alternative designs can be quickly brought on the shop floor.
4. Productivity improvement.
5. Higher production system flexibility.
6. Administrative and ease and simplicity.

Need For Material Management

The costs associated with material management are hidden in other activities or included as overhead costs. Stukhart states that studies from the Construction Industry Cost Effectiveness Project (CICEP) concluded that senior management have not recognized the contribution of material management to cost issues in projects, that personnel involved in material management activities do not receive an adequate training, and that the computer systems used by companies are not good sources of information for materials control. Historically managers had paid more attention to the costs associated with personnel, equipment and plant and little attention has been given to materials. For manufacturing organizations, the costs related to materials have increased and had become the largest expenditure of the organization; therefore more attention has been placed into activities related to materials. The cost of materials has escalated to twice the cost of labor between 1975 and 1980 inducing companies to pay more attention to activities related to materials (Bernold and Treseler, 1991).

Traditionally the responsibilities for activities related to materials flow have been divided between different departments. The activities related to material management are divided between different departments. For example, the finance department is in charge of the purchasing activities while the manufacturing department is in charge of the control of materials during production. This division of responsibilities makes it difficult to coordinate the activities related to materials. In addition, this division can make the control and identification of materials extremely difficult. The integration of the functions related to materials into a single department makes it easier to control and identify all the activities related to material flow and costs. Material Management is designed to coordinate and control the materials needed and activities related to those materials. In a typical organization, the material activities are interrelated.

Issues in Material Management

The major issue that materials managers face is maintaining a consistent flow of materials for production. There are many factors that inhibit the accuracy of inventory which results in production shortages, premium freight, and often inventory adjustments. The major issues that all materials managers face are incorrect bills of materials, inaccurate cycle counts, un-reported scrap, shipping errors, receiving errors, and production reporting errors. Materials managers have striven to determine how to manage these issues in the business sectors of manufacturing since

the beginning of the industrial revolution. Although there are no known methods that eliminate the afore mentioned inventory accuracy inhibitors, there are best methods available to eliminate the impact upon maintaining an interrupted flow of materials for production.

One challenge for materials managers is to provide timely releases to the supply base. On the scale of worst to best practices, sending releases via facsimile or PDF file is the worst practice and transmitting releases to the supplier based web site is the best practice. Why? The flaw in transmitting releases via facsimile or email is that they can get lost or even interpreted incorrectly into the suppliers system resulting in a stock out. The problem with transmitting EDI releases is that not all suppliers have EDI systems capable of receiving the release information. The best practice is to transmit the releases to a common supplier web base site where the suppliers can view (for free) the releases. The other advantage is that the supplier is required to use the carrier listed in the web site, must transmit an ASN (advanced shipping notification), and review the accumulative balances of the order.

Importance of Material Management

Importance of Effective Materials Management:

Materials management addresses the increased integration of the materials management process. Materials management is a process that requires single point responsibility, early planning, and effective communication tools.

Effective materials management involves maximizing material productivity. This requires well coordinated approach towards various problems related to materials. With respect materials it helps in decision making. Effective material management solves many problems and some of important problems are as follow:

1. **Inventory Problem -** It helps in solving problems related to reducing inventories in the context of reducing uncertainties in demand and supply. It helps in projection of demand. The gap between demand and supply is very crucial for any business hence effective materials management is very important.
2. **Pilferage –** Issues of proper planning regarding avoidance of pilferage are also solved by effective materials management,
3. **Improving Materials Productivity -** Problems regarding standardization and reduction methodologies for improving productivity are also solved by effective materials management,
4. **Waste Management -** Effective materials management also helps in developing policies and procedure for managing waste materials.

   Issues of proper planning of store or warehouse are also important part of effective management and it involves store layout. Hence for solving above problems an integrated approach of material management must be applied properly.

Self Assessment Questions

1. What is the importance of the materials management?
2. What is the scope of materials management?
3. How will you integrate the various activities of materials management?
4. Explain the objectives of materials management.
5. What are the functions of stores?
6. Explain the reasons for keeping inventories.
7. What are the objectives of inventory control?

Skill Development

Fast Food Restaurant Visit: Get the information for the following questions:

1. Material Requirement Plan for procurements of Raw material.
2. Purchase procedures adopted.
3. Preparation of Bill of Material.
4. The supplier or vendors selection.
5. In process spares and etc.
6. Adaptation of Just In Time Manufacturing Technique.

UNIT - 18

INDEPENDENT DEMAND INVENTORY SYSTEMS

18.1

Inventory is the stock of any item or resource used in an organization. An inventory system is the set of policies and controls that monitor levels of inventory and determine what levels should be maintained, when stock should be replenished, and how large orders should be. By convention, manufacturing inventory generally refers to items that contribute to or become part of a firm's product output. Manufacturing inventory is typically classified into raw materials, finished products, component parts, supplies, and work-in-process. In distribution, inventory is classified as in-transit, meaning that it is being moved in the system, and warehouse, which is inventory in a warehouse or distribution center. Retail sites carry inventory for immediate sale to customers. In services, inventory generally refers to the tangible goods to be sold and the supplies necessary to administer the service.

The basic purpose of inventory analysis, whether in manufacturing, distribution, retail, or services, is to specify (1) when items should be ordered and (2) how large the order should be. Many firms are tending to enter into longer-term relationships with vendors to supply their needs for perhaps the entire year. This changes the "when" and "how many to order" to "when" and "how many to deliver."

PURPOSES OF INVENTORY

All firms (including JIT operations) keep a supply of inventory for the following reasons:

1. 1 .**To maintains independence of operations**. A supply of materials at a work center allows that center flexibility in operations. For example, because there are costs for making each new production setup, this inventory allows management to reduce the number of setups. Independence of workstations is desirable on assembly lines as well. The time that it takes to do identical operations will naturally vary from one unit to the next. Therefore, it is desirable to have a cushion of several parts within the workstation so that shorter performance times can compensate for longer performance times. This way the average output can be fairly stable.
2. 2 **To meet variation in product demand**. If the demand for the product is known precisely, it may be possible (though not

necessarily economical) to produce the product to exactly meet the demand. Usually, however, demand is not completely known, and a safety or buffer stock must be maintained to absorb variation.

3. **To allow flexibility in production scheduling**.

4. A stock of inventory relieves the pressure on the production system to get the goods out. This causes longer lead times, which permit production planning for smoother flow and lower-cost operation through larger lot-size production. High setup costs, for example, favor producing a larger number of units once the setup has been made.

5. **To provide a safeguard for variation in raw material delivery time.** When material is ordered from a vendor, delays can occur for a variety of reasons: a normal variation in shipping time, a shortage of material at the vendor's plant causing backlogs, an unexpected strike at the vendor's plant or at one of the shipping companies, a lost order, or a shipment of incorrect or defective material.

6. **To take advantage of economic purchase order size.** There are costs to place an order: labor, phone calls, typing, postage, and so on. Therefore, the larger each order is, the fewer the orders that need be written. Also, shipping costs favor larger orders—the larger the shipment, the lower the per-unit cost.

Many other domain-specific reasons. Depending on the situation, inventory may need to be carried. For example, in-transit inventory is material being moved from the suppliers to customers and depends on the order quantity and the transit lead time.

Another example is inventory that is bought in anticipation of price changes such as fuel for jet planes or semiconductors for computers. There are many other examples. For each of the preceding reasons (especially for items 3, 4, and 5), be aware that inventory is costly and large amounts are generally undesirable. Long cycle times are caused by large amounts of inventory and are undesirable as well.

INVENTORY COSTS

In making any decision that affects inventory size, the following costs must be considered:

1. Holding (or carrying) costs: This broad category includes the costs for storage facilities, handling, insurance, pilferage, breakage, obsolescence, depreciation, taxes, and the opportunity cost of capital. Obviously, high holding costs tend to favor low inventory levels and frequent replenishment.

2. Setup (or production change) costs: To make each different product involves obtaining the necessary materials, arranging specific equipment setups, filling out the required papers,

appropriately charging time and materials, and moving out the previous stock of material.

3. If there were no costs or loss of time in changing from one product to another, many small lots would be produced. This would reduce inventory levels, with a resulting savings in cost. One challenge today is to try to reduce these setup costs to permit smaller lot sizes. (This is the goal of a JIT system.)

4. Ordering costs: These costs refer to the managerial and clerical costs to prepare the purchase or production order. Ordering costs include all the details, such as counting items and calculating order quantities. The costs associated with maintaining the system needed to track orders are also included in ordering costs.

5. Shortage costs: When the stock of an item is depleted, an order for that item must either wait until the stock is replenished or be canceled. When the demand is not met and the order is canceled, this is referred to as a stock out. A backorder is when the order is held and filled at a later date when the inventory for the item is replenished.

There is a trade-off between carrying stock to satisfy demand and the costs resulting from stock outs and backorders. This balance is sometimes difficult to obtain because it may not be possible to estimate lost profits, the effects of lost customers, or lateness penalties. Frequently, the assumed shortage cost is little more than a guess, although it is usually possible to specify a range of such costs. Establishing the correct quantity to order from vendors or the size of lots submitted to the firm's productive facilities involves a search for the minimum total cost resulting from the combined effects of four individual costs: holding costs, setup costs, ordering costs, and shortage costs. Of course, the timing of these orders is a critical factor that may impact inventory cost.

ABC INVENTORY PLANNING

Maintaining inventory through counting, placing orders, receiving stock, and so on takes personnel time and costs money. When there are limits on these resources, the logical move is to try to use the available resources to control inventory in the best way. In other words, focus on the most important items in inventory.

In the nineteenth century Villefredo Pareto, in a study of the distribution of wealth in

Milan, found that 20 percent of the people controlled 80 percent of the wealth. This logic of the few having the greatest importance and the many having little importance has been broadened to include many situations and is termed the Pareto principle.

This is true in our everyday lives (most of our decisions are relatively unimportant, but a few shape our future) and is certainly true in inventory systems (where a few items account for the bulk of our investment).

Any inventory system must specify when an order is to be placed for an item and how many units to order. Most inventory control situations involve so many items that it is not practical to model and give thorough treatment to each item. To get around this problem, the ABC inventory classification scheme divides inventory items into three groupings: high dollar volume (A), moderate dollar volume (B), and low dollar volume (C). Dollar volume is a measure of importance; an item low in cost but high in volume can be more important than a high-cost item with low volume.

ABC CLASSIFICATION

If the annual usage of items in inventory is listed according to dollar volume, generally, the list shows that a small number of items account for a large dollar volume and that a large number of items account for a small dollar volume. Exhibit 11.11A illustrates the relationship.

The ABC approach divides this list into three groupings by value: A items constitute roughly the top 15 percent of the items, B items the next 35 percent, and C items the last 50 percent. From observation, it appears that the list in Exhibit 11.11A can be meaningfully grouped with A including 20 percent (2 of the 10), B including 30 percent, and C including 50 percent. These points show clear delineations between sections. The result of this segmentation is shown in Exhibit 11.11B and plotted in Exhibit 11.11C . Segmentation may not always occur so neatly. The objective, though, is to try to separate the important from the unimportant. Where the lines actually break depends on the particular inventory under question and on how much personnel time is available. (With more time, a firm could define larger A or B categories.)

The purpose of classifying items into groups is to establish the appropriate degree of control over each item. On a periodic basis, for example, class A items may be more clearly controlled with weekly ordering, B items may be ordered biweekly, and C items may be ordered monthly or bimonthly. Note that the unit cost of items is not related to their classification. An A item may have a high dollar volume through a combination of either low cost and high usage or high cost and low usage. Similarly, C items may have a low dollar volume because of either low demand or low cost. In an automobile service station, gasoline would be an A item with daily or weekly replenishment; tires, batteries, oil, grease, and transmission fluid may be B items and ordered every two to four weeks; and C items would consist of valve stems, windshield wiper blades, radiator caps, hoses, fan belts, oil and gas additives, car wax, and so forth. C items may be ordered every two or three months or even be allowed to run out before reordering because the penalty for stock out is not serious.

Sometimes an item may be critical to a system if its absence creates a sizable loss. In this case, regardless of the item’s classification, sufficiently large stocks should be kept on hand to prevent run out. One way to ensure closer control is to designate this item an A or a B, forcing

it into the category even if its dollar volume does not warrant such inclusion.

Advantages of ABC Analysis:

1. Better exercise of control over all materials.
2. The capital invested in inventory can be reduced to minimum levels.
3. Warehouse and storage costs can be reduced.

LIMITATIONS OF ABC ANALYSIS

- ABC analysis mainly provides a guideline for inventory management. It need to be supplemented by basic understanding and judgment as there are certain items which may fall into category C or category B due to their low usage value but are otherwise very critical for the production process of the firm. Their inventory levels have to be carefully monitored.
- The ABC analysis, to be effective, needs to be constantly undertaken and periodically reviewed by the management, as the number of items and value of items keep on undergoing changes.
- The practical problem in the usage of ABC analysis is that generally, thousands of items fall in category *C,* as a result, a lot of time is spent on managing inventory of items of this category (even if it needs simple control). The time left for controlling the inventory stocks of categories *A* is therefore much shorter than that required for their effective management.

Economic Order Quantity (EOQ)

The Economic Order Quantity (EOQ) is the number of units that a company should add to inventory with each order to minimize the total costs of inventory—such as holding costs, order costs, and shortage costs. The EOQ is used as part of a continuous review inventory system in which the level of inventory is monitored at all times and a fixed quantity is ordered each time the inventory level reaches a specific reorder point. The EOQ provides a model for calculating the appropriate reorder point and the optimal reorder quantity to ensure the instantaneous replenishment of inventory with no shortages. It can be a valuable tool for small business owners who need to make decisions about how much inventory to keep on hand, how many items to order each time, and how often to reorder to incur the lowest possible costs.

The EOQ model assumes that demand is constant, and that inventory is depleted at a fixed rate until it reaches zero. At that point, a specific number of items arrive to return the inventory to its beginning level. Since the model assumes instantaneous replenishment, there are no inventory

shortages or associated costs. Therefore, the cost of inventory under the EOQ model involves a tradeoff between inventory holding costs (the cost of storage, as well as the cost of tying up capital in inventory rather than investing it or using it for other purposes) and order costs (any fees associated with placing orders, such as delivery charges). Ordering a large amount at one time will increase a small business's holding costs, while making more frequent orders of fewer items will reduce holding costs but increase order costs. The EOQ model finds the quantity that minimizes the sum of these costs.

One of the major inventory control problems to be resolved is how much inventory should be added when inventory is replenished. If the firm is buying raw materials, it has to decide lots in which it has to be purchased on each replenishment. These problems are called order e1quantity problems, and the task of the firm is to determine the optimum or Economic Order Quantity. Determining an optimum inventory level involves 2 types of costs: (a) Ordering Cost and, (b) Carrying Cost. The Economic Order Quantity is that inventory level which minimizes the total of ordering and carrying cost.

a. **Ordering Cost:** The term ordering cost is used in case of raw material and includes the entire cost of acquiring raw materials. They include cost incurred in the following activities: Requisitions, Purchase Ordering, Transporting, Receiving, inspecting and Storing. Ordering cost includes the number of orders; thus the more frequently inventory is required, the higher the firms ordering cost. On the other hand, if the firm maintains large inventory levels, there will be few orders placed and ordering cost will relatively small. Thus ordering cost decrease with increasing size of the inventory.

b. **Carrying Cost:** Cost incurred on maintaining a given level of inventory are called carrying costs. They include storage, insurance, taxes, deterioration and obsolescence, etc. Carrying cost vary with inventory size. The economic size of inventory would thus depend on trade off between carrying cost and ordering cost.

Formula

Following is the formula for the economic order quantity (EOQ) model:

$$Q^* = \sqrt{\frac{2DS}{H}}$$

Where Q = optimal order quantity

D = units of annual demand

S = cost incurred to place a single order or setup

H = carrying cost per unit

This formula is derived from the following cost function:

Total cost = purchase cost + ordering cost + holding cost

Limitations of the economic order quantity model:

It is necessary for the application of EOQ order that the demands remain constant throughout the year. It is also necessary that the inventory be delivered in full when the inventory levels reach zero.

Underlying assumption of the EOQ model

Following are the underlying assumptions for the EOQ model. Without these assumptions, the EOQ model cannot work to its optimal potential.

- The cost of the ordering remains constant.
- The demand rate for the year is known and evenly spread throughout the year.
- The lead time is not fluctuating (lead time is the latency time it takes a process to initiate and complete).
- No cash or settlement discounts are available, and the purchase price is constant for every item.
- The optimal plan is calculated for only one product.
- There is no delay in the replenishment of the stock, and the order is delivered in the quantity that was demanded, i.e. in whole batch.

  These underlying assumptions are the key to the economic order quantity model, and these assumptions help the companies to understand the shortcomings they are incurring in the application of this model.

Limitations of EOQ:

1. The assumptions listed above may not come true in real life situations, thus limiting the use of this model.
2. Price off materials may not remain same throughout the year.
3. Availability of materials is another constraint. Material can only be purchased at the time when it is available.
4. There can be delays in real situation in placing orders since many times the calculated EOQ is an inconvenient number and some time is wasted in taking decision for rounding off this number. In real situations, suppliers receive an irregular stream of orders since the use of EOQ usually leads to orders at random points.
5. If suppliers are allowing discounts after purchasing quantities above a particular level, the discount will also have to be taken into consideration for fixing the ordering quantity. Also purchasing costs are nowadays reduced to a great extent because of computer links between buyer and seller. So in practice purchasing cost and inventory carrying cost are not exactly opposite to each other.

Often the inventory carrying cost and purchasing cost cannot be identified accurately and sometimes cannot be even identified properly.

Exercise

1. Explain different inventory models in manufacturing.
2. How does inventory help in increasing profits & reducing wastage?
3. Differentiate between ABC analysis & EOQ model.

UNIT - 19

DEPENDENT DEMAND INVENTORY SYSTEM

19.1 MATERIAL REQUIREMENT PLANNING (MRP)

MRP refers to the basic calculations used to determine components required from end item requirements. It also refers to a broader information system that uses the dependence relationship to plan and control manufacturing operations.

"Materials Requirement Planning (MRP) is a technique for determining the quantity and timing for the acquisition of dependent demand items needed to satisfy master production schedule requirements."

OBJECTIVES OF MRP

1. **Inventory reduction:** MRP determines how many components are required when they are required in order to meet the master schedule. It helps to procure the materials/ components as and when needed and thus avoid excessive build up of inventory.
2. **Reduction in the manufacturing and delivery lead times:** MRP identifies materials and component quantities, timings when they are needed, availabilities and procurements and actions required to meet delivery deadlines. MRP helps to avoid delays in production and priorities production activities by putting due dates on customer job order.
3. **Realistic delivery commitments:** By using MRP, production can give marketing timely information about likely delivery times to prospective customers.
4. **Increased efficiency:** MRP provides a close coordination among various work centres and hence help to achieve uninterrupted flow of materials through the production line. This increases the efficiency of production system.

MRP SYSTEM

The inputs to the MRP system are: (1) A master production schedule, (2) An inventory status file and (3) Bill of materials (BOM).

Using these three information sources, the MRP processing logic (computer programme) provides three kinds of information (output) for

each product component: order release requirements, order rescheduling and planned orders.

1. **Master Production Schedule (MPS)**

   MPS is a series of time phased quantities for each item that a company produces, indicating how many are to be produced and when. MPS is initially developed from firm customer orders or from forecasts of demand before MRP system begins to operate. The MRP system whatever the master schedule demands and translates MPS end items into specific component requirements. Many systems make a simulated trial run to determine whether the proposed master can be satisfied.

2. **Inventory Status File**

   Every inventory item being planned must have an inventory status file which gives complete and up to date information on the on-hand quantities, gross requirements, scheduled receipts and planned order releases for an item. It also includes planning information such as lot sizes, lead times, safety stock levels and scrap allowances.

3. **Bill of Materials (BOM)**

   BOM identifies how each end product is manufactured, specifying all subcomponents items, their sequence of build up, their quantity in each finished unit and the work centers performing the buildup sequence. This information is obtained from product design documents, workflow analysis and other standard manufacturing information.

REORDER POINT

The reorder point ("ROP") is the level of inventory when an order should be made with suppliers to bring the inventory up by the Economic order quantity ("EOQ").

The reorder point for replenishment of stock occurs when the level of inventory drops down to zero. In view of instantaneous replenishment of stock the level of inventory jumps to the original level from zero level.

In real life situations one never encounters a zero lead time. There is always a time lag from the date of placing an order for material and the date on which materials are received. As a result the reorder point is always higher than zero, and if the firm places the order when the inventory reaches the reorder point, the new goods will arrive before the firm runs out of goods to sell. The decision on how much stock to hold is generally referred to as the order point problem, that is, how low should the inventory be depleted before it is reordered.

The two factors that determine the appropriate order point are the delivery time stock which is the Inventory needed during the lead time (i.e., the difference between the order date and the receipt of the inventory ordered)

and the safety stock which is the minimum level of inventory that is held as a protection against shortages due to fluctuations in demand.

Therefore:

Reorder Point = Normal consumption during lead-time + Safety Stock.

Several factors determine how much delivery time stock and safety stock should be held. In summary, the efficiency of a replenishment system affects how much delivery time is needed. Since the delivery time stock is the expected inventory usage between ordering and receiving inventory, efficient replenishment of inventory would reduce the need for delivery time stock. And the determination of level of safety stock involves a basic trade-off between the risk of stock out, resulting in possible customer dissatisfaction and lost sales, and the increased costs associated with carrying additional inventory.

Another method of calculating reorder level involves the calculation of usage rate per day, lead time which is the amount of time between placing an order and receiving the goods and the safety stock level expressed in terms of several days' sales.

Reorder level = Average daily usage rate x lead-time in days.

From the above formula it can be easily deduced that an order for replenishment of materials be made when the level of inventory is just adequate to meet the needs of production during lead-time.

Comparison of Order Point and MRP Models

Feature	**MRP**	**Order Point**
Demand	Dependent	Independent
Order philosophy	Requirements	Replenishment
Objectives	Meet manufacturing needs	Meet customer need
Demand pattern	Lumpy and predictive	Random
Type of inventory	Work-in-process and raw material	Finished goods and spare parts
Forecast	Based on MPS	Based on past demand
Control concept	Control all items	ABC analysis
Lot sizing	Discrete	Economic Order Quantity (EOQ)

Three principal functions of MRP:

Inventory

- Order the right part
- Order in the right quantity

- Order at the right time

Priorities

- Order with the right due date
- Keep the due date valid

Capacity

- A complete load
- An accurate (valid) load
- An adequate time span for visibility of future load

MRP Elements

Inputs

1. Master Schedule
2. Bill of Materials (BOM)
3. Inventory Records

Capacity planning (feasibility)

Planned Order Releases (*outputs*)

- Purchasing (buy)
- Shop Floor Control (make)

MRP Inputs

Master schedule

Product structure file (bill of materials or BOM)

- Parts & subassemblies contained in product
- Sequence of operations

Inventory master file

- Item master information
- Balances & ordering information
-

The Function of Material Requirements Planning (MRP)

What is MRP? MRP is a tool to help manage production and purchasing. MRP assumes that there is sufficient capacity to produce the suggestions put forth.

Although MRP is a common term, no two MRP systems look and plan in the same ways. The differences may include the underlying logic, the user interface, and the phrases or jargon used.

MRP has three basic steps. These steps are:

- Identifying requirements for items to be included in an MRP run.
- Running MRP and creating the suggestions.
- Firming the suggestions to release manufacturing orders and purchase orders.

The purpose of this guide is to outline how System 2000's MRP operates, and the data used to develop the plan. In order to fully utilize MRP, several other modules of System 2000 are required to be installed and operational. These required modules include Customer Orders, Purchasing, Inventory Management, Sales Analysis and Manufacturing.

Methodology of a MRP project implementation / alternative techniques

MRP represents an innovation in the manufacturing environment. Thus, its effective implementation requires explicit management action. Steps need to be clearly identified and necessary measures be taken to ensure organizational responsiveness to the technique being implemented.

"Cookbook" like models for implementing MRP does not exist. Each organization poses a unique environment and that means that specific actions need to be taken with due regard to environment specifics.

We approach MRP as an organizational innovation and identify the necessary measure which management should adopt in implementing it. Motivational influences underlying MRP implementation include:

1. *Recognition of business opportunity* for the timely acquisition of MRP.
2. *Recognition of technical opportunity* for the timely acquisition of the technologies supporting MRP implementation.
3. *Recognition of need* for solving manufacturing and/or inventory problems using MRP.

   Given the above motivational factors one may readily identify *what* and *how* issues underlying MRP design and implementation.

   What refers to a generic process model composed of steps and indicative levels of effort to implement each step? *How* refers to management involvement with respect to the process.

CONDITIONS FOR IMPLEMENTATION

Several requirements have to be met, in order to given an MRP implementation project a chance of success:

- Availability of a computer based manufacturing system is a must. Although it is possible to obtain material requirements plan manually, it would be impossible to keep it up to date because of the highly dynamic nature of manufacturing environments.

- . A feasible master production schedule must be drawn up, or else the accumulated planned orders of components might "bump" into the resource restrictions and become infeasible.
- The bills of material should be accurate. It is essential to update them promptly to reflect any engineering changes brought to the product. If a component part is omitted from the bill of material it will never be ordered by the system.
- Inventory records should be a precise representation of reality, or else the netting process and the generation of planned orders become meaningless.
- Lead times for all inventory items should be known and given to the MRP system.
- Shop floor discipline is necessary to ensure that orders are processed in conformity with the established priorities. Otherwise, the lead times passed to MRP will not materialize.

IMPLEMENTATION PROCEDURE OF MRP

Steps / Phases of a MRP project

The material requirements planning portion of manufacturing activities interacts with the master schedule, bill of materials file, inventory records file, and the output reports.

INPUTS TO A STANDARD MRP PROGRAM

Demand for Products: Product demand for end items stems from two main reasons. The first is known customers who have placed specific orders, such as those generated by sales personnel, or from interdepartmental transactions. The second source is forecast demand.

Demand from known customers and demand forecast are combined and become the input to the master production schedule.

Bill of Materials File: The bill of Materials file contains the complete product description, listing materials, parts, and components but also the sequence in which the product is created.

The BOM file is often called the product structure file or product tree because it shows how a product is put together. It contains the information to identify each item and the quantity used per unit of the item of which it is a part.

Inventory Records File: Inventory records file under a computerized system can be quite lengthy. Each item in inventory is carried as a separate file and the range of details carried about an item is almost limitless. The MRP program accesses the status segment of the file according to specific time periods. These files are accessed as needed during the program run.

MRP COMPUTER PROGRAM

The MRP program works as follows:

- A list of end items needed by time periods is specified by the master production schedule.
- A description of the materials and parts needed to make each item is specified in the bill of materials file.
- The number of units of each item and material currently on hand and on order are contained in the inventory file.
- The MRP program "works" on the inventory file. In addition, it continuously refers to the bill of materials file to compute quantities of each item needed.
- The number of units of each item required is then corrected for on hand amounts, and the net requirement is "offset" to allow for the lead time needed to obtain the material.

Output Reports

Primary Reports: Primary reports are the main or normal reports used for the inventory and production control. These report consist of

1. *Planned orders* to be released at a future time.
2. *Order release notices* to execute the planned orders.
3. *Changes in due dates* of open orders due to rescheduling.
4. *Cancellations or suspensions* of open orders due to cancellation or suspension of orders on the master production schedule.
5. *Inventory status data.*

Secondary Reports: Additional reports, which are optional under the MRP system, fall into three main categories:

1. *Planning reports* to be used, for example, in forecasting inventory and specifying requirements over some future time horizon.
2. *Performance reports* for purposes of pointing out inactive items and determining the agreement between actual and programmed item lead times and between actual and
3. *Exceptions reports* that point out serious discrepancies, such as errors, out of range situations, late or overdue orders, excessive scrap, or nonexistent parts.

PARTIAL TECHNIQUES AND TOOLS INCLUDED IN EACH STEP

In order to achieve successful results from the use of a MRP system, many variables (e.g. demand of orders) must be taken into

consideration and thorough examination. Statistical tools and forecasting techniques are necessary to predict the unknown demand. In addition to these, many more techniques are used, which are borrowed from the fields of:

- Production management
- Control of production
- Warehouse management

RELATED SOFTWARE

Since the start of MRP in the late 1960s, many systems have been developed and sold by many software and consulting firms. While other competing-type integrated information programs have been and will probably continue to be developed, MRP- based systems will likely stay in the lead. This is because the firms currently in MRP systems are continuing to develop and enhance them. The list also includes MRPII and ERP software, which can be used in order to apply MRP method.

MANUFACTURING RESOURCE PLANNING

Manufacturing resource planning (**MRP II**) is defined as a method for the effective planning of all resources of a manufacturing company. Ideally, it addresses operational planning in units, financial planning, and has a simulation capability to answer "what-if" questions and extension of closed-loop MRP.

This is not exclusively a software function, but management of people skills, dedication to database accuracy, and computer resources. It is a total company management concept for using human resources more productively.

KEY FUNCTIONS AND FEATURES

MRP II is not a proprietary software system and can thus take many forms. It is almost impossible to visualize an MRP II system that does not use a computer, but an MRP II system can be based on either purchased–licensed or in-house software.

Almost every MRP II system is modular in construction. Characteristic basic modules in an MRP II system are:

- Master production schedule (MPS)
- Item master data (technical data)
- Bill of materials (BOM) (technical data)
- Production resources data (manufacturing technical data)
- Inventories and orders (inventory control)

- Purchasing management
- Material requirements planning (MRP)
- Shop floor control (SFC)
- Capacity planning or capacity requirements planning (CRP)
- Standard costing (cost control)
- Cost reporting / management (cost control)

Together with auxiliary systems such as:

- Business planning
- Lot traceability
- Contract management
- Tool management.
- Engineering change control
- Configuration management
- Shop floor data collection
- Sales analysis and forecasting
- Finite capacity scheduling (FCS)

And related systems such as:

- General ledger
- Accounts payable (purchase ledger)
- Accounts receivable (sales ledger)
- Sales order management
- (Distribution requirements planning) (DRP)
- Automated warehouse management
- Project management
- Technical records
- Estimating
- Computer-aided design/computer-aided manufacturing (CAD/CAM)
- CAPP

The MRP II system integrates these modules together so that they use common data and freely exchange information, in a model of how a manufacturing enterprise should and can operate. The MRP II approach is therefore very different from the “point solution” approach, where individual systems are deployed to help a company plan, control or

manage a specific activity. MRP II is by definition fully integrated or at least fully interfaced.

MRP AND MRPII: GENERAL CONCEPTS

Material requirements planning (MRP) and manufacturing resource planning (MRPII) are both incremental information integration business process strategies that are implemented using hardware and modular software applications linked to a central database that stores and delivers business data and information.

MRP is concerned primarily with manufacturing materials while MRPII is concerned with the coordination of the entire manufacturing production, including materials, finance, and human relations. The goal of MRPII is to provide consistent data to all players in the manufacturing process as the product moves through the production line.

Paper-based information systems and non-integrated computer systems that provide paper or disk outputs result in many information errors, including missing data, redundant data, numerical errors that result from being incorrectly keyed into the system, incorrect calculations based on numerical errors, and bad decisions based on incorrect or old data. In addition, some data is unreliable in non-integrated systems because the same data is categorized differently in the individual databases used by different functional areas.

MRPII systems begin with MRP, material requirements planning. MRP allows for the input of sales forecasts from sales and marketing. These forecasts determine the raw materials demand. MRP and MRPII systems draw on a master production schedule, the breakdown of specific plans for each product on a line. While MRP allows for the coordination of raw materials purchasing, MRPII facilitates the development of a detailed production schedule that accounts for machine and labor capacity, scheduling the production runs according to the arrival of materials. An MRPII output is a final labor and machine schedule. Data about the cost of production, including machine time, labor time and materials used, as well as final production numbers, is provided from the MRPII system to accounting and finance (Monk and Wagner).

Benefits

MRP II systems can provide:

- Better control of inventories
- Improved scheduling
- Productive relationships with suppliers

For design / engineering:

- Improved design control
- Better quality and quality control

For financial and costing:

- Reduced working capital for inventory
- Improved cash flow through quicker deliveries
- Accurate inventory records

Self Assessment Questions

1. What are the objectives of material requirement planning? How in a company MRP plays an important role?
2. What is the difference between MRP and MRP II?
3. Explain the key features 7 functions of MRP.

UNIT - 20

SCHEDULING

20.1

Scheduling can be defined as "prescribing of when and where each operation necessary to manufacture the product is to be performed."

It is also defined as "establishing of times at which to begin and complete each event or operation comprising a procedure". The principle aim of scheduling is to plan the sequence of work so that production can be systematically arranged towards the end of completion of all products by due date.

Scheduling is an important tool for manufacturing and engineering, where it can have a major impact on the productivity of a process. In manufacturing, the purpose of scheduling is to minimize the production time and costs, by telling a production facility when to make, with which staff, and on which equipment. Production scheduling aims to maximize the efficiency of the operation and reduce costs.

Production scheduling tools greatly outperform older manual scheduling methods. These provide the production scheduler with powerful graphical interfaces which can be used to visually optimize real-time work loads in various stages of production, and pattern recognition allows the software to automatically create scheduling opportunities which might not be apparent without this view into the data. For example, an airline might wish to minimize the number of airport gates required for its aircraft, in order to reduce costs, and scheduling software can allow the planners to see how this can be done, by analyzing time tables, aircraft usage, or the flow of passengers.

Companies use backward and forward scheduling to allocate plant and machinery resources, plan human resources, plan production processes and purchase materials. Forward scheduling is planning the tasks from the date resources become available to determine the shipping date or the due date.

Backward scheduling is planning the tasks from the due date or required-by date to determine the start date and/or any changes in capacity required.

The benefits of production scheduling include:

- Process change-over reduction
- Inventory reduction, leveling
- Reduced scheduling effort
- Increased production efficiency

- Labor load leveling
- Accurate delivery date quotes
- Real time information

PRINCIPLES OF SCHEDULING

1. **The principle of optimum task size:** Scheduling tends to achieve maximum efficiency when the task sizes are small, and all tasks of same order of magnitude.
2. **Principle of optimum production plan:** The planning should be such that it imposes an equal load on all plants.
3. **Principle of optimum sequence:** Scheduling tends to achieve the maximum efficiency when the work is planned so that work hours are normally used in the same sequence.

INPUTS TO SCHEDULING

1. *Performance standards:* The information regarding the performance standards (standard times for operations) helps to know the capacity in order to assign required machine hours to the facility.
2. Units in which loading and scheduling is to be expressed.
3. Effective capacity of the work centre.
4. Demand pattern and extent of flexibility to be provided for rush orders.
5. Overlapping of operations.
6. Individual job schedules.

SCHEDULING STRATEGIES

Scheduling strategies vary widely among firms and range from 'no scheduling' to very sophisticated approaches.

These strategies are grouped into four classes:

1. **Detailed scheduling:** Detailed scheduling for specific jobs that are arrived from customers is impracticable in actual manufacturing situation. Changes in orders, equipment breakdown, and unforeseen events deviate the plans.
2. **Cumulative scheduling:** Cumulative scheduling of total work load is useful especially for long range planning of capacity needs. This may load the current period excessively and under load future periods. It has some means to control the jobs.

3. **Cumulative detailed:** Cumulative detailed combination is both feasible and practical approach. If master schedule has fixed and flexible portions.

4. **Priority decision rules:** Priority decision rules are scheduling guides that are used independently and in conjunction with one of the above strategies, *i.e*., first come first serve.

These are useful in reducing Work-In-Process (WIP) inventory.

TYPES OF SCHEDULING

Types of scheduling can be categorized as forward scheduling and backward scheduling.

1. **Forward scheduling** is commonly used in job shops where customers place their orders on "needed as soon as possible" basis. Forward scheduling determines start and finish times of next priority job by assigning it the earliest available time slot and from that time, determines when the job will be finished in that work centre. Since the job and its components start as early as possible, they will typically be completed before they are due at the subsequent work centers in the routing. The forward method generates in the process inventory that is needed at subsequent work centers' and higher inventory cost. Forward scheduling is simple to use and it gets jobs done in shorter lead times, compared to backward scheduling.

2. **Backward scheduling** is often used in assembly type industries and commit in advance to specific delivery dates. Backward scheduling determines the start and finish times for waiting jobs by assigning them to the latest available time slot that will enable each job to be completed just when it is due, but done before. By assigning jobs as late as possible, backward scheduling minimizes inventories since a job is not completed until it must go directly to the next work centre on its routing.

SCHEDULING METHODOLOGY

The scheduling methodology depends upon the type of industry, organization, product, and level of sophistication required. They are:

1. Charts and boards,
2. Priority decision rules, and
3. Mathematical programming methods.

1. Gantt Charts and Boards

Gantt charts and associated scheduling boards have been extensively used scheduling devices in the past, although many of the charts are now drawn by computer. Gantt charts are extremely easy to

understand and can quickly reveal the current or planned situation to all concerned. They are used in several forms, namely,

(*a*) Scheduling or progress charts, which depicts the sequential schedule;

(*b*) Load charts, which show the work assigned to a group of workers or machines; and

(*c*) Record a chart, which are used to record the actual operating times and delays of workers and machines.

2. Priority Decision Rules

Priority decision rules are simplified guidelines for determining the sequence in which jobs will be done. In some firms these rules take the place of priority planning systems such as MRP systems. Following are some of the priority rules followed.

Symbol	*Priority rule*
FCFS	First come, first served
EDO	Earliest due date
LS	Least slack (that is, time due less processing time)
SPT	Shortest processing time
LPT	Longest processing time
PCO	Preferred customer order
RS	Random selection

3. Mathematical Programming Methods

Scheduling is a complex resource allocation problem. Firms process capacity, labor skills, materials and they seek to allocate their use so as to maximize a profit or service objective, or perhaps meet a demand while minimizing costs.

The following are some of the models used in scheduling and production control.

a. Linear programming model: Here all the constraints and objective functions are formulated as a linear equation and then problem is solved for optimality. *Simplex method, transportation methods* and *assignment method* are major methods used here.

b. PERT/CPM network model: PERT/CPM network is the network showing the sequence of operations for a project and the precedence relation between the activities to be completed.

MASTER PRODUCTION SCHEDULE SYSTEM

A **master production schedule** (MPS) is a plan for individual commodities to produce in each time period such as production, staffing, inventory etc.It is usually linked to manufacturing where the plan indicates

when and how much of each product will be demanded. This plan quantifies significant processes, parts, and other resources in order to optimize production, to identify bottlenecks, and to anticipate needs and completed goods. Since an MPS drives much factory activity, its accuracy and viability dramatically affect profitability. Typical MPS's are created by software with user tweaking.

Due to software limitations, but especially the intense work required by the "master production schedulers", schedules do not include every aspect of production, but only key elements that have proven their control effectively, such as forecast demand, production costs, inventory costs, lead time, working hours, capacity, inventory levels, available storage, and parts supply. The choice of what to model varies among companies and factories. The MPS is a statement of what the company expects to produce and purchase (i.e. quantity to be produced, staffing levels, dates, available to promise, projected balance).The MPS translates the business plan, including forecast demand, into a production plan using planned orders in a true multi-level optional component scheduling environment. Using MPS helps avoid shortages, costly expediting, last minute scheduling, and inefficient allocation of resources. Working with MPS allows businesses to consolidate planned parts, produce master schedules and forecasts for any level of the Bill of Material (BOM) for any type of part.

MASTER PRODUCTION SCHEDULE (MPS)

- Anticipated build schedule for manufacturing end products (or product options).
- A statement of production, not a statement of market demand.
- MPS takes into account capacity limitations, as well as desires to utilize capacity fully.
- Stated in product specifications – in part numbers for which bill of material exist.
- Since it is a build schedule, it must be stated in terms used to determine component part needs and other requirements; not in monetary or other global unit of measure.
- Specific products may be groups of items such as models instead of end items.
    - The exact product mix may be determined with Final Assembly Schedule (FAS), which is not ascertained until the latest possible moment.
    - If the MPS is to be stated in terms of product groups, we must create a special bill of material (planning bill) for these groups.

TASK PERFORMED BY A MASTER PRODUCTION SCHEDULER

Construct and update the MPS.

- Involves processing MPS transactions, maintaining MPS records and reports, having a periodic review and update cycle (rolling through time), processing and responding to exception conditions, and measuring MPS effectiveness on a routine basis.
- On a day-to-day basis, marketing and production are coordinated through the
- MPS in terms of Order Promising
- Order promising is the activity by which customer order requests receive shipment dates.

AN EFFECTIVE MPS PROVIDES

- Basis for making customer delivery promises
- Utilizing plant capacity effectively
- Attaining the firm's strategic objectives as reflected in the production plan and
- Resolving trade-off between manufacturing and marketing

- Since MPS is the basis for manufacturing budgets, the financial budgets should be integrated with production planning/MPS activities
- When MPS is extended over a time horizon, is a better basis for capital budgeting.
- Based on the production output specified in the MPS the day-to-day cash flow can be forecasted.
- The MPS should be realizable and not overstated.
- When scheduled production exceeds capacity, usually some or all of the following occur:
  - Invalid priority
  - Poor customer service (missed deliveries)
  - Excess in-process inventories
  - High expediting costs
  - Lack of accountability

MASS PRODUCTION

Mass production is the production of large amounts of standardized products, including and especially on assembly lines. With job production and batch production it is one of the three main production methods.[1]

The concepts of mass production are applied to various kinds of products, from fluids and particulates handled in bulk (such as food, fuel, chemicals, and mined minerals) to discrete solid parts (such as fasteners) to assemblies of such parts (such as household appliances and automobiles).Mass production is a diverse field, but it can generally be contrasted with craft production or distributed manufacturing. It has occurred for centuries; there are examples of production methods that can best be defined as mass production that predate the Industrial Revolution. However, it has been widespread in human experience, and central to economics, only since the late 19th century.

Mass Production involves making many copies of products, very quickly, using assembly line techniques to send partially complete products to workers who each work on an individual step, rather than having a worker work on a whole product from start to finish.

Mass production of fluid matter typically involves pipes with centrifugal pumps or screw conveyors (augers) to transfer raw materials or partially complete product between vessels. Fluid flow processes such as oil refining and bulk materials such as wood chips and pulp are automated using a system of process control which uses various instruments to measure variables such as temperature, pressure, volumetric and level, providing feedback. Bulk materials such as coal, ores, grains and wood chips are handled by belt, chain, slat, pneumatic or screw conveyors, bucket elevators and mobile equipment such as front-end loaders. Materials on pallets are handled with forklifts. Also used for handling heavy items like reels of paper, steel or machinery are electric overhead cranes, sometimes called bridge cranes because they span large factory bays.

Mass production is capital intensive and energy intensive, as it uses a high proportion of machinery and energy in relation to workers. It is also usually automated while total expenditure per unit of product is decreased. However, the machinery that is needed to set up a mass production line (such as robots and machine presses) is so expensive that there must be some assurance that the product is to be successful to attain profits.

One of the descriptions of mass production is that "the skill is built into the tool", which means that the worker using the tool need not have the skill. For example, in the 19th or early 20th century, this could be expressed as "the craftsmanship is in the workbench itself" (not the training of the worker). Rather than having a skilled worker measures every dimension of each part of the product against the plans or the other parts as it is being formed, there were jigs ready at hand to ensure that the

part was made to fit this set-up. It had already been checked that the finished part would be to specifications to fit all the other finished parts—and it would be made more quickly, with no time spent on finishing the parts to fit one another. Later, once computerized control came about (for example, CNC), jigs were obviated, but it remained true that the skill (or knowledge) was built into the tool (or process, or documentation) rather than residing in the worker's head. This is the specialized capital required for mass production; each workbench and set of tools (or each CNC cell, or each fractionating column) is different (fine-tuned to its task).

ADVANTAGES AND DISADVANTAGES

The economies of mass production come from several sources. The primary cause is a reduction of nonproductive effort of all types. In craft production, the craftsman must bustle about a shop, getting parts and assembling them. He must locate and use many tools many times for varying tasks. In mass production, each worker repeats one or a few related tasks that use the same tool to perform identical or near-identical operations on a stream of products. The exact tool and parts are always at hand, having been moved down the assembly line consecutively. The worker spends little or no time retrieving and/or preparing materials and tools, and so the time taken to manufacture a product using mass production is shorter than when using traditional methods.

The probability of human error and variation is also reduced, as tasks are predominantly carried out by machinery. A reduction in labor costs, as well as an increased rate of production, enables a company to produce a larger quantity of one product at a lower cost than using traditional, non-linear methods.

However, mass production is inflexible because it is difficult to alter a design or production process after a production line is implemented. Also, all products produced on one production line will be identical or very similar, and introducing variety to satisfy individual tastes is not easy. However, some variety can be achieved by applying different finishes and decorations at the end of the production line if necessary. the starter cost for the machinery can be expensive so the producer must be sure is sells or the producers will lose a lot of money.

The Ford Model T produced tremendous affordable output but was not very good at responding to demand for variety, customization, or design changes. As a consequence Ford eventually lost market share to General Motors, who introduced annual model changes, more accessories and a choice of colors.[5]

With each passing decade, engineers have found ways to increase the flexibility of mass production systems, driving down the lead times on new product development and allowing greater customization and variety of products.

BATCH PRODUCTION

Batch production is a technique used in manufacturing, in which the object in question is created stage by stage over a series of workstations. With job production and flow production it is one of the three main production methods.

Batch production is most common in bakeries and in the manufacture of sports shoes, pharmaceutical ingredients, purifying water (APIs), inks, paints and adhesives. In the manufacture of inks and paints, a technique called a color-run is used. A color-run is where one manufactures the lightest color first, such as light yellow followed by the next increasingly darker color such as orange, then red and so on until reaching black and then starts over again.

For example, in small bakeries and many homes, as opposed to large food manufacturing companies, cookies are baked in batches. A baker must first make the dough, then place it onto baking sheets, and then bake it. People are limited as to how many cookies they can produce at one time by the number of baking sheets and ovens they possess, and by the size of bowls available to mix each batch.

This is batch production, since a large number of cookies is baked at the same time, and bakers can't skip from one step to the next until each process is complete. They can't start cooking the cookies until they've made the dough, and they can't remove the cookies from the oven (in most cases) until all the cookies are done, unless using an oven with a conveyor belt. There are necessary steps that apply to the whole batch of cookies. Cooking may requires a baker to bake in individual batches, increasing the final time between finishing the dough and actually having completed baking all the cookies.

Sometimes, this type of production is necessary when a manufacturer is producing similar things, but with variants. For instance, if a company manufactures two colors of the same shoe, it would probably use batch production. Any dyeing of leather or fabric can't apply to the whole set of shoes since they're different colors, which can mean stopping in between each batch to change or clean machines, or prepare to add new dyes for the next variation. The necessity of stopping between batches is called "down time," and is why some people find this method of production an inefficient manufacturing process. Time needed to prepare equipment or machines for the next batch can reduce total amount that can be manufactured and take longer in total production time.

ADVANTAGES AND DISADVANTAGES

There are several advantages of batch production; it can reduce initial capital outlay (the cost of setting up the machines) because a single production line can be used to produce several products. As shown in the example, batch production can be useful for small businesses who cannot afford to run continuous production lines. If a retailer buys a batch of a

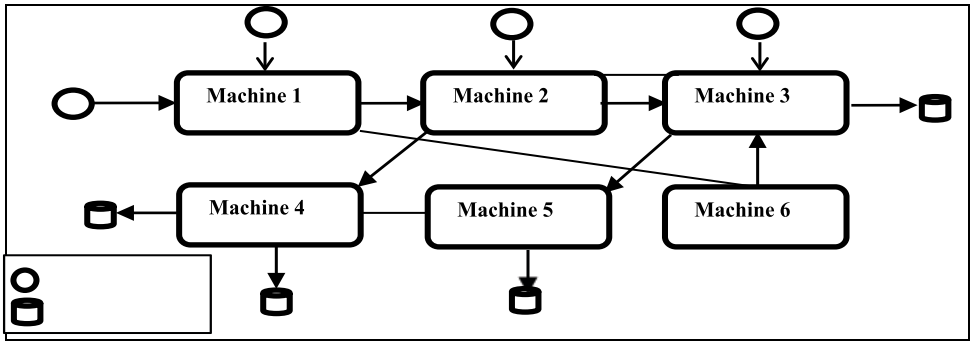
product that does not sell, then the producer can cease production without having to sustain huge losses. Batch production is also useful for a factory that makes seasonal items, products for which it is difficult to forecast demand, a trial run for production, or products that have a high profit margin.

Batch production also has some drawbacks. There are inefficiencies associated with batch production as equipment must be stopped, re-configured, and its output tested before the next batch can be produced. Idle time between batches is known as downtime. The time between consecutive batches is known as cycle time. Cycle time variation is a Lean Manufacturing metric.

Continuous production is used for products that are made in a similar manner. For example, a certain car model has the same body shape and therefore, many of the same model cars can be made at the same time without stop, decreasing manufacturing cost.

JOB SHOP PRODUCTION

Job shops are typically small manufacturing systems that handle job production, that is, custom/bespoke or semi-custom/bespoke manufacturing processes such as small to medium-size customer orders or batch jobs. Job shops typically move on to different jobs (possibly with different customers) when each job is completed. In job shops machines are aggregated in shops by the nature of skills and technological processes involved, each shop therefore may contain different machines, which gives this production system processing flexibility, since jobs are not necessarily constrained to a single machine. In computer science the problem of job shop scheduling is considered strongly NP-hard.



In a job shop product is twisted, also notice that in this drawing each shop contains a single machine.

A typical example would be a machine shop, which may make parts for local industrial machinery, farm machinery and implements, boats and ships, or even batches of specialized components for the aircraft industry. Other types of common job shops are grinding, honing, jig-boring, gear manufacturing, and fabrication shops.

The opposite would be continuous flow manufactures such as textile, steel, food manufacturing and manual labor.

ADVANTAGES

- High production mix flexibility
- High flexibility in product engineering
- High expansion flexibility (machines are easily added or substituted)
- High production volume elasticity
- Low obsolesce
- High robustness to machine failures

  Compare to transfer line

DISADVANTAGES

- Very hard scheduling
- Low capacity utilization

Self Assessment Questions

1. What is scheduling?

2. Mention the types of scheduling.

3. What are the inputs to scheduling?

4. Explain the scheduling strategies.

5. Discuss the scheduling methods.

6. Describe different types of production method.

Notes