TEERTHANKER MAHAVEER UNIVERSITY
MORADABAD, INDIA

CENTRE FOR DISTANCE AND ONLINE EDUCATION

Programme Name- MBA
Semester-II

Course Name-Production & Operation Management

Course Aim:

- To introduce concepts of production and operations management in an organization and expose to analytical methods.

Learning Outcome:

- The students will be able to understand operations management, product & process design, analysis, plant location, layout, Scheduling and Material Management.

Unit-I: Introduction to Operations Management

Introduction: Functional Subsystems of Organization - Definition - Systems Concept of Production.
Types of Production Systems: Flow Shop - Job Shop - Batch Manufacturing - The Project – Productivity.
Strategic Management: Corporate Strategic - Generic Competitive Strategies - Functional Strategies
Line Balancing - World Class Manufacturing.

Unit-II: Product & Process Design and Analysis

Product Design and Analysis New Product Development - Steps of Product Design.
Process Planning and Design: Selection of Process - Process Selection Decision - Process Planning Design - Responsibilities of Process Planning Engineer - Steps in Process Planning - Process Design - Process Research - Work Study - Method Study and Work Measurement.
Value Analysis/Value Engineering: When to Apply Value Analysis - Function - Aims - Value Engineering Procedure - Advantages and Application Areas.
Standardization: Standardization Procedure - Advantages of Standardization - Application of Standardization.
Ergonomic Considerations in Product Design.

Unit-III: Plant Location & Plant Layout

Plant Location: Factors Influencing Plant Location - Single Facility Location Problem - Multifacility Location Problems - Model for Multi-facility Location Problem - Method of Transformation - Model to Determine X- Coordinates of New Facilities - Model to Determine Y-Coordinate.
Plant Layout: Classification of Layout - Advantages and Limitations of Product Layout - Advantages and Limitations of Group Technology Layout - Layout Design Procedures.

Unit-IV: Scheduling

Scheduling: Johnson‘s Problem - Extension of Johnson‘s rule. Job Shop Scheduling: Introduction - Types of Schedules - Schedule Generation - Heuristic Procedures - Two Jobs and Machines Scheduling.

Unit-V: Materials Management

Components of Integrated Materials Management: Materials Planning - Inventory Control - Purchase Management - Stores Management. Inventory Control: Inventory Decisions - Costs Trade Off - Models of Inventory - Operation of Inventory Systems - Quantity Discount - Implementation of Purchase Inventory Model - Purchasing Management. Stores Management: Incoming Materials Control - Store Accounting - Obsolete Surplus and Scrap Management - ABC Analysis - XYZ Analysis - VED Analysis - FSN Analysis - SDE Analysis. Computer Aided Techniques in POM.

REFERENCES:

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- Ajay K Garg, Production and Operations Management, TMH.
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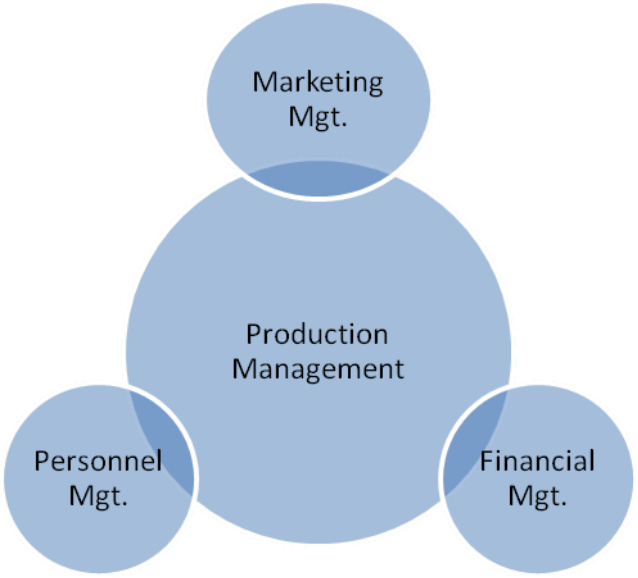
UNIT 1

Introduction to Operation Management

FUNCTIONAL SUBSYSTEMS OF ORGANIZATION

An organization consists mainly of four functional subsystems, viz. marketing, production, finance and personnel as shown in following figure.



The marketing function of an organization aims to promote its products among customers, which helps it to obtain substantial sales order. This, in turn, is communicated to the production subsystem which is concerned with the management of physical resources for the production of an item or provision of a service. To manufacture the products as per the specifications, the production function needs to organize its resources (raw materials, equipments, labour and working capital) according to the predetermined production plans. The finance function provides authorization and control to all other subsystems to utilize money more effectively through a well designed mechanism. The personnel function is a supporting function which plans and provides manpower to all other subsystems of the organization and to itself by formulating proper recruitment and training programmes.

It is therefore, amply clear that all the functional subsystems of any business organization are interwoven by many linkages. They cannot function in isolation. They are all parts of an organization working together for a common purpose — for the operation to run successfully. Independently, these subsystems have their own structure and ideas, but together they become the core of the organization. Independently, these subsystems have their own structure and ideas, but together they become the core of the organization. These subsystems have to take relative decisions at different level of managements. They are:

1. Vision: An organization_s vision involves the mission and values of the organization. The vision describes what the company is, what their purpose is and where they want to go in the future. The vision is extremely important for every employee to embrace. Once a vision is clearly defined, everyone in the organization should share and work toward the collective goals of that vision.

2. Culture: The culture of the organization describes the atmosphere and environment. It includes people's behavior, attitude and work ethic. An organization's culture should be learning-based, so people always feel the need to learn new things and embrace change. The organization's shared vision will help build a solid culture of which people will enjoy being a part.

3. Strategy: A company_s policies and procedures help make up the strategy of the organization. The strategy encompasses hiring the right people, training them to embrace the vision and the culture of the company, and teaching them the correct way to do their jobs. Training them from the first day of employment is important to establish standards and make sure everyone understands what is expected of them.

4. Structure: The structure of the organization is important. Structure can be defined as a top-down managerial organization chart that is topped off by the CEO or president and branches down to lower levels within the organization. It is important to have an established structure from the beginning, so employees know and understand where they stand in the organization, to whom they answer and who is in charge. With established structure, the organization will avoid any confusion when it comes for people to perform certain functions.

Systems Concept of Production:

A system can be defined as a purposeful collection of people, objects & producers for operating within an environment. Thus every organization can be represented as a system consisting of interacting sub-system. The features of a system are that these have inputs and outputs .the basic process of the system converts the resource inputs into some useful form of outputs. Depending upon the efficiency of the conversion process we may have undesirable outputs too-such as pollution, scraps or wastage, rejection, lose of human life etc. Using the generalized concepts of production we can say such system a production system.

Input and Output of System

1. The inputs to the system can be labour, material, equipment (machines), facilities, energy, information & technology. Other inputs to production system can be customers in a bank, patients in a hospital, commuters to a public transport system, files papers to an office etc.
2. The outputs from a system can be finished products, transported goods, delivered messages, cured patients, serviced customers etc.

MANUFACTURING & SERVICE SYSTEM

1) The generalized model of production system including both manufacturing system as well as service system. Example of manufacturing system are; manufacturing of cement, fertilizer, coal, textile, steel, automobiles etc. example of service system include a post office, hospital, bank, transport organization ,university etc.

2) The management of service system is slightly difficult than that of manufacturing system. some of the features of service system are;

a) Outputs from the system is non-inventorial. We cannot generally produce to stock.

b) Demand for the service is variable

c) Operation can be labour-intensive.

d) Location of service operation is dictated by location of user.

A system is a purposeful collection of people, objects & procedures to achieve a specific goal. The production system is a system where land, labour, capital & management undergo conversion process to achieve the specific goal as goods or service.

DEFINITION OF PRODUCTION MANAGEMENT

One cannot demarcate the beginning and end point of Production and Operation Management in an establishment. The reason is that it is interrelated with many other functional areas of business viz. marketing, finance, industrial relations policies etc .Alternately, Production and Operation Management is not independent of marketing, financial, and personnel management due to which it is difficult to formulate some single appropriate definition of Production and Operation Management. The following definitions try to explain main characteristics of Production and Operation Management:

- In the words of Mr. E.L. Brech: ‑Production and Operation Management is the process of effective planning and regulating the operations of that section of an enterprise which is responsible for the actual transformation of materials into finished products‖. This definition limits the scope of operation and production management to those activities of an enterprise which is associated with the transformation process of inputs into outputs. The definition does not include the human factors involved in production process. It lays stress on materialistic features only.
- Production and Operation Management deals with decision making related to production processes, so that the resulting goods and services are produced in

accordance with the quantitative specifications and demand schedule with minimum cost. According to this definition design and control of the production system are two main functions of production and operation management.

- Production and Operation Management is a set of general principles for production economies, facility design, job design, schedule design, quality control, inventory control work study and cost band budgeting control. This definition explains the main areas of an enterprise where the principles of production and operation management can be applied. This definition clearly points out that the production and operation management is not a set of techniques.

It is evident from the above definitions that production planning and its control are the main characteristics of production and operation management. In the case of poor planning and control of production activities the organization may not be not be able to attain its objectives and may result in loss of customer_s_ confidence and retardation in the progress of the establishment.

In short, the main activities of operation and production management can be listed as;

- Specialization and procurement of input resources namely management, material and labor, equipment and capital.
- Product design and development to determine the production process for transforming the input factors into output goods and services.
- Specialization and control of transformation process for efficient production of goods and services.

TYPES OF PRODUCTION SYSTEMS

Production system of a company mainly uses facilities, equipments, and operating methods to produce goods that that satisfy customers_ demand. The various methods of production are not associated with a particular volume of production. Similarly, several methods may be used at different stages of the overall production process.

1. Job Method

With Job production, the complete task is handled by a single worker or group of workers. Jobs can be small-scale/low technology as well as complex/high technology.

Low technology jobs: here the organization of production is extremely simply, with the required skills and equipment easily obtainable. This method enables customer's specific requirements to be included, often as the job progresses. Examples include: hairdressers; tailoring

High technology jobs: high technology jobs involve much greater complexity - and therefore present greater management challenge. The important ingredient in high-technology job

production is project management, or project control. The essential features of good project control for a job are:

> Clear definitions of objectives - how should the job progress (milestones, dates, stages) Decision-making process - how are decisions taking about the needs of each process in the job, labour and other resources

Examples of high technology / complex jobs: film production; large construction projects (e.g. the Millennium Dome)

2. Batch Method

As businesses grow and production volumes increase, it is not unusual to see the production process organized so that "Batch methods" can be used.

Batch methods require that the work for any task is divided into parts or operations. Each operation is completed through the whole batch before the next operation is performed. By using the batch method, it is possible to achieve specialization of labour. Capital expenditure can also be kept lower although careful planning is required to ensure that production equipment is not idle. The main aims of the batch method are, therefore, to:

- Concentrate skills (specialization)
- Achieve high equipment utilization

This technique is probably the most commonly used method for organizing manufacture. A good example is the production of electronic instruments.

Batch methods are not without their problems. There is a high probability of poor work flow, particularly if the batches are not of the optimal size or if there is a significant difference in productivity by each operation in the process. Batch methods often result in the build up of significant "work in progress" or stocks (i.e. completed batches waiting for their turn to be worked on in the next operation).

3. Flow Methods

Flow methods are similar to batch methods - except that the problem of rest/idle production/batch queuing is eliminated. Flow has been defined as a "method of production organization where the task is worked on continuously or where the processing of material is continuous and progressive,"

The aims of flow methods are:

- Improved work & material flow
- Reduced need for labour skills
- Added value / completed work faster

Flow methods mean that as work on a task at a particular stage is complete, it must be passed directly to the next stage for processing without waiting for the remaining tasks in the "batch". When it arrives at the next stage, work must start immediately on the next process. In order for the flow to be smooth, the times that each task requires on each stage must be of equal length and there should be no movement off the flow production line. In theory, therefore, any fault or error at a particular stage

In order that flow methods can work well, several requirements must be met:

(1) There must be substantially constant demand

If demand is unpredictable or irregular, then the flow production line can lead to a substantial build up of stocks and possibility storage difficulties. Many businesses using flow methods get round this problem by "building for stock" - i.e. keeping the flow line working during quiet periods of demand so that output can be produced efficiently.

(2) The product and/or production tasks must be standardized

Flow methods are inflexible - they cannot deal effectively with variations in the product (although some "variety" can be accomplished through applying different finishes, decorations etc at the end of the production line).

(3) Materials used in production must be to specification and delivered on time

Since the flow production line is working continuously, it is not a good idea to use materials that vary in style, form or quality. Similarly, if the required materials are not available, then the whole production line will come to a close - with potentially serious cost consequences.

(4) Each operation in the production flow must be carefully defined - and recorded in detail

(5) The output from each stage of the flow must conform to quality standards

Since the output from each stage moves forward continuously, there is no room for sub-standard output to be "re-worked" (compare this with job or batch production where it is possible to compensate for a lack of quality by doing some extra work on the job or the batch before it is completed).

The achievement of a successful production flow line requires considerable planning, particularly in ensuring that the correct production materials are delivered on time and that operations in the flow are of equal duration.

Common examples where flow methods are used are the manufacture of motor cars, chocolates and televisions.

Project manufacturing

It is an operation designed to produce large, expensive, specialized products such as custom homes, defense weapons such as aircraft carriers and submarines, and aerospace products such as passenger planes, and the space shuttle. Project manufacturing is highly flexible, because each project is usually significantly different from the one before it, even if the project_s size and expense and high degree of customization, project manufacturing can take an extremely long time to complete. Project Manufacturing is an operation designed to produce unique but similar products. It takes advantage of common manufacturing requirements (and therefore efficiencies), while allowing for customization into ‑unique‖ combinations. Unique orders may be managed like a project. The more components of that order that are common to other unique orders the more they may be manufactured – taking advantage of manufacturing methodology. Project Manufacturing then is the melding of Manufacturing and Project Management at a level where the most advantage may be gleaned from each to the financial advantage of the company.

PRODUCTIVITY

Effectiveness of production and operation system may be viewed as the efficiency with which inputs are converted into outputs. The conversion efficiency can be gauged by ratio of the output to the inputs and is commonly known as productivity of the system.

Productivity = Output/Input

Productivity describes various measures of the efficiency of production. Productivity is a crucial factor in production performance of firms and nations. Increasing national productivity can raise living standards because more real income improves people's ability to purchase goods and services, enjoy leisure, improve housing and education and contribute to social and environmental programs. Productivity growth also helps businesses to be more profitable.

Strategies for improving productivity

- Increased output for the same input
- Decreased input for the same output
- Proportionate increase in the output is more than the proportionate increase in the input
- Proportionate decrease in the input is more than the proportionate decrease in the output
- Simultaneous increase in the output with decrease in the input

Factors Affecting Productivity

Productivity stands tall on four important pillars of Capital, Quality, Management and Techn ology.

These pillars are also responsible for positively as well as negatively affecting the Productivit y ofthe Organization.

1. **CAPITAL**: An existing machine or facility if it

is not functioning upto full capacity or turningout products which are not acceptable can lowe r productivity. A new machineor repair of existing machine would require capital input.

2. **QUALITY: Poor** quality products would not meet customer requirements and would need repairs and reworks on the product to meet the standards.

3. MANAGEMENT:

With better scheduling, planning, coordinating and controlling activities of management the machine operations can be carried to improve productivity.

4. TECHNOLOGY:

Technological improvements have increased productivity. Machinesof todaywould outperfor m machineofyesterday but may not withstand machines of tomorrow.

5. **CAUTION**: Without careful planning technology can reduce productivity as

it often leads to increased costs, inflexibility or mismatched operations.

All leads to reduction in value.

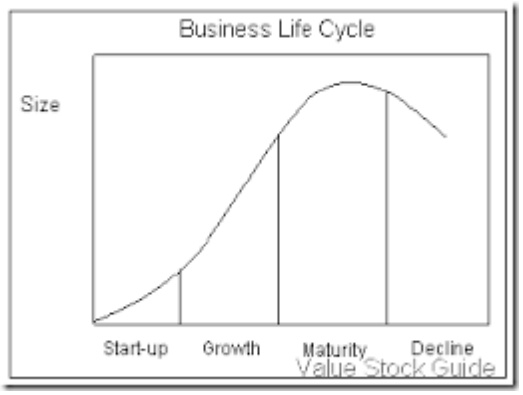
CORPORATE STRATEGIES

A corporate strategy entails a clearly defined, long-term vision that organizations set, seeking to create corporate value and motivate the workforce to implement the proper actions to achieve customer satisfaction. In addition, corporate strategy is a continuous process that requires a constant effort to engage investors in trusting the company with their money, thereby increasing the company_s equity. Organizations that manage to deliver customer value unfailingly are those that revisit their corporate strategy regularly to improve areas that may not deliver the aimed results.

1. **Corporate Strategies**

- Stable growth strategies

- Growth strategies
- Concentration on a single product or services
- Concentric diversification
- Vertical diversification
- Horizontal diversification
- Conglomerate diversification



2. Endgame strategies

- Leadership strategy
- Niche strategy
- Harvest strategy
- Disinvestment strategy

3. Retrenchment strategies

- Turnaround strategy
- Disinvestment strategy

- Liquidation strategy

4. Combination Strategies

- Simultaneous strategy
- Sequential strategy

5. Generic Competitive Strategies

- Overall cost leadership strategy
- Differentiation strategy
- Focus strategy

6. Functional Strategies

- Marketing strategies
- Financial strategies
- Personnel strategies
- Production/Manufacturing strategies

The above corporate strategies are taken based on the stages of business life cycle. These may pertain to different aspects of a firm, yet the strategies that most organizations use are cost leadership and product differentiation.

Cost leadership is a strategy that organizations implement by providing their products and services as low as consumers are willing to pay, thereby being competitive and realizing a volume of sales that allows them to be the leaders in the industry. Typical examples of cost leaders are Wal-Mart in the retail industry, McDonalds in the restaurant industry, and Ikea, the furniture retailer that offers low-priced, yet good quality home equipment by sourcing its products in emerging markets, thereby having a high-profit margin.

Product differentiation refers to the effort of organizations to offer a unique value proposition to consumers. Typically, companies that manage to differentiate their products

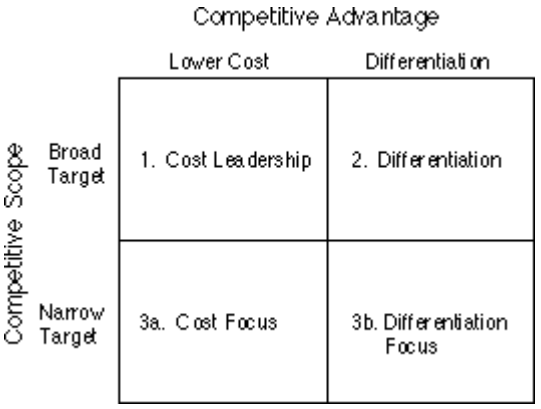
from the competition are gaining a competitive edge, thereby realizing higher profits. Often, competitors employ cost leadership to directly compete with these companies; yet, customer satisfaction and customer loyalty are the factors that eventually make or break a strategy.

Other examples of corporate strategies include the horizontal integration, the vertical integration, and the global product strategy, i.e. when multinational companies sell a homogenous product around the globe.

Corporate strategies are always growth-oriented, seeking to retain a company_s existing customer base while attracting new customers.

Generic Competitive Strategies:

A firm's relative position within its industry determines whether a firm's profitability is above or below the industry average. The fundamental basis of above average profitability in the long run is sustainable competitive advantage. There are two basic types of competitive advantage a firm can possess: low cost or differentiation. The two basic types of competitive advantage combined with the scope of activities for which a firm seeks to achieve them, lead to three generic strategies for achieving above average performance in an industry: cost leadership, differentiation, and focus. The focus strategy has two variants, cost focus and differentiation focus.



1. Cost Leadership

In cost leadership, a firm sets out to become the low cost producer in its industry. The sources of cost advantage are varied and depend on the structure of the industry. They may include the pursuit of economies of scale, proprietary technology, preferential access to raw materials and other factors. A low cost producer must find and exploit all sources of cost advantage. if

a firm can achieve and sustain overall cost leadership, then it will be an above average performer in its industry, provided it can command prices at or near the industry average.

2. Differentiation

In a differentiation strategy a firm seeks to be unique in its industry along some dimensions that are widely valued by buyers. It selects one or more attributes that many buyers in an industry perceive as important, and uniquely positions itself to meet those needs. It is rewarded for its uniqueness with a premium price.

3. Focus

The generic strategy of focus rests on the choice of a narrow competitive scope within an industry. The focuser selects a segment or group of segments in the industry and tailors its strategy to serving them to the exclusion of others.

The focus strategy has two variants.

(a) In cost focus a firm seeks a cost advantage in its target segment, while in **(b)** differentiation focus a firm seeks differentiation in its target segment. Both variants of the focus strategy rest on differences between a focuser's target segment and other segments in the industry. The target segments must either have buyers with unusual needs or else the production and delivery system that best serves the target segment must differ from that of other industry segments. Cost focus exploits differences in cost behaviour in some segments, while differentiation focus exploits the special needs of buyers in certain segments.

Functional Strategies:

Functional strategy - organizational plans prepared for various functional areas of a company's organizational structure (e.g., marketing strategy, financial strategy, production strategy etc.). Functional strategies can be part of overall corporate strategy or serve as separate plans of strategy cascading/implementation within a functional area. [1]

Some common functional strategies are:

- **Production strategy** ("make or buy") - defines what the company produces itself, and those purchases from suppliers or partners, that is, how far worked out the production chain.
- **Financial Strategy**- to select the main source of funding: the development of their own funds (depreciation, profit, the issue of shares, etc.) or through debt financing (bank loans, bonds, commodity suppliers' credits, etc.).
- **Organizational strategy**- decision on the organization of the staff (choose the type of organizational structure, compensation system, etc.).
- Others, such as: research and development (R & D) strategy, investment strategy, etc.

In addition, each of the functional strategies can be divided into components. For example, organizational strategy can be divided into three components:

- Strategy of building organizations - to select the type of structure (divisional, functional, project, etc.);
- strategy to work with the staff - a way of training (mainly administrative staff), training of staff (in a business or educational institutions), career planning, etc.;
- Strategy of remuneration (wages, rewards and penalties) - in particular, the approach to the compensation of senior managers (salary, bonuses, profit sharing, etc.).

Responsible for implementation of the strategy at the functional level are senior specialists (Ch. Engineer, Director of Finance). At the enterprise level - CEO, general director or director of the department, at the level of groups of companies - a collegiate body (board of directors).

GROSS DOMESTIC PRODUCT AND ITS IMPACT

Gross domestic product (GDP) measures the value of a country_s overall goods and services at market prices, without including income from abroad. In the U.S., for example, GDP figures are released quarterly. Although the GDP gauges the economy_s health, it can also have either a positive or negative effect on the economy. Because of its importance, financial analysts and government officials pay close attention to the GDP.

Business Planning

Businesses use the GDP as a planning tool to decide whether they will expand or contract in the coming year. If the GDP has grown since the last year, a company may take the growth as a positive sign and hire more employees, build a new factory or purchase more raw materials for production. Conversely, when the GDP shrinks, firms may not focus on expanding their operations. Instead, many will concentrate on survival.

1. Change the Values

When a country releases its GDP data, its currency can appreciate or depreciate as a result. Let_s say that the U.S. releases its GDP for the past year, and the GDP has risen since the last time the data was published. It will likely take more of a foreign currency--for example, the British pound--to buy fewer U.S. dollars. If the U.S. GDP shrinks in comparison to the previous year, it will generally cost fewer British pounds to buy more U.S. dollars.

2. Government Policies

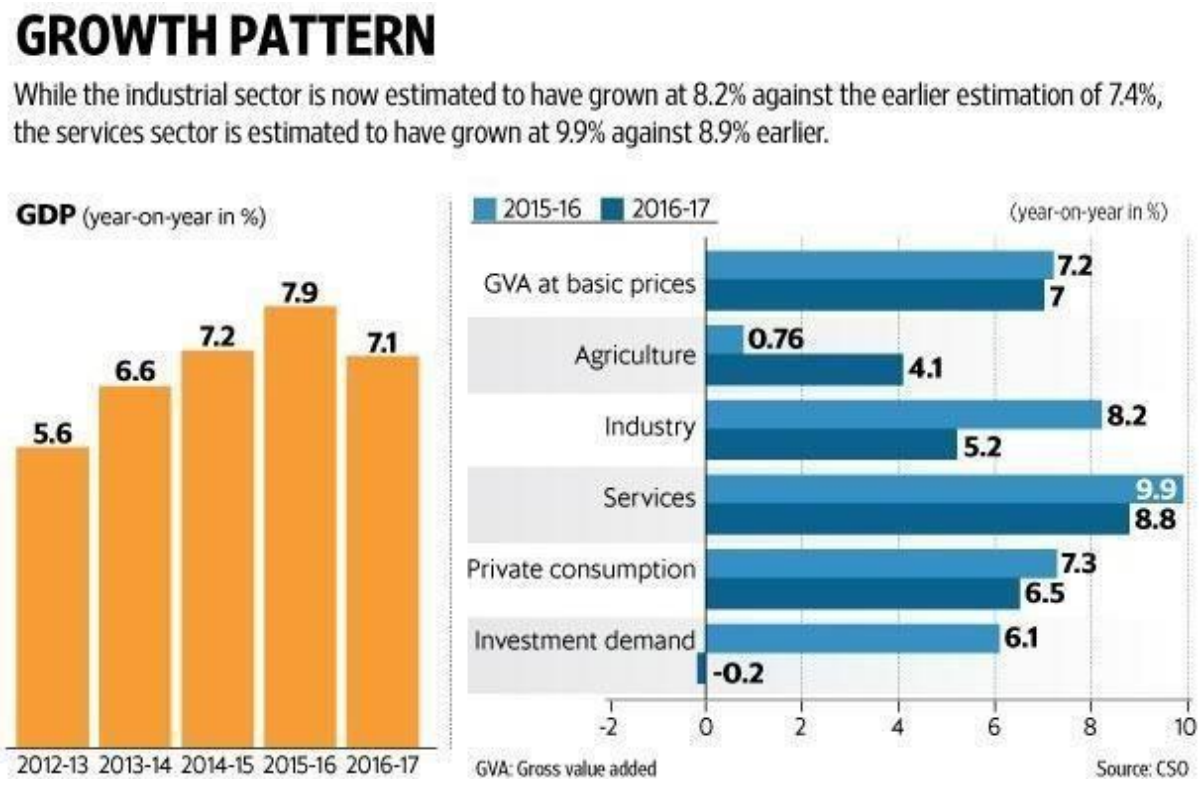
As the GDP measures economic performance, governments watch it closely. A low GDP will cause a government to embark on a different economic policy, one which will boost

economic performance. If, on the other hand, the GDP rises from the previous year, the government will propose policies to maintain economic growth, but will also seek to prevent inflation.

3. Interest Rate Changes

Rising or shrinking GDP also affects interest rates. The interest rate refers to the amount of money charged for loans. In the U.S., the Federal Reserve sets the basic interest rates. If the GDP rises, it means the economy has grown. GDP growth also means that people are spending more money to purchase goods on the market. To prevent inflation, the Federal Reserve will raise the prime interest rate, making the supply of money scarcer. When the GDP shrinks, the Federal Reserve often lowers the interest rate, making it easier to borrow money and encouraging expenditures.

When the economy is healthy, you will typically see low unemployment and wage increases as businesses demand labor to meet the growing economy. A significant change in GDP, whether up or down, usually has a significant effect on the stock market. It's not hard to understand why; a bad economy usually means lower earnings for companies, which translates into lower stock prices. Investors often pay attention to both positive and negative GDP growth when assessing an investment idea or coming up with an investment strategy.



WORLD CLASS MANUFACTURING

Introduction

Manufacturing has evolved considerably since the advent of industrial revolution. In current global and competitive age, it is very important for organization to have manufacturing practice which is lean, efficient, cost-effective and flexible.

World class manufacturing is a collection of concepts, which set standard for production and manufacturing for another organization to follow. Japanese manufacturing is credited with pioneer in concept of world-class manufacturing. World class manufacturing was introduced in the automobile, electronic and steel industry.

World class manufacturing is a process driven approach where various techniques and philosophy are used in one combination or other.

Some of the techniques are as follows:

- Make to order
- Streamlined Flow
- Smaller lot sizes
- Collection of parts
- Doing it right first time
- Cellular or group manufacturing
- Total preventive maintenance
- Quick replacement
- Zero Defects
- Just in Time
- Increased consistency
- Higher employee involvement
- Cross Functional Teams
- Multi-Skilled employees
- Visual Signaling
- Statistical process control

Idea of using above techniques is to focus on operational efficiency, reducing wastage and creating cost efficient organization. This leads to creation of high-productivity organization, which used concurrent production techniques rather than sequential production method.

World class manufacturers tend to implement best practices and also invent new practices as to stay above the rest in the manufacturing sector. The main parameters which determine world-class manufacturers are quality, cost effective, flexibility and innovation.

Steps to Achieve World Class Manufacturing

World class manufacturers implement robust control techniques but there are five steps, which will make the system efficient. These five steps are as follows:

- **Reduction of set up time and in tuning of machinery:** It is important that organizations are able to cut back time in setting up machinery and also tune machinery before production.
- **Cellular Manufacturing:** It is important that production processes are divided into according to its nature, with similar nature combined together.
- **Reduce WIP material:** It is normal tendency of manufacturing organization to maintain high levels of WIP material. Increased WIP leads to more cost and decreased WIP induces more focus on production and fast movement of goods.
- **Postpone product mutation:** For to achieve a higher degree of customization many changes are made to final product. However, it is important that mutation conceived for the design stage implement only after final operation.
- **Removal the trivial many and focus on vital few:** It is important for organization to focus on production of products which are lined with forecast demand as to match customer expectation.

Principles of World Class Manufacturing

There are three main principles, which drive world-class manufacturing.

- Implementation of JIT and lean management leads to reduction in wastage thereby reduction in cost.
- Implementation of TQM leads to reduction of defects and encourages zero tolerance towards defects.
- Implementation of Total Preventive Maintenance leads to any stoppage of production through mechanical failure.

UNIT 2

Product Design and analysis

INTRODUCTION

A company has to be good at developing new products, without products there would be no customers. Without customers, there would be no revenue. Developing a new product is a major activity. Thomas Alva Edison, with as many as 1,300 inventions and 1100 patents to his credit ,said about the product development process,‖ Genius is 1 per cent inspiration and 99 per cent perspiration,‖ Product development requires more of perspiration and less of genius to be successful. The company also must manage them in the face of changing tastes, technologies and competitions. Every product seems to go through a life cycle—it is born. Goes through several phases, and eventually dies as newer products come along that better serve the consumers needs.

The product life cycle presents two major challenges:

- First, because all products eventually decline, the firm must find new products to replace aging ones (the problem of product development).
- Second, the firm must understand how the products age and adapt its marketing strategies as product pass through life cycle stages (the problem of product life-cycle strategies

The Operation management addresses the issue of innovation for product development by enabling firms with some distinctiveness in their offerings. The distinctiveness may be on account of products/services offered, technologies and channel employed and various processes used while providing the product or services to the customers. In recent years we have been witnessing a rise in customer expectations with respect to the products and services offered. Firms can benefits in this scenario, either by offering highly differentiated products and services or by offering very cost effective products. Furthermore, firms can also benefit by bringing these products and services much faster than the competitors and gain from the early mover advantage, In order to achieve this, firms need to have a robust mechanism to understand customers expectations. Firms must also have the capability to reach faster once the expectations are understood. In the 1950sand 1960s Hindustan Motors introduced variations of its Ambassador (Mark 2, Mark3 and so on) roughly once in ten years. Today, no automobile manufacturer can afford to take that much time to introduce new products and variations of existing ones. A good product development process addresses these issues and provides a firm with a set of tools, techniques and concepts to bring products faster and cheaper into the market and realize the associated gains.

Organizations have experienced several tangible benefits from good product development processes. Some of them are:

- The International Motor Vehicles Programme showed that while Japanese manufacturers such as Honda and Toyota introduced as many as 85 models between1982 and 1989, their American counterpart were able to introduce only 49 models . This significantly affected the competitive positioning of these firms.

- Another study analyzed the market impact of new product introduction. It was shown that by introducing products six months ahead of competitors, a firm can gain as much as three times the cumulative profit earned over the life of the product

It is, therefore clear that product development is an important aspects of the operation management function in every organization, be it services or manufacturing. An organization armed with good product development process will be in a better position to bring new products and services to the market ahead of competition and will be able to retain customers and its market share in the sector.

Aspects of Product Design and Analysis

- **Design for Function:** A product must perform the function which its customer expects it to do. If a product is designed by taking its functional features into account, then it will create satisfied customers, and will further lead to having more repeat customers. The factors which are to be considered for functional design are strength and wear-ability of the product and its components
- **Design for Making:** A product design that solves the functional problem smoothly, but is impossible to manufacture, is of no use. Attention must be given to materials, fastening devices etc., while designing a product. The hardness of the material specified at the design stage must be within the permitted range while machining. In some intricate design, to join components, we may require small size fasteners. If these are not available in the market, then the design may become infeasible at the manufacturing stage. Making use of standard parts is an important aspect of product design. Also, operational convenience of the machineries must be taken into account at the design stage.
- **Design for Selling**: A product that functions well and is easy to make, but is wanted by no one is of no avail. It makes no difference whether the product is pen or a CNC machine; it has to sell itself to the customers. The features like, appearance and convenience, depending on the customers_ needs are to be considered.

NEW PRODUCT DEVELOPMENT

A successful product development requires a total-company effort. The most successful innovating companies make a consistent commitment of resources to product development, design a new product strategy that is linked to their strategic planning process, and set up formal and sophisticated organizational arrangements for managing product development process. The product development process for finding and growing new products consist of eight major steps as explained below:

Step 1: Generating

Utilizing basic internal and external SWOT analyses, as well as current marketing trends, one can distance themselves from the competition by generating ideologies which take affordability, ROI, and widespread distribution costs into account.
Lean, mean and scalable are the key points to keep in mind. During the NPD process, keep the system nimble and use flexible discretion over which activities are executed. You may want to develop multiple versions of your road map scaled to suit different types and risk levels of projects.

Step 2*:* Screening the Idea

Wichita, possessing more aviation industry than most other states, is seeing many new innovations stop with Step 2 – screening. *Do you go/no go?* Set specific criteria for ideas that should be continued or dropped. Stick to the agreed upon criteria so poor projects can be sent

back to the idea-hopper early on. Because product development costs are being cut in areas like Wichita, *"prescreening product ideas,* –means taking your Top 3 competitors_ new innovations into account, how much market share they_re chomping up, what benefits end consumers could expect etc. An interesting industry fact: Aviation industrialists will often compare growth with metals markets; therefore, when Boeing is idle, never assume that *all airplanes are grounded,* per se.

Step 3*:* Testing the Concept

As GauravAkrani has said, *"Concept testing is done after idea screening."* And it is important to note, it is different from test marketing.
Aside from patent research, design due diligence, and other legalities involved with new product development; knowing where the marketing messages will work best is often the biggest part of testing the concept. Does the consumer understand, need, or want the product or service?

Step 4: Business Analytics

During the New Product Development process, build a system of metrics to monitor progress. Include input metrics, such as average time in each stage, as well as output metrics that measure the value of launched products, percentage of new product sales and other figures that provide valuable feedback. It is important for an organization to be in agreement for these criteria and metrics.
Even if an idea doesn_t turn into product, keep it in the hopper because it can prove to be a valuable asset for future products and a basis for learning and growth.

Step 5: Beta / Marketability Tests

Arranging private tests groups, launching beta versions, and then forming test panels after the product or products have been tested will provide you with valuable information allowing last minute improvements and tweaks. Not to mention helping to generate a small amount of buzz. Word Press is becoming synonymous with beta testing, and it_s effective; Thousands of programmers contribute code, millions test it, and finally even more download the completed end-product.

Step 6: Technicalities + *Product Development*

Provided the technical aspects can be perfected without alterations to post-beta products, heading towards a smooth step 7 is imminent. According to Akrani, in this step, –The production department will make plans to produce the product. The marketing department will make plans to distribute the product. The finance department will provide the finance for introducing the new product‖.

As an example; In manufacturing, the process before sending technical specs to machinery involves printing MSDS sheets, a requirement for retaining an ISO 9001 certification (the organizational structure, procedures, processes and resources needed to implement quality management.)
In internet jargon, honing the technicalities after beta testing involves final database preparations, estimation of server resources, and planning automated logistics. Be sure to have your technicalities in line when moving forward.

Step 7: Commercialize

At this stage, your new product developments have gone mainstream, consumers are purchasing your good or service, and technical support is consistently monitoring progress. Keeping your distribution pipelines loaded with products is an integral part of this process too, as one prefers not to give physical (or perpetual) shelf space to competition. Refreshing advertisements during this stage will keep your product_s name firmly supplanted into the minds of those in the contemplation stages of purchase.

Step 8: *Post Launch Review and* Perfect Pricing

Review the NPD process efficiency and look for continues improvements. Most new products are introduced with introductory pricing, in which final prices are nailed down after consumers have _gotten in_. In this final stage, you_ll gauge overall value relevant to COGS (cost of goods sold), making sure internal costs aren_t overshadowing new product profits. You continuously differentiate consumer needs as your products age, forecast profits and improve delivery process whether physical, or digital, products are being perpetuated.

STEPS OF PRODUCT DESIGN

Designing a product is not simple to do. Many different ideas may come to mind for a new product, but not all of those ideas will be unique and function properly, which is important when creating a new product. **Product design** is when you create a brand-new product to sell to customers. There are several different stages to completing a product and making it successful.

For instance, you work for a toy company. You want to create a brand-new toy for customers to buy. To do this, you would follow the steps of the product design process: create an idea, determine product feasibility, test the product, and then launch the product for customers to buy. Once all the necessary steps are finished, you can now enjoy the fruits of your labor.

- **Idea Creation**

During the idea creation stage, the company comes up with new concepts to create a product. You want to concentrate on creating a product that will be useful to customers while also being a good fit for the company. Creating products that fit with the company's purpose is important because you want customers to have a clear representation of your brand.

To come up with a new concept, it would be best for a bunch of employees to work together and throw around ideas on what product should be developed. Imagine you are sitting at a

table having a conversation with yourself about developing a product. You may have a good idea, but when there are a group of people, the idea can be even better. Joining ideas can help one good idea become a great idea, because other people can help develop functions that can be beneficial to the product.

- **Product Feasibility**

Once all of the ideas have been created, the company has to determine the product feasibility. It is up to the research and development team to analyze the ideas and determine which products can be created and manufactured. The R&D team then will create a prototype to give the company an idea of how the product will look and function. The prototype should mirror what the actual product will be like, and once it does, it's time for the next step.

- **Product Testing**

Now that the product has a prototype, is is ready for **product testing** among employees and customers. Customer testing is important because this will determine whether the product is effective. Customers can give information on what improvements or changes are needed for the product. Depending on the success of the testing, the product may have to go back to the research and development team for changes.

PROCESS PLANNING AND DESIGN

process planning is concerned with planning the conversion or transformation processes needed to convert the materials into finished products .A production process is a series of manufacturing operations performed at workstations to achieve the design specifications of the planned output .A vast number of different operations and various kinds of equipments and machines may be required to produce a complex product (for e.g. an aircraft or a ship). Simpler parts may require fewer operations (for e.g. a bolt and a nut).

Process planning consists of two parts namely

1. Process design
2. Operations design

Both stages provide information on what is required to effectively utilize the existing equipment and machinery and to determine what new equipment and machinery would be required.

- **Process Design**

Process design is concerned with the overall sequence of operations required to achieve the product specifications. It specifies the type of work stations that are to be used, the machines and equipment necessary and the quantities in which each are required.

The sequence of operations in the manufacturing process is determined by

1. The nature of the product
2. The materials used
3. The quantities being produced
4. The existing physical layout of the plant.

- **Operations Design**

Operations design is concerned with the design of the individual manufacturing operations .It consists of examining the man-machine relationship in the manufacturing process for converting the raw materials into the finished or semi-finished product .Operations design must specify how much of man and machine time is required for each unit of production.

Frame Work for Process Design

The design of the transformation process requires answers to several questions given below:

1. What are the characteristics of the product or service being supplied or offered to the customer?

2. What is the expected volume of the output?

3. What kinds of equipment or machinery are available?

4. Should the equipment or machinery be custom built?

5. What is the cost of equipment and machinery needed?

6. What types of labor skills are available, in what quantities and at what wage rates?

7. How much money can be spent on the manufacturing process?

8. Should the process be capital intensive or labor intensive?

9. Should the components or parts be made or purchased?(Make or buy decision)

10. Which would be the best way to handle the materials?

RESPONSIBILITIES OF PROCESS PLANNING ENGINEER

- Prepare various strategies for all planning activities for projects.
- Maintain all asset investment plans and ensure compliance to capital expenditure.
- Ensure accuracy for all operational requirements for projects and achieve all investment objectives.
- Evaluate all system capacity and analyze all production requirement and system deficiencies.
- Provide support to all operations and extension requests.

- Manage work as per component technical resource for all Water System Plans and assist to prepare all capital plans and project requirements.
- Analyze all engineering activities for all internal and external departments.
- Prepare required presentation for all regulatory agencies.
- Develop required to enhance performance of planning projects.
- Manage all communication and provide efficient feedback for all processes.
- Ensure optimal utilization of all common tools and processes.
- Prepare plans and schedule for all project delivery.
- Recommend appropriate improvements and ensure optimal quality of all project schedules and evaluate reports.
- Perform regular analysis of all schedule trends.
- Maintain an efficient performance of all schedule and analyze all software tools and assist in transmission and distribution of all various projects.
- Administer all distribution and transmission system.
- Manage all customer site and maintain product suite for all applications.
- Evaluate all alternative transmissions for all distribution systems and install all required AMSC products.

WORK STUDY

1. Method Study

Method study is the process of subjecting work to systematic, critical scrutiny to make it more effective and/or more efficient. It is one of the keys to achieving productivity improvement.

It was originally designed for the analysis and improvement of repetitive manual work but it can be used for all types of activity at all levels of an organisation.

The process is often seen as a linear, described by its main steps of:

- Select (the work to be studied);
- Record (all relevant information about that work);
- Examine (the recorded information);
- Develop (an improved way of doing things);
- Install (the new method as standard practice);
- Maintain (the new standard proactive).

Although this linear representation shows the underlying simplicity of method study, in practice the process is much more one of repeated passes through the sequence of steps with each dominating at a different stage of the investigation?

The cyclic process often starts with a quick, rough pass in which preliminary data are collected and examined before subsequent passes provide and handle more comprehensive and more detailed data to obtain and analyze a more complete picture.

- **Select**

Work selected for method study may be an identified problem area or an identified opportunity. It may be identified through a systematic review of available data, normal monitoring or control processes, high levels of dissatisfaction and complaint or as part of a change in management policy, practice, technology or location, and usually because it meets certain conditions of urgency and/or priority.

- **Record**

The Record stage of method study involves gathering sufficient data (in terms of both quality and quantity) to act as the basis of evaluation and examination. A wide range of techniques are available for recording; the choice depends on the nature of the investigation; the work being studied; and on the level of detail required. Many of the techniques are simple charts and diagrams, but these may be supplemented by photographic and video recording, and by computer based techniques.

Especially with "hard" (clearly defined) problems, method study often involves the construction and analysis of models, from simple charts and diagrams used to record and represent the situation to full, computerized simulations. Manipulation of and experimentation on the models leads to ideas for development.

- **Examine**

The recorded data are subjected to examination and analysis. Formalized versions of this process are critical examination and systems analysis. The aim is to identify, often through a structured, questioning process, those points of the overall system of work that require improvements or offer opportunity for beneficial change.

- **Develop**

The Examine stage merges into the Develop stage of the investigation as more thorough analysis leads automatically to identify areas of change. The aim here is to identify possible actions for improvement and to subject these to evaluation in order to develop a preferred solution.

Sometimes it is necessary to identify short-term and long-term solutions so that improvements can be made (relatively) immediately, while longer-term changes are implemented and come to fruition.

- **Install**

The success of any method study project is realized when actual change is made 'on the ground' - change that meets the originally specified terms of reference for the project. Thus, the Install phase is very important. Making theoretical change is easy; making real change demands careful planning - and handling of the people involved in the situation under review. They may need reassuring, retraining and supporting through the acquisition of new skills. Install, in some cases ,will require a parallel running of old and new systems, in others, it may need the build-up of buffer stocks, and other planning to manage the change. what matters is

that the introduction of new working methods is successful. There is often only one chance to make change!

- **Maintain**

Some time after the introduction of new working methods, it is necessary to check that the new method is working, that it is being properly followed, and that it has brought about the desired results. This is the Maintain phase. Method drift is common - when people either revert to old ways of working, or introduce new changes. Some of these may be helpful and should formally be incorporated; others may be inefficient or unsafe. A methods audit can be used to formally compare practice with the defined method and identify such irregularities.

2. Work Measurement

Work measurement is concerned with the determination of the amount of time required to perform a unit of work. Work measurement is very important for promoting productivity of an organization. It enables management to compare alternate methods and also to do initial staffing. Work measurement provides basis for proper planning.

Since it is concerned with the measurement of time it is also called _Time Study_. The exact examination of time is very essential for correct pricing. To find the correct manufacturing time for a product, time study is performed. To give competitive quotations, estimation of accurate labour cost is very essential. It becomes a basis for wage and salary administration and devising incentive schemes.

Objectives of Work Measurement:

1. To compare the times of performance by alternative methods.

2. To enable realistic schedule of work to be prepared.

3. To arrive at a realistic and fair incentive scheme.

4. To analyze the activities for doing a job with the view to reduce or eliminate unnecessary jobs.

5. To minimize the human effort.

6. To assist in the organization of labour by daily comparing the actual time with that of target time.

Uses of Work Measurement:

1. Wok measurement is used in planning work and in drawing out schedules.

2. Wok measurement is used to determine standard costs.

3. Wok measurement is used as an aid in preparing budgets.

4. It is used in balancing production lines for new products.

5. Wok measurement is used in determining machine effectiveness.

6. To determine time standards to be used as a basis for labour cost control.

7. To establish supervisory objectives and to provide a basis for measuring supervisory efficiency.

8. To determine time standards to be used for providing a basis for wage incentive plans.

VALUE ANALYSIS (VA) AND VALUE ENGINEERING (VE)

Value Analysis is one of the major techniques of cost reduction and control. It is a disciplined approach which ensures the necessary functions for the minimum cost without diminishing quality, reliability, performance and appearance.

It is a creative approach to eliminate the unnecessary costs which add neither to quality nor to the appearance of the product. It is a systematic application of techniques to identify the functions of a product or a component and to provide the desired function at the lowest total cost.

These are the days of providing the customer with really best quality products at least cost which is possible through value analysis which proves wrong rightly –Best and Cheap‖ or –Best is never cheap‖ or –Cheap is Costly‖.

- Value Analysis (VA) specifically deals with products already in production and is a cost reduction technique. It is used to analyze product specifications as shown in production documents to achieve similar or better performance at a lower cost while maintaining all functional requirements defined by the customer.
- Value engineering is performed before the production stage and is considered a cost avoidance method.

Value = Function/Cost

Merits of Value Analysis:

Value analysis is really a very valuable technique of cost reduction and quality improvement. The specific merits of its are:

1. Improvement in Product Design:

It leads to improvements in the product design so that more useful products are given shape. Now in case of ball points, we do not have clogging, there is easy and even flow of ink and rubber pad is surrounding that reduces figures fatigue.

2. High Quality is maintained:

High quality implies higher value. Thus, dry cells were leaking; now they are leak proof; they are pen size with same power. Latest is that they are rechargeable.

3. Elimination of Wastage:

Value analysis improves the overall efficiency by eliminating the wastages of various types. It was a problem to correct the mistakes. It was done by pasting a paper. Now, pens are there and liquid paper is developed which dries fast and can write back.

4. Savings in Costs:

The main aim of value analysis is to cut the unwanted costs by retaining all the features of performance or even bettering the performance. Good deal of research and development has taken place. Now milk, oils, purees pulp can be packed in tetra packing presuming the qualities and the tetra pack is degradable unlike plastic packs.

5. Generation of New Ideas and Products:

In case of took brushes, those in 1930_s were flat and hard, over 60 to 70 years brushes have come making brushing teeth easy, cosy and dosy as it glides and massages gums.

6. Encourages Team-Spirit and Morale:

Value analysis is a tool which is not handled by one, but groups or teams and an organisation itself is a team of personnel having specification. A product is the product of all team efforts. Therefore, it fosters team spirit and manures employee morale as they are pulling together for greater success.

7. Neglected Areas are brought under Focus:

The organizational areas which need attention and improvement are brought under the spot-light and even the weakest gets a chance of getting stronger and more useful finally join_s the main strain.

8. Qualification of Intangibles:

The whole process of value analysis is an exercise of converting the intangibles to tangible for decision making purpose. It is really difficult to make decisions on the issues where the things are (variables) not quantifiable.

However, value analysis does it. The decision makers are provided with qualified data and on the basis of decisions are made. Such decisions are bound to be sound.

9. Wide Spectrum of Application:

The principles and techniques of value analysis can be applied to all areas-man be purchasing, hardware, products, systems, procedures and so on.

10. Building and Improving Company Image:

The company_s status or image or personality is built up or improved to a great extent. Improvement in quality and reduction in cost means competitive product and good name in product market; it is a good pay master as sales and profits higher and labour market it enjoys reputation; it capital market, nobody hesitates to invest as it is a quality company.

History of Value Analysis:

Value engineering began at General Electric Co. during World War II. Because of the war, there were shortages of skilled labour, raw materials, and component parts. Lawrence Miles, Jerry Leftow, and Harry Erlicher at G.E. looked for acceptable substitutes. They noticed that these substitutions often reduced costs, improved the product, or both. What started out as an accident of necessity was turned into a systematic process. They called their technique "value analysis".

When to apply Value Analysis:

We apply value analysis when we need……

- ## Eliminating Costs

A critical advantage to using value analysis is its potential for reducing costs, which is a benefit that permeates all advantages of the system. Because value analysis breaks down a product or service into components, it enables you to analyze each component on its own, evaluating its importance and efficiency. A value analysis correctly implemented and applied allows you to identify components that are not worth the cost they require and that can be eliminated or replaced with an alternative. In this manner, the process for the product or service being analyzed is refined to be done at less expense.

- ## Modernizing

The value analysis process often allows users to root out practices that have grown out of date and can be replaced with more modern approaches. This is particularly beneficial when something has been done the same way for an extended period of time. Because the old way works and was new when it was instituted, you have had little impetus to make changes. However, a value analysis, which calls for questioning every step of a process, can reveal new methods that are cheaper, more efficient and sometimes more effective.

- **Design Flaws**

Value analysis can uncover design flaws that not only operate inefficiently but also create problems. In the case of a product, this could mean a high rate of malfunctioning items, creating customer complaints and warranty claims that put a strain on personnel and inventory. It also can lead to bad publicity and damage to the product brand and the company producing it. Similarly, in the case of a service, value analysis can help pinpoint design flaws in the customer support system that causes service to fall short of customer expectations.

- **Customer Service**
  Value analysis is oriented to weigh costs and the benefit to customers of a product or service. It forces you to consider every aspect of a process in the context of how it serves the customer, which could be a consumer or another business. This means that each step in the process is scrutinized and questioned from the perspective of the benefit that it provides the customer. If the benefit to the customer is small and the step is not necessary for the product or service as a whole, it can be eliminated, allowing you to streamline your operation and to reduce the use of resources**.**

Functions

–Specific purposes or intended use of an item (What is this? What is it supposed to do? What else can it do?)

- Function is that which makes a product, process or project work or sell.
- All cost is for function.
- Primary functions posses value and are required to make a product work or sell.
- Secondary functions have no value and are present due to the current design of the product.
- That characteristic that makes a product or service have value.
- Determine by considering the user_s actual needs.

Aims of value engineering/value analysis:

- **Increased profits –** With the cost reduction of a product, the profits of an organization increased. This results in time reduction. It also ensures greater returns on invested capital. The competitive position of company also improves.

- **Improved product Design** – With the modification in design, the customer will get a new and more acceptable product.

- **Efficiency** – It increases the efficiency of employees as it motivates them to come forward with their creative ideas. It also makes contributions to improve human factors such as creativity, team work and positive attitude among employees. The team approach also improves the decision making.
- **Time consideration** – A product has value for the customer if it is available to him on time. So time element has great importance in value engineering. It may have no value if it arrives later.
- **Improvement in quality** – This results in improvement in quality, reliability, performance and maintainability of a product.

Value Engineering Procedure:

The 6 Steps of a Value Analysis

1. Blast

- **Identify the product and collect relevant information**

In this first phase, the team attempts to understand why the project exists and who or what it is to produce. They obtain project data, present the original design or product concepts, and understand the project scope. Schedule, costs, budget, risk, and other non-monetary issues are studied until the team is comfortable with the concept of the project, what it is to produce, and who its end users are.

This step also includes things like site visits and meetings with the project team, if required. Project documents like plans, drawings, specifications, and reports are obtained and the value engineering team becomes familiar with them.

- **Define Different Functions**

This step represents the meat and potatoes of the value analysis. The team attempts to determine the functions the project serves. Functions come in two forms:

1. ***Primary functions*** are those that represent the reason for the project_s existence, for example, a building project might have adequate plumbing as a primary function.
2. ***Secondary functions*** are those that the project serves without being core to the project.

This phase represents the generation of improvement ideas. The team develops alternative ways that the project can perform the functions that have been identified. At this

step, the functions are looked at individually and each one gets a list of alternative ways to perform the function. There is no judging between the importance of the various functions.

2. Create

- **Different Alternatives**

This phase represents the generation of improvement ideas. The team develops alternative ways that the project can perform the functions that have been identified. At this step, the functions are looked at individually and each one gets a list of alternative ways to perform the function. There is no judging between the importances of the various functions.

- **Critically Evaluate each Alternatives**

At this stage, a priority is given to each project improvement idea. The ideas are discussed and potential costs are determined. Once the risk-reward profile of each idea is itemized, the team has determined which ideas are worth implementing into the project or feature.

A few years ago, there was a pedestrian bridge built near my home which was originally designed for emergency vehicles. Although this type of design is standard practice for the bridges of this type, the value engineering team identified that emergency vehicle passage was not needed (verb/noun pair = _maintain passage for emergency vehicles_). Also, a second major outcome of this value analysis was to change the design to an aesthetic, curved bridge because it was in a prominent location. The redesign of the bridge cost some money but this was more than made up by the cost of the bridge construction. Thus, the value analysis paid for itself about 10 times over in the reduced construction cost, and the bridge was significantly more aesthetic.

3. Refine:

- **Develop the best alternative**

Once the value improvement options have been whittled down to the ones that make sense, the value engineering team develop the options to the point of passing them back to the original project team. They must be clearly written and explained so that the project owner and stakeholders can understand how it benefits the project and act on it. Any potential negative factors are identified. Potential costs and cost savings are itemized.

- **Implement the Alternative**

This last phase represents the presentation of the alternatives to the stakeholders. Often value engineering represents a change in the normal practices that people are used to, an ‑out of the box thinking.‖ Thus the best salesperson on the team is often the best one to do the presentation.

Application Areas:

1. Manufacturing Industry
2. Services Industry
3. Construction Industry
4. Product Design

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.

1. Benefits to Design Department

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

2. Benefits to Manufacturing Department

- Lower unit cost.
- Better quality products.
- Better methods and tooling.
- Increased interchangeability of parts.
- Better utilization of manpower and equipment.
- Accurate delivery dates.
- Better services of production control, stock control, purchasing, etc.
- More effective training.

Standardization Procedure:

1) The first step consists of emerging of a proposal for a new standard or the revision or the amendment of an existing standard. The proposal can emerge from a representative of any sector of the economy (such as a trade association or a professional association).

2) The directorate of the standardization organization preliminarily examines the proposal to determine whether it is consistent with the underlying principles for the preparation of standards.

3) The division council of the standardization organization decides to approve or reject the proposal for the preparation of new standard or amendment of the existing standard.

4) After the approval by the division council, the work of drafting the standard is allotted to the existing technical committee or sectional committee. This committee does the maximum work involved in the preparation of the draft standard. The technical committee is to work within the framework of the governing policies and procedures for the preparation of the standards. The members of the committee are required to have good technical knowledge about what is to be standardized. Also, they are to understand that the preparation of a standard needs consensus where the views of various parties are to be accommodated. Further, the committee is required to have a balance of members who can represent the needs of both suppliers and consumers. Representatives from academia and government can bring additional balance to the committee.

5) The technical committee prepares the draft standard or alternatively, the committee may appoint a subcommittee and/or panel for preparation of the draft.

6) After the draft has been prepared, the technical committee reviews it extensively and then passes it on to the secretariat for editing and wide circulation.

7) The draft is widely circulated. The aim of wide circulation is to inform every interest in the country or abroad which may be affected by the draft and to invite critical review and comments.

8) The comments on the draft are systematically examined by the technical or sectional committee. In the light of committee discussions, the final version of the draft is drawn up by the secretariat incorporating the comments accepted by the technical or sectional committee.

9) The final version of the draft is submitted to the division council for approval and finally to the general council or its chairman. Once approved by these offices, the draft gets the status of a standard.

10) The approved standard is then published by the secretariat and the published standard is then released for sale to the public. The new standard or amendment of the existing standard is given wide publicity by the standardization organization. The standard after publication or revision is put to use. At this stage, it goes into the maintenance phase. During the maintenance phase of the standard, it is normal to discover that updates to the standard are needed because of the advances in the technology. The process for updating of the standard is carried out by amending the standard. In case no amendment is required in an existing standard, still the standard is to be reaffirmed after a certain period. For reaffirmation of an existing

Standard, the process to be adopted is same as that of creation of the new standard.

Application of Standardization:

1. Standardization Statistics
2. Standardization Chemistry
3. Standardization IT Infrastructure

Ergonomic considerations in Product Design: Ergonomic is a human factor of engineering. It considers the human characteristics, behavior, usage and the living environment while designing a product/process.

What makes a product ―ergonomic‖? Much to the dismay of consumers, product designers, and even ergonomists, there is not a single answer to this seemingly simple question. That lack of a single answer hints at the heart of what ergonomics is really about, designing to fit the user. A product has different stages of use, including:

- Building the product
- Using the product
- Maintaining/repairing the product

These different stages may also have very different users. For instance, when building a product (such as a refrigerator), a supplier may manufacture a sub-assembly (such as a compressor) that is installed in the larger product. The user requirements to build the compressor may be quite different than the user requirements to install that compressor into the refrigerator. An example of two different types of users who are using the same product is found in the hospital environment. Both patients and nurses ―use‖ a hospital bed, but each has their own specific needs during use.

A product may fit user needs for one stage quite well, but not fit users in other stages. Examining a product in one context would result in concluding that it is an ergonomic product, while looking at other contexts would provide very different conclusions.

A truly ergonomic product considers the user needs at each stage

UNIT-III

Plant Location and Plant Layout

FACTORS INFLUENCING PLANT LOCATION

(i) Availability of Raw Materials:

One of the most important considerations involved in selection of industrial location has been the availability of raw materials required. The biggest advantage of availability of raw material at the location of industry is that it involves less cost in terms of _transportation cost.

If the raw materials are perishable and to be consumed as such, then the industries always tend to locate nearer to raw material source. Steel and cement industries can be such examples. In the case of small- scale industries, these could be food and fruit processing, meat and fish canning, jams, juices and ketchups, etc.

(ii) Proximity to Market:

If the proof of pudding lies in eating, the proof of production lies in consumption. Production has no value without consumption. Consumption involves market that is, selling goods and products to the consumers. Thus, an industry cannot be thought of without market.

Therefore, while considering the market an entrepreneur has not only to assess the existing segment and the region but also the potential growth, newer regions and the location of competitors. For example, if one_s products are fragile and susceptible to spoilage, then the proximity to market condition assumes added importance in selecting the location of the enterprise.

Similarly if the transportation costs add substantially to one_s product costs, then also a location close to the market becomes all the more essential. If the market is widely scattered over a vast territory, then entrepreneur needs to find out a central location that provides the lowest distribution cost. In case of goods for export, availability of processing facilities gains importance in deciding the location of one_s industry. Export Promotion Zones (EPZ) are such examples.

(iii) Infrastructural Facilities:

Of course, the degree of dependency upon infrastructural facilities may vary from industry to industry, yet there is no denying of the fact that availability of infrastructural facilities plays a deciding role in the location selection of an industry. The infrastructural facilities include power, transport and communication, water, banking, etc.

Yes, depending upon the types of industry these could assume disproportionate priorities. Power situation should be studied with reference to its reliability, adequacy, rates

(concessional, if any), own requirements, subsidy for standby arrangements etc. If power contributes substantially to your inputs costs and it is difficult to break even partly using your own standby source, entrepreneur may essentially have to locate his/her enterprise in lower surplus areas such as Maharashtra or Rajasthan.

Similarly adequate water supply at low cost may become a dominant decisional factor in case of selection of industrial location for leather, chemical, rayon, food processing, chemical and alike. Just to give you an idea what gigantic proportions can water as a resource assumes. Note that a tone of synthetic rubber requires 60 thousand gallons, a tone of aluminum takes 3 lakhs gallons, and a tone of rayon consumes 2 lakh gallons of water.

Similarly, location of jute industry on river Hoogly presents an example where transportation media becomes a dominant decisional factor for plant location. Establishing sea food industry next to port of embarkation is yet another example where transportation becomes the deciding criteria for industrial location.

(iv) Government Policy:

In order to promote the balanced regional development, the Government also offers several incentives, concessions, tax holidays for number of years, cheaper power supply, factory shed, etc., to attract the entrepreneurs to set up industries in less developed and backward areas. Then, other factors being comparative, these factors become the most significant in deciding the location of an industry.

(v) Availability of Manpower:

Availability of required manpower skilled in specific trades may be yet another deciding factor for the location of skill- intensive industries. As regards the availability of skilled labour, the existence of technical training institutes in the area proves useful. Besides, an entrepreneur should also study labour relations through turnover rates, absenteeism and liveliness of trade unionism in the particular area.

Such information can be obtained from existing industries working in the area. Whether the labour should be rural or urban; also assumes significance in selecting the location for one_s industry. Similarly, the wage rates prevalent in the area also have an important bearing on selection of location decision.

While one can get cheaper labour in industrially backward areas, higher cost of their training and fall in quality of production may not allow the entrepreneur to employ the cheap manpower and, thus, establish his/her enterprise in such areas.

(vi) Local Laws, Regulations and Taxes:

Laws prohibit the setting up of polluting industries in prone areas particularly which are environmentally sensitive. Air (Prevention and Control of Pollution) Act, 1981 is a classical example of such laws prohibiting putting up polluting industries in prone areas. Therefore, in order to control industrial growth, laws are enforced to decongest some areas while simultaneously encourage certain other areas.

For example, while taxation on a higher rate may discourage some industries from setting up in an area, the same in terms of tax holidays for some years may become the dominant decisional factor for establishing some other industries in other areas. Taxation is a Centre as well as State Subject. In some highly competitive consumer products, its high quantum may turn out to be the negative factor while its relief may become the final deciding factor for some other industry.

(vii) Ecological and Environmental Factors:

In case of certain industries, the ecological and environmental factors like water and air pollution may turn out to be negative factor in deciding enterprise location. For example, manufacturing plants apart from producing solid waste can also pollute water and air. Moreover, stringent waste disposal laws, in case of such industries, add to the manufacturing cost to exorbitant limits.

In view of this, the industries which are likely to damage the ecology and environment of an area will not be established in such areas. The Government will not grant permission to the entrepreneurs to establish such industries in such ecologically and environmentally sensitive areas.

(viii) Competition:

In case of some enterprises like retail stores where the revenue of a particular site depends on the degree of competition from other competitors_ location nearby plays a crucial role in selecting the location of an enterprise. The areas where there is more competition among industries, the new units will not be established in these areas. On the other hand, the areas where there is either no or very less competition, new enterprises will tend to be established in such areas.

(ix) Incentives, Land Costs, Subsidies for Backward Areas:

With an objective to foster balanced economic development in the country, the Government decentralizes industries to less developed and backward areas in the country. This is because the progress made in islands only cannot sustain for long. The reason is not difficult to seek.

-Poverty anywhere is dangerous for prosperity everywhere.‖ That many have-not_s will not tolerate a few haves is evidently clear from ongoing protests leading to problems like terrorism. Therefore, the Government offers several incentives, concessions, tax holidays, cheaper lands, assured and cheaper power supply, price concessions for departmental (state) purchases, etc. to make the backward areas also conducive for setting up industries.

It is seen that good number of entrepreneurs considers these facilities as decisive factor to establish industries in these locations. However, it has also been observed that these facilities can attract entrepreneurs to establish industries in backward areas provided other required facilities do also exist there.

For example, incentives and concessions cannot duly compensate for lack of infrastructural facilities like communication and transportation facilities. This is precisely one of the major

reasons why people in-spite of so many incentives and concessions on offer by the Government, are not coming forward to establish industries in some backward areas.

(x) Climatic Conditions:

Climatic conditions vary from place to place in any country including India. And, climatic conditions affect both people and manufacturing activity. It affects human efficiency and behaviour to a great extent. Wild and cold climate is conducive to higher productivity. Likewise, certain industries require specific type of climatic conditions to produce their goods. For example, jute and textiles manufacturing industries require high humidity.

As such, these can be established in Kashmir experiencing humidity-less climate. On the other hand, industrial units manufacturing precision goods like watches require cold climate and hence, will be established in the locations having cold climate like Kashmir and Himachal Pradesh.

(xi) Political Conditions:

Political stability is essential for industrial growth. That political stability fosters industrial activity and political upheaval derails industrial initiates is duly confirmed by political situations across the countries and regions within the same country. The reason is not difficult to seek.

The political stability builds confidence and political instability causes lack of confidence among the prospective and present entrepreneurs to venture into industry which is filled with risks. Community attitudes such as the ‑Sons of the Soil Feeling‖ also affect entrepreneurial spirits and may not be viable in every case.

Besides, an entrepreneur will have also to look into the availability of community services such as housing, schools and colleges, recreational facilities and municipal services. Lack of these facilities makes people hesitant and disinterested to move to such locations for work.

Very closer to political conditions is law and order situation prevalent in an area also influences selection of industrial location. Hardly any entrepreneur will be interested to establish his / her industry in an area trouble-torn by nexalites and terrorists like Jharkhand, Nagaland and Jammu & Kashmir

BREAK EVEN ANALYSIS

The break-even point (BEP) or break-even level represents the sales amount—in either unit (quantity) or revenue (sales) terms—that is required to cover total costs, consisting of both fixed and variable costs to the company. Total profit at the break-even point is zero. It is only possible for a firm

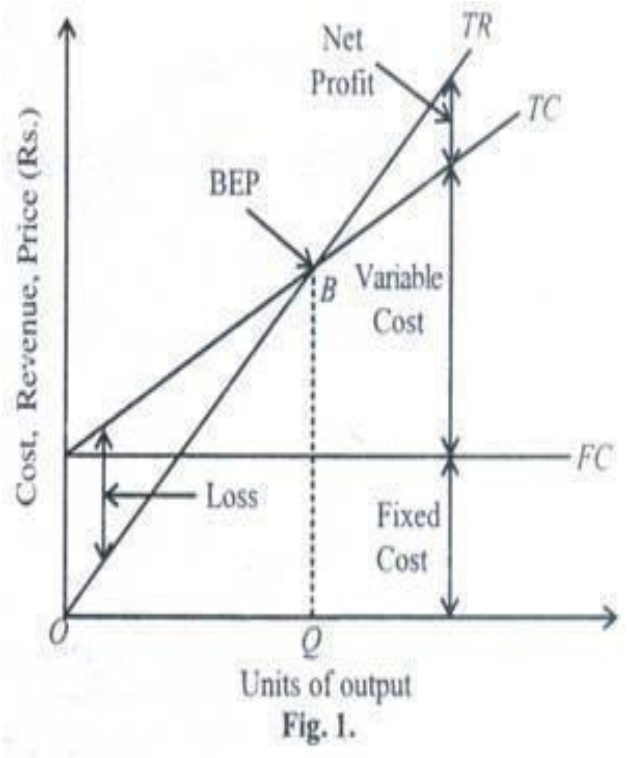


Fig. 1.

The break-even point is one of the most commonly used concepts of financial analysis, and is not only limited to economic use, but can also be used by entrepreneurs, accountants, financial planners, managers and even marketers. Break-even points can be useful to all avenues of a business, as it allows employees to identify required outputs and work towards meeting these.

The Breakeven value is not a generic value and will vary dependent on the individual business. Some businesses may have a higher or lower breakeven point, however it is important that each business develop a break-even point calculation, as this will enable them to see the number of units they need to sell to cover their variable costs. Each sale will also make a contribution to the payment of fixed costs as well.

For example, a business that sells tables needs to make annual sales of 200 tables to break-even. At present the company is selling fewer than 200 tables and is therefore operating at a loss. As a business, they must consider increasing the number of tables they sell annually in order to make enough money to pay fixed and variable costs.

If the business does not think that they can sell the required number of units, they could consider the following options:

1. Reduce the fixed costs. This could be done through a number of negotiations, such as reductions in rent, or through better management of bills or other costs.

2. Reduce variable costs by, for example, finding a new supplier that sells tables for less.

Either option can reduce the break-even point so the business need not sell as many tables as before, and could still pay fixed costs

PLANT FACILITY LOCATION PROBLEMS:

Business systems utilize facilities like plant and machinery, warehouses etc., while performing the task of producing products and services a proper planning of these facilities would definitely reduce their cost of operation and maintenance. Plant location decisions are very important because they have direct bearing on factors like financial, employment and distribution patterns.

In the long run, relocation may even benefit the organization. But, the relocation of the plant involves stoppage of production, and also cost for shifting the facilities to a new location. In addition to these things, it will introduce some inconvenience in the normal functioning of the business. Hence at the time of starting any industry, one should generate several alternate sites for locating the plant. After a critical analysis, it is the best site to be selected for commissioning the plant. Location of warehouses and other facilities are also having direct bearing on the operational performance of organization.

Facility location is a strategic management decision. Such a decision is usually made applying the current conditions such as population, infrastructure, service requirements and others. Common location models deal with single and multiple facility location, covering, p-median, p-center problems, their applications and extensions. Many of these problems can be very difficult to solve.

The strategic nature of facility location problems requires that models consider some aspect of future uncertainty. Since the investment required by locating or relocating facilities is usually large, facilities are expected to remain operable for an extended time period. Thus, the problem of facility location truly involves an extended planning horizon. Decision makers must not only select locations which will effectively serve changing demand over time, but must also consider the timing of facility expansions and relocations over the long term.

PLANT LAYOUT: CONCEPT, OBJECTIVES, PRINCIPLES AND TYPES

Concept of Plant Layout:

The concept of plant layout may be described as follows:

Plant layout is a plan for effective utilization of facilities for the manufacture of products; involving a most efficient and economical arrangement of machines, materials, personnel, storage space and all supporting services, within available floor space.

–Plant layout is a plan of optimum arrangement of facilities including personnel, equipment_s, storage space, material handling equipment and all other supporting services along with the decision of best structure to contain all these facilities.‖

(i) Plant layout is very complex in nature; because it involves concepts relating to such fields as engineering, architecture, economics and business management.

(ii) Most of managers now realize that after the site for plant location is selected; it is better to develop the layout and build the building around it – rather than to construct the building first and then try to fit the layout into it.

Objectives/Advantages of Plant Layout:

Following are the objectives/advantages of plant layout:

(i) Streamline flow of materials through the plant

(ii) Minimize material handling

(iii) Facilitate manufacturing progress by maintaining balance in the processes

(iv) Maintain flexibility of arrangements and of operation

(v) Maintaining high turnover of in-process inventory

(vi) Effective utilization of men, equipment and space

(vii) Increase employee morale

(viii) Minimize interference (i.e. interruption) from machines

(ix) Reduce hazards affecting employees

(x) Hold down investment (i.e. keep investment at a lower level) in equipment.

Principles of Plant Layout:

(i) Principle of Minimum Movement: Materials and labour should be moved over minimum distances; saving cost and time of transportation and material handling.

(ii) Principle of Space Utilization: All available cubic space should be effectively utilized – both horizontally and vertically.

(iii) Principle of Flexibility: Layout should be flexible enough to be adaptable to changes required by expansion or technological development.

(iv) Principle of Interdependence: Interdependent operations and processes should be located in close proximity to each other; to minimize product travel.

(v) Principle of Overall Integration: All the plant facilities and services should be fully integrated into a single operating unit; to minimize cost of production.

(vi) Principle of Safety: There should be in-built provision in the design of layout, to provide for comfort and safety of workers.

(vii) Principle of Smooth Flow: The layout should be so designed as to reduce work bottlenecks and facilitate uninterrupted flow of work throughout the plant.

(viii) Principle of Economy: The layout should aim at effecting economy in terms of investment in fixed assets.

(ix) Principle of Supervision: A good layout should facilitate effective supervision over workers.

(x) Principle of Satisfaction: A good layout should boost up employee morale, by providing them with maximum work satisfaction.

Types of Plant Layout:

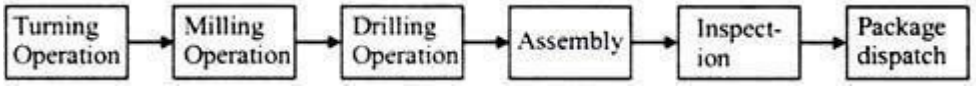
Two basic plans of the arrangement of manufacturing facilities are – product layout and process layout. The only other alternative is a combination of product and process layouts, in the same plant.

(a) Product Layout (or Line Layout):

In this type of layout, all the machines are arranged in the sequence, as required to produce a specific product. It is called line layout because machines are arrange in a straight line. The raw materials are fed at one end and taken out as finished product to the other end.

Special purpose machines are used which perform the required jobs (i.e. functions) quickly and reliably.

Product layout is depicted below:



Advantages:

1. Reduced material handling cost due to mechanized handling systems and straight flow

2. Perfect line balancing which eliminates bottlenecks and idle capacity.

3. Short manufacturing cycle due to uninterrupted flow of materials

4. Simplified production planning and control; and simple and effective inspection of work.

5. Small amount of work-in-progress inventory

6. Lesser wage cost, as unskilled workers can learn and manage production.

Disadvantages:

1. Lack of flexibility of operations, as layout cannot be adapted to the manufacture of any other type of product.

2. Large capital investment, because of special purpose machines.

3. Dependence of whole activity on each part; any breakdown of one machine in the sequence may result in stoppage of production.

4. Same machines duplicated for manufacture of different products; leading to high overall operational costs.

5. Delicate special purpose machines require costly maintenance / repairs.

Suitability of product layout:

Product layout is suitable in the following cases:

1. Where one or few standardized products are manufactured.

2. Where a large volume of production of each item has to travel the production process, over a considerable period of time.

3. Where time and motion studies can be done to determine the rate of work.

4. Where a possibility of a good balance of labour and equipment exists.

5. Where minimum of inspection is required, during sequence of operations.

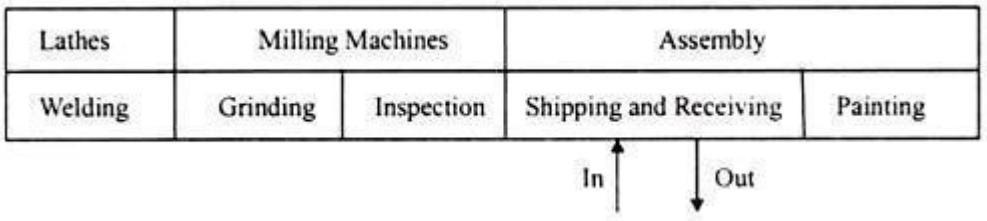
6. Where materials and products permit bulk or continuous handling by mechanical parts.

7. Where minimum of set-ups are required.

(b) Process Layout (or Functional Layout):

In this type of layout, all machines performing similar type of operations are grouped at one location i.e. all lathes, milling machines etc. are grouped in the shop and they will be clustered in like groups.

A typical process layout is depicted below:



Advantages:

1. Greater flexibility with regard to work distribution to machinery and personnel. Adapted to frequent changes in sequence of operations.

2. Lower investment due to general purpose machines; which usually are less costly than special purpose machines.

3. Higher utilization of production facilities; which can be adapted to a variety of products.

4. Variety of jobs makes the work challenging and interesting.

5. Breakdown of one machine does not result in complete stoppage of work.

Disadvantages:

1. Backtracking and long movements occur in handling of materials. As such, material handling costs are higher.

2. Mechanization of material handling is not possible.

3. Production planning and control is difficult

4. More space requirement; as work-in-progress inventory is high-requiring greater storage space.

5. As the work has to pass through different departments; it is quite difficult to trace the responsibility for the finished product.

Suitability of process layout:

Process layout is suitable in the following cases, where:

1. Non-standardized products are manufactured; as the emphasis is on special orders.

2. It is difficult to achieve good labour and equipment balance.

3. Production is not carried on a large scale.

4. It is difficult to undertake adequate time and motion studies.

5. It is frequenStly necessary to use the same machine or work station for two or more difficult operations.

6. During the sequence of operations, many inspections are required.

7. Process may have to be brought to work, instead of **"vice-versa"**; because materials or products are too large or heavy to permit bulk or continuous handling by mechanical means.

(c) Group Technology Layout or Combined Layout:

Product layouts are feasible only in case of mass production systems. When the production volume is less, it may be difficult to justify dedication of resource to individual products. Therefore, organizations have been using process layouts for such situations. However, since process layouts create more problems in production planning and control_ due to complex routing of various components on the shop floor, operation managers were looking for alternatives to the

process layout. On the other hand, there has been an increasing trend towards more variety. The industrial fans and blowers division of ABB Ltd, a multinational company operating in India manufactures about 725 models, Titan Industries increased the jumpers of watch models from 850 in 1993 to 1200 in 1996, an average more than 100 new models every year. Group Technology (GT) layout provides an alternative method for configuring resources in organizations that have mid-value, mid variety product portfolios. Group Technology is a philosophy that seeks to exploit commonality in manufacturing and uses this as the basis for grouping components and resources. The implications of GT are often known as cellular manufacturing. In cellular manufacturing, the available components are grouped part families. An approximate measure for manufacturing similarity is used to identify part families. Corresponding to each part family, machine groups are identified and layout is formed accordingly.

Advantage of GT Layout

The benefits of GT are many. Once the part families and the machine groups are identified, the layout ensures that each cell has only a certain number of components to be processed. In essence, it is akin to breaking a monolith structure into smaller, more manageable and independent units of production. The components seldom travel outside their respective cell for processing. Therefore, material handling becomes easier and traceability improves.

Moreover, employees are able to relate better to their workplace and make concerned improvements. The new structure also helps to implement several other operations management practices such as small group improvement, Kaizen and JIT manufacturing practices.

(d) Fixed Position Layout:

There are several situations in which the product manufactured is very bulky, difficult to move and is often made in quantities of one or few pieces. In such situations, the layout design ought to be very different. Typical examples include building very large machines tools and equipments, ships, and aircraft building. Since the equipments are very large and bulky they dictate several choices with respect to layout. The specific orientation of the equipment will dictate the placement of specific resources required for the process. Layout planning in such cases is often a question of a good work place organization Some examples include the nuclear engineering division of Bharat Heavy Electrical Division at Tiruchirapalli, the final assembly panel of advanced helicopter division.

LAYOUT DESIGN PROCEDURE

Design of Product layout:

Layout design for products can be classified into the following two methods

1. Manual methods
2. Computerized methods

Manual Methods: Under this category there are some conventional methods like travel chart and Systematic Layout Planning (SLP). We will discuss Systematic Layout process:

Systematic Layout Design Method (SLP) : This is an organized approach to layout planning. This approach has been developed by Muther. It is clear that once the appropriate

information is gathered, a flow analysis can be combined with an activity analysis to develop the relationship diagram. This space-relationship diagram is constructed by combining space considerations with the relationship diagram. Based on space relationship diagram, modifying considerations and practical limitations, a number of alternative layouts are designed and evaluated.

Computerized methods: Under these methods the layout design procedures can be classified into constructive type algorithms and improvement type algorithms. Constructive type algorithms are:

- Automated Layout Design Program (ALDEP)
- Computerized Relationship Layout Planning (CORELAP)
- Improvement type algorithms are:
- Computerized Relative allocation of Facilities Technique (CRAFT)

UNIT 4

Scheduling

Introduction to scheduling:

Scheduling is the process of arranging, controlling and optimizing work and workloads in a production process. 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

Types of Scheduling

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

1. Forward scheduling

It 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 are 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

It 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. Forward and backward scheduling

UNIT 5

Material Management

INTEGRATED MATERIAL MANAGEMENT

Integrated Material Management has following components

1. Materials Planning:

In any integrated Materials Management environment, planning for getting the materials is the starting point for the whole MM function. Materials planning set the procurement function and the subsequent material functions rolling.

Material planning is a scientific way of determining the requirements starting with raw materials, consumables, spare parts and all other materials that are required to meet the given production plan for a certain period.

Material planning is derived from the overall organizational planning and hence it is always a sub-plan of the broad organizational plan.

What it does is forecasting and initiating for procurement of materials

2. Inventory Control:

What Is Inventory Control?

Inventory control, also known as stock control, involves regulating and maximizing your company_s inventory. The goal of inventory control is to maximize profits with minimum inventory investment, without impacting customer satisfaction levels. Inventory control is also about knowing where all your stock is and ensuring everything is accounted for at any given time.

Inventory control involves warehouse management. This includes:

- Keeping track of the stock that is already in the warehouse. This includes knowing what products are being stocked and how much of a particular item is available.
- Aspects of warehousing designs, such as knowing where everything is and ensuring that the products are stored well.

3. Purchase management:

Purchase Management refers to sourcing of goods & services from different suppliers. The Purchase Management extension allows you to manage suppliers, quotations, purchase orders, and incoming shipments. You can add suppliers to a product, specifying each supplier's price & order quantity. A draft purchase order is created when any product goes out of stock. After receiving the incoming shipments and the inventories becomes updated. You can also receive partial shipments too.

Features of Purchase Management -

- Select default procurement method as – auto or manual.
- Send quotation and purchase order emails to suppliers.
- Add any comments in purchase orders and incoming shipments for notifying the suppliers.
- Mention cost price and minimal quantity for every product.
- Manage incoming shipments and products from store backend.
- Update received quantity of partial shipments.
- An auto-draft purchase order is created for out of stock products.
- Merge two or more purchase orders.

4. Stores Management:

Stores management takes care:

1. That the required material is never out of stock;

2. That no material is available in (much) excess than required;

3. To purchase materials on the principle of economic order quantity so that the associated costs can be minimized; and

4. To protect stores against damage, theft, etc.

This can be achieved through:

1. A proper purchasing practice (i.e., when to order materials).

2. An adequate procedure of receipt and issue of materials.

3. Proper methods of storing materials.

4. An effective system of physical control of materials.

5. A proper method of keeping store records.

Functions of Stores Department and the Duties of the Storekeeper:

1. To receive materials, goods and equipment, and to check them for identification.

2. To receive parts and components which have been processed in the factory.

3. To record the receipt of goods.

4. To correct positioning of all materials and supplies in the store.

5. To maintain stocks safely and in good and condition by taking all precautions to ensure that they do not suffer from damage, pilfering or deterioration.

6. To issue items to the users only on the receipt of authorized stores requisitions.

7. To record and update receipts and issues of materials.

8. To check the bin card balances with the physical quantities in the bins.

9. To make sure that stores are kept clean and in good order.

10. To prevent unauthorized persons from entering the stores.

11. To make sure that materials are issued promptly to the users.

12. To plan store for optimum utilization of the cubic space (i.e., length, breadth and height).

13. To ensure that the required materials are located easily.

14. To initiate purchasing cycle at the appropriate time so that the materials required are never out of stock.

15. To coordinate and cooperate to the full extent with the purchasing, manufacturing, inspection and production planning and control departments.

INVENTORY DECISIONS:

The approach to stock in manufacturing company needs to be different from that in a trading or a commercial business. For a Supermarket the main reason for holding stock will be to provide good customer service. A high degree of such service will be required. If the cornflakes are out of stock, the customer will go elsewhere. The goods classed as "Stock" will mainly be finished goods; ready for sale, ordering from Suppliers will be done largely without considering the consequences on any manufacturing activity. For a manufacturing company, stock control systems must take account of manufacturing activities. Inevitably there will be clashes or trade offs between the level of stock carried, the service given to the customers, the cash flow involved in carrying stock and the influence stock ordering policy has on manufacturing costs.

"Stocks" will cover finished goods stocks, but also raw materials, work in process and components ready for use. The term "Inventory" refers to the stock of raw materials, Parts and finished products at hand at a given time (a tangible asset which can be seen, weighed or counted). In a wider sense "inventory consists of usable but idle resources". The resources may be

of any type; for example men, materials, machines or money. When the resource involved is material or goods in any stage of completion, inventory is referred to as stock".

Inventory consists of the following-

- **Raw Materials:** They are the physical resources to use in the production of finished goods. The purpose of holding raw material is to ensure uninterrupted production in the event of delays in delivery and to take advantage of bulk or other favorable terms of purchase.
- **Bought out components**: Items not manufactured/fabricated by the organization but used with or without further processing and/or packing the finished product, e.g. Rubber parts by Egg co. Tin cans by a Vanaspati Mill.
- **Work in process- or intermediate goods are in the process of production**. Their purpose is to disconnect the various stages of production which facilitate production planning. Such Inventory helps to stabilize the rate of output at successive stages in the face of fluctuation. Partly manufactured/processed inventories awaiting further mfg/processing between two operations and are in the process of being fabricated or assembled into finished products, including materials lying with subcontractors and material lying in shop food for further processing or assembly.
- **Finished Goods:** They are the inventory held for sale in ordinary course of business. Such inventory serves as a buffer against fluctuations in demand for a product. Stock of finished goods facilitates a reasonable rate of output and enables the firm to provide a quick service to customers. It helps to reduce the risk associated with stoppages or reductions in production on account of strikes, break down, shortage of material/power etc.
- **MRO:** Maintenance, Repair and operating supplies. The group include spare parts and consumables which are required for use in the process but do not form a part of the finished product, e.g. Lubricants, V Belt, Electrodes, Pencil, Soap etc

Things to Consider When Making a Decision in Inventory

- ### Warehousing

Physical space may cap the amount of material held on-site. At a manufacturing site, space for raw materials must be adequate to supply production for a given period of time. Since square footage devoted to storage does not contribute directly to sales, most decisions attempt to reduce the amount of floor space used without jeopardizing supply for production. Smaller supply shipments more frequently may be one solution. Finished goods may also be shipped frequently or sent to off-site storage to maximize room for raw materials.

- ### Cost

Several cost factors influence inventory management decisions. The value of raw materials represents stalled cash flow, assets that don't actively contribute to the bottom line. This feeds the theory of "just in time" delivery, where raw materials arrive as they are consumed, thus eliminating costs associated with warehouse space and unused inventory. Bulk purchasing is the flip side of the scenario. Suppliers may offer discounts on quantities of materials in excess of your immediate needs. This can improve profit margin on finished goods, but only if additional warehousing and finance charges are avoided.

- ## Cost trade off:

If the order quantity is less, the cost of order will be more but inventory carrying cost will be less. On the other hand, if the order quantity is more, the ordering cost will be less but the inventory carrying cost will be more.

- ## Delivery Time

Lead time between order and delivery of raw materials is an important factor. If a supplier can deliver the day after an order is placed, an inventory manager has the greatest flexibility, effectively using the supplier's warehousing space for free. When the time between order and delivery is weeks, an inventory manager must factor this in to maintain sufficient supply, while balancing warehousing space and inventory costs. Unless there is the option to switch product lines in the event of supply shortages, ensuring constant supply is usually an inventory manager's chief priority.

- ## Turnaround

Turnaround has several definitions when considering inventory. Where finished goods are concerned, turnaround refers to how long stock sits before sale. An inventory manager wants this time to be as short as possible, though this may be a function of sales and marketing. On the inbound side, turnaround refers to how long current stock supplies production. Where minimum and maximum inventory levels are set, the minimum level considers supply turnaround and delivery time, while maximum values address warehousing and cost factors.

Models of Inventory:

Understanding which of the core inventory management models applies to divisions of you business it a critical first step in using the right techniques to manage your inventory. Inventory management models fall into two fundamental categories: independent and dependent inventory demand models.

- **Purchase model with instantaneous replenishment and without shortages**: in this model of inventory, orders of equal size are placed at periodic intervals. The items against an order are replenished instantaneously and the items are consumed at constant rate.
- **Manufacturing model without shortages:** if a company manufactures its components which is required for its main products, then the corresponding model of inventory is called manufacturing model without shortages.
- **Purchasing model without shortages**: in this model, the items on the order will be received instantaneously after they are exhausted in the company.
- **Manufacturing model with shortage:** in this model, the items are produced and consumed simultaneously for a portion of cycle time.

Independent Demand

Independent demand inventory systems are at their very essence market driven. Whether the inventory is raw materials or a finished product, it is the end product of that particular organization. Pulls from inventory occur as an external customer purchases the units, either directly or as restock to a forward retail position.

Items with an independent demand tend to be managed through one of two processes: periodic review or perpetual inventory management.

- **Periodic Review:** This process involves regular review of usage and reorder to a carrying point.
- **Perpetual Inventory:** This process revolves around reorders when an item reaches a pre-set minimum stocking level, or reorder point.

While demand can be somewhat indirectly influenced via pricing, merchandising, marketing and a whole spectrum of marketing initiative, in the end the market determines the inventory turns. The challenges in predicting independent demand is that there may not be a history, or the history may not match due to the life cycle stage of the product.

Dependent Demand

Dependent demand inventory systems are classically associated with Enterprise Resource Planning systems. The known demand is generally based on production numbers and the inventory represents the raw materials required to meet those requirements.

This overall demand model allows the use of such inventory management models as Economic Ordering Quantity, Safety Stock Analysis, Fill Rates, and Cycle Service Levels.

In this demand model, supply chain concerns become more and more critical to inventory control decisions. Lead times, quantity price breaks, and the costs of expediting orders all play a role.

Knowing the type of demand you need to accommodate is the first step in developing your own customized inventory management models. Different segments of your inventory may actually service a different demand type.

Learning how to recognize the operating demand conditions is the first step to growing into a more efficient organization. The next step is implementing the processes that support the inventory management models.

Quantity Discount

When items are purchased in bulk, the buyers are given discount in the purchase price of goods. This is called Quantity Discount.

Incoming Material Control

The quality of incoming materials is tested by anyone of the following methods.

- Acceptance sampling for attributes
- Acceptance sampling for variables

Acceptance sampling is a technique for controlling quality of raw materials or finished goods. Based on producers_ risk, consumers_ risk, acceptance quality level and lot tolerance defective, one can design a suitable plan for acceptance sampling.

Store Accounting

Store accounting is very much useful in determining the material cost of a product. The issues of store are accounted using anyone of the following methods:

- First in first out method (FIFO): here, assumption is that the old stock is depleted first.
- Last in first out method (LIFO): here, assumption is the most recent receipts are issued first
- Average cost method: the issues to the production department are divided into equal batches from each shipment at a stock.
- Standard cost method: a standard rate for the materials is fixed based on the detailed analysis of market prices. This cost will be used for the fixed period.
- Market price method: the prevailing market rate of material is applied for costing the material at the time of issue.

Obsolete Surplus and Scrap Management

The following are the main reasons for accumulation of obsolete surplus and scrap items.

- Change in product design
- Faulty planning, over estimation of demand
- Faulty purchase procedur

We can avoid these by using following methods.

- Periodically, items can be classified into moving and non-moving items.
- If there is a change in design, then corresponding details must be circulated among concerned departments.

ABC Analysis (Refer Class-work problem)

ABC analysis is one such technique which classifies items into A, B and C class items.

- 10% of items account for 70% of annual consumption value of items.

- 20% of items account for 20% of annual consumption value of items.
- 70% of items account for 10% of annual consumption value of items.

XYZ Analysis

- X class items represent 70% of the total stock value but only account for 10% number-wise.
- Y class items represent 20% of the total stock value but only account for 20% number-wise.
- Z class items represent 10% of the total stock value but only account for 70% number-wise.

VED Analysis

VED analysis attempts to classify the items used into three broad categories.

- Vital: vital category items are those without which the production activities would come to a halt.
- Essential: essential items are those items whose stock-out cost is very high for the company.
- Desirable: desirable items are those whose stock-out causes only minor disturbance in the production schedule.

FSN Analysis

In FSN analysis, items are classified according to their rate of consumptions. Items are broadly classified into three categories.

- F – Fast moving items
- S – Slow moving items
- N – Non-moving items

SDE Analysis

It attempts to classify items on the basis of its availability in the market.

- **Scares**: these are generally short in supply or channelized through government agencies
- **Difficult:** these items are available but are difficult to procure
- **Easy:** these items are easily and readily available

Computer Aided Techniques in POM

Computer-aided design (CAD): It involves creating computer models defined by geometrical parameters. These models typically appear on a computer monitor as a three-dimensional representation of a part or a system of parts, which can be readily altered by changing relevant parameters. CAD systems enable designers to view objects under a wide variety of representations and to test these objects by simulating real-world conditions.

Computer-aided manufacturing (CAM): It uses geometrical design data to control automated machinery. CAM systems are associated with computer numerical control (CNC) or direct numerical control (DNC) systems. These systems differ from older forms of numerical control (NC) in that geometrical data are encoded mechanically. Since both CAD and CAM use computer-based methods for encoding geometrical data, it is possible for the processes of design and manufacture to be highly integrated. Computer-aided design and manufacturing systems are commonly referred to as CAD/CAM.